ANFACO-CECOPESCA

# PART 1: UPDATING OF ANALYTICAL DATA FOR THE NUTRITIONAL LABELLING OF TRADITIONAL CLIPFISH, SALTFISH & STOCKFISH.

FHF PROJECT 901307

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# 1. SAMPLING.

## 1.1. RECEPTION & LABORATORY CHECK-IN.

Coordinated by FHF and ANFACO-CECOPESCA, sampling consisted in planning, gathering of fish products from several Norwegian producers, and shipment to ANFACO-CECOPESCA´s laboratories in Vigo (Spain).

Two shipments were carried out. Clipfish materials (140 kg, aprox.) were expedited to Spain at the beginning of March 2017. The second shipment (35 Kg. aprox.), containing stockfish cod (ST), lutefish (LU), dried cod heads (TH) and rehydrated stockfish cod (RS) samples took place at the end of March 2017. Materials were properly received and stored either in freezing (-21°c) or chilling (2-3°c) conditions until analysis.

Clipfish materials from 4 fish species were supplied by four Norwegian producers). Dried, rehydrated and lutefisk cod materials were gathered from three Norwegian companies. Different production batches from each producer were required. Dried salted cod (7/8) was divided in two different sets (A & B) that correspond to two different quality requirements from importing countries where the fish is intended to be exported to.

Sampling was completed with an extra shipment carried out in June-July 2018, and consisting in five individuals of four species of stockfish (ling *(Molva molva)*, saithe *(Pollachius virens)*, haddock *(Melanogrammus aeglefinus)*, and tusk *(Brosme brosme)*.

The received materials were made laboratory samples and assigned an internal code for analysis, distributing materials and providers to maximize representation of the expected results.

*Fig. 1: Sample check - in at ANFACO-CECOPESCA´s pilot plant.*

| | | | Shipped | Samples for analysis |
|---|---|---|---|---|
| **Cod** *(Gadus morhua)* | Wet-salted cod | 3 suppliers. | 12 individuals | 10 |
| | Dried-salted (7/8- type B) | 3 suppliers. | 10 individuals | 10 |
| | Dried-salted (7/8- type B) | 3 suppliers. | 12 individuals | 9 |
| **Ling** *(Molva molva)* | Dried-salted (7/8) | 3 suppliers. | 12 individuals | 10 |
| **Tusk** *(Brosme brosme)* | Dried-salted (7/8) | 3 suppliers. | 12 individuals | 10 |
| **Saithe** *(Pollachius virens)* | Dried-salted (7/8) | 3 suppliers. | 20 individuals | 12 |

| | | | | |
|---|---|---|---|---|
| **Cod** *(Gadus morhua)* | Dried cod heads | 2 suppliers. | 10 heads | 5 |
| | Stockfish cod | 2 suppliers. | 10 individuals | 8 |
| | Rehydrated stockfish | 3 suppliers. | 12 fillets | 9 |
| | Lutefisk | 2 suppliers. | 10 fillets | 8 |

| | | | | |
|---|---|---|---|---|
| **Haddock** *(Melanogrammus aeglefinus)* | Stockfish haddock | 1 supplier | 5 | 5 |
| **Ling** *(Molva molva)* | Stockfish ling | 1 supplier | 5 | 5 |
| **Tusk** *(Brosme brosme)* | Stockfish tusk | 1 supplier | 5 | 5 |
| **Saithe** *(Pollachius virens)* | Stockfish saithe | 1 supplier | 5 | 5 |

| | Nutrit. Basic + (Na,K,P), + fatty acids | Ca, Mg, Zn | aW | Se |
|---|---|---|---|---|
| **Dried Cod heads.** | 5 | 1 | 2 | - |
| **Stockfish cod** | 8 | 2 | 4 | 1 |
| **Rehydrated stockfish** | 9 | 3 | 1 | - |
| **Lutefisk** | 8 | 2 | 1 | 1 |
| **Total analysis** | 30 | 8 | 8 | 2 |

| | Nutrit. Basic + (Na,K,P), + fatty acids | Sugars |
|---|---|---|
| **Stockfish haddock** | 5 | 5 |
| **Stockfish ling** | 5 | 5 |
| **Stockfish saithe** | 5 | 5 |
| **Stockfish tusk** | 5 | 5 |
| **Total analysis** | 20 | 20 |

| | Nutrit. Basic + (Na,K,P), + fatty acids | Ca, Mg, Zn | aW |
|---|---|---|---|
| **Wetsalted cod** | 10 | 3 | 3 |
| **Driedsalted cod 7/8 type A** | 10 | 3 | 3 |
| **Dried salted cod 7/8 type B** | 9 | 3 | 3 |
| **Dried salted tusk 7/8** | 9 | 3 | 3 |
| **Dried salted ling 7/8** | 10 | 3 | 3 |
| **Dried salted saithe 7/8** | 12 | 5 | 5 |
| **Total *analysis*** | 61 | 20 | 20 |

*Table1:Distribution of the samples and analysis.*

### 1.2. PREPARATION OF THE SAMPLES FOR ANALYSIS.

The samples were processed according to general homogenization protocols and guidelines. Frozen materials were defrosted and minced to a homogeneous paste. The dried cod heads were very difficult to homogenize with standard laboratory materials. Therefore, heads were cut in small pieces making use of an industrial saw. The released powder was collected and further manual and mechanical milling was carried out. For the case of stockfish and making use of a sharp knife, slices of skin and muscle were cut followed by milling.

For the preparation of the heavy-salted samples, the protocol described in the Portuguese regulation (*Decreto- Lei 25/2005*) was implemented, where; after mechanical elimination of the surface salt excess, transversal sections in its length were selected and homogenized to get the analytical sample.

*Fig.2: Left: Cod heads sawing / Right: Preparation of analytical samples of clipfish under Decreto- Lei 25/2005.*

Dried fish was cut by using an industrial saw (Figure 2) allowing the selection of the edible part of the fish (muscle). Once at laboratories samples were prepared using standard protocols and submitted to analysis.

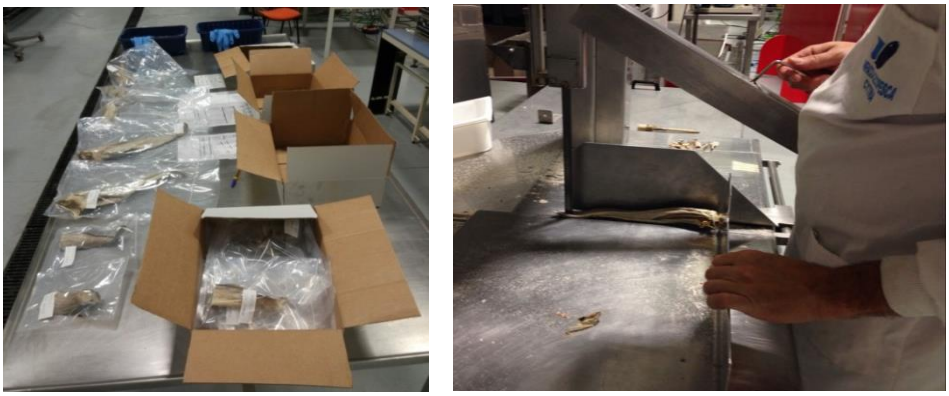

*Fig. 3: Sample check - in at ANFACO-CECOPESCA´s pilot plant.*

## 2. METHODS.

Analysis of the **moisture, fat, and ashes** content was developed following under gravimetric procedures meanwhile **protein** was obtained after sample mineralization, Kjeldahl distillation and acid / base volumetric titration. Fatty acid profiling was assessed using a standardized gas chromatography method. The energy and carbohydrates content were calculated. All these methods are certified by the Spanish Accreditation body (ENAC). **Water activity** was determined by using the Aqualab 4TE instrument. The technique used for mineral analysis was ICP-OES (Varian Vista MPX) with a preliminar acid mineralization of the samples in pressurized vessels in a microwave oven. Analyzed minerals were Na, K, Ca, Mg, Zn, and P. The levels of Na will be used as the key to salt (NaCl) content making use of the Na:Cl factor. Selenium levels were determined by ICP-MS.


*Fig. 4: Detail of analytical instrumental used for analysis at ANFACO-CECOPESCA.*

# 3. NUTRITIONAL RESULTS.

## 3.1. DRIED COD HEADS.

The mean results of the nutritional analysis in 5 replicates of cod heads are displayed in table below. It should be underlined that according to Annex V of the regulation EU 1169/2011, the inclusion of the nutritional information is not mandatory in this product.

| | **Mean (n=5)** |
|---|---|
| *Humidity (%)* | 16,5 ± 2,4 |
| *Fat (%)* | 2,7 ± 1,8 |
| *Protein (%)* | 46,9 ± 2,9 |
| *Ash (%)* | 33,1 ± 3,1 |
| *Carbohydrates (%)* | 0,7 ± 0,2 |
| *Energy (kJ / 100 g)* | 912 ± 108 |
| *Energy (kcal / 100 g)* | 215 ± 26 |
| *Fat Energy (kJ / 100 g)* | 102 ± 66 |
| *Fat Energy (kcal / 100 g)* | 25 ± 16 |
| *Salt (g NaCl / 100g)* | 3,53 ± 0,20 |

*Considering this is a dried product, it contains low fat, a very high content of protein and specially ash.* High variation was found in fat results (min: 1,2%/ max: 5,5%) of the 5 replicates. Replicate 5 could be considered as an outlier since humidity (12,5%) and fat results are remarkably different to the others. If we remove this replicate we get mean values of: *Humidity: 17,5 ± 1,1 % , Fat: 2,1 ±1,0 % and Fat energy: 18,7 ± 9,3 Kcal/100g.* This high variation could be attributed in part to the fact that it has not been possible to fully turn cod heads to fine powder (representative and homogeneous analytical sample).

*Table 2: Nutrition results of dried cod heads.*

As expected, around 75% of the **mineral** content in the samples was due to calcium phosphate present in fish bone and cartilage, so this material could be interesting as a dietary source of these elements for the preparation of food supplements (capsules, powder, ….). The rest of the elements analyzed, also have relevant concentration levels which complement phosphorus and calcium. All these elements could be included in the nutritional label.

| | **Minerals Mean (mg/100g)** |
|---|---|
| *Potassium (n=5)* | 418 ± 41 |
| *Phosphorus (n=5)* | 4378 ± 762 |
| *Calcium (n=1)* | 11222 |
| *Magnesium (n=1)* | 307 |
| *Zinc (n=1)* | 10,0 |

*Table 3 Mineral results of dried cod heads.*

Complementary to humidity values, the **water activity** was determined in two of the replicates obtaining 0,649 and 0,657 values.

The mean **fatty acid profile** is displayed in fig.5. The more predominant fatty acids present correspond to monounsaturated oleic acid, saturated palmitic and stearic acids, and ω-6 linoleic acid. EPA, DHA and linolenic ω-3 fatty acids cannot be considered as quantitatively important. One of the replicates showed trans-fatty acid values (0,29g/100g) to the contrary of the nearly undetectable values of the other replicates. It should be reminded that Brazilian and US labelling regulation requires the inclusion of trans-fatty acid values in the food nutritional label. In any case, this trans- fatty acid levels would be included in label either as " < 0,5 g/100g" or "0g/100g".

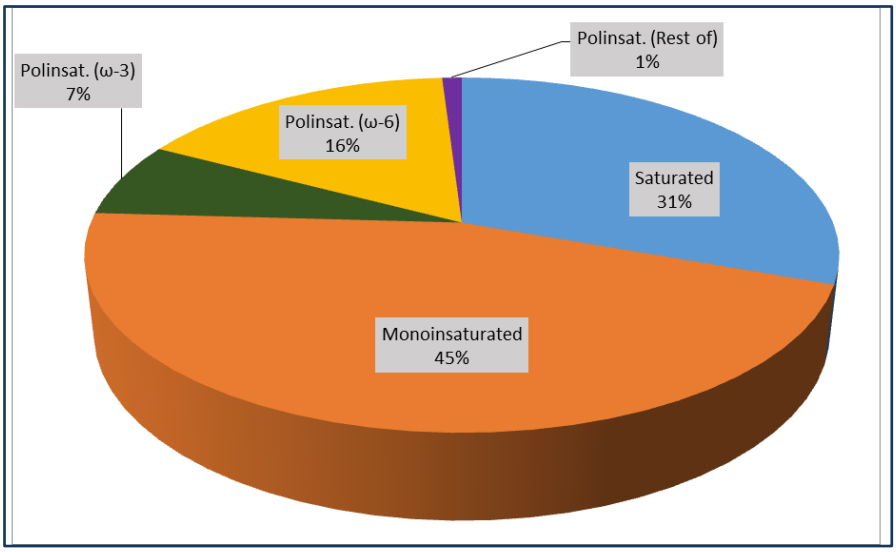


*Fig.5: Mean fatty acid profile of dried cod heads.*

### 3.2. STOCKFISH COD

The mean nutritional values of the eight analyzed samples of dried cod supplied by two different companies are shown in table 4 below. Again, attending to EU regulation this product is exempt of the mandatory inclusion of nutritional information. Humidity borders 20%, approximately 3% points higher than dried cod heads. Significant differences were detected between supplying companies. Since in this case, no bone was included in the analytical sample, the levels of ashes, phosphorus and calcium become reduced (5,8 %), compared to the previous very high levels of cod heads, and thus very high protein levels (72,6%) were found. The mean salt (NaCl) content remains below 1%.

| | **Mean (n=8)** |
|---|---|
| *Humidity (%)* | 19,8 ± 1,4 |
| *Fat (%)* | 1,5 ± 0,9 |
| *Protein (%)* | 72,6 ± 2,3 |
| *Ash (%)* | 5,8 ± 1,9 |
| *Carbohydrates (%)* | 0,4 ± 0,3 |
| *Energy (kJ / 100 g)* | 1294 ± 49 |
| *Energy (kcal / 100 g)* | 305 ± 12 |
| *Salt (g NaCl / 100g)* | 0,88 ± 0,25 |

| *Potassium (mg/100g) (n=8)* | *Phosphorus (mg/100g) (n=8)* | *Calcium (mg/100 g) (n=2)* | *Magnesium (mg/100g) (n=2)* | *Zinc (mg/100g) (n=2)* |
|---|---|---|---|---|
| 1034 ± 169 | 971 ± 297 | 121,6 | <80 | <4,0 |
| | | 794,8 | 126,8 | <4,0 |

*Table 4: Nutritional and mineral results of stockfish cod.*

Phosphorus and potassium levels were high in this dried cod, but we should take into account the weigh and dilution effect when rehydrated for consumption. The two calcium results showed high variation to be interpreted.

The **water activity** is consistent to the previous humidity and salt levels and also higher than dried cod heads (0,790 ± 0.021 (n=4)).

The fatty acid profile closely matches the cod head fat profile. The main difference is a reduction in the presence of monounsaturated (oleic acid) in favor of ω-6 polyunsaturated fatty acids.

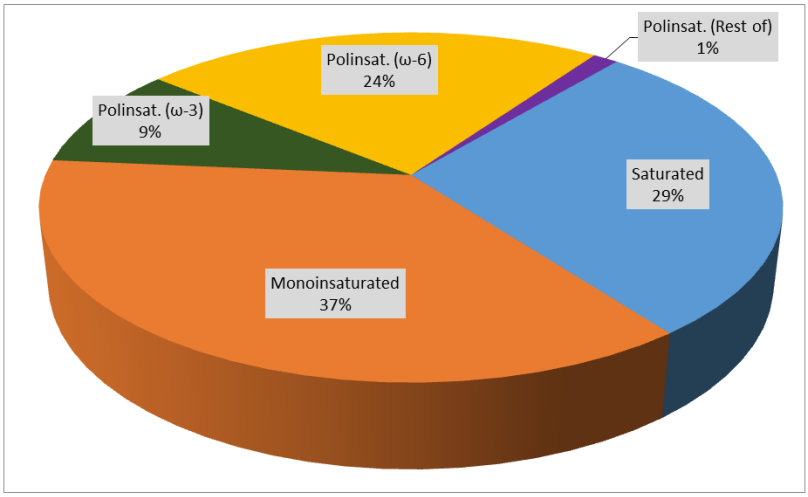


*Fig.6: Mean fatty acid profile of stockfish cod.*

### 3.3. STOCKFISH (SAITHE, LING, TUSK, HADDOCK).

The mean humidity values in dried fish samples rounds 20% with a slightly higher result in tusk. These data inversely correlate to protein with approximately 72% content. As expected low fat levels were found in all products with a maximum mean value in saithe 1,33 g/100g. Ashes vary between 5,4% – 8,2% with salt (sodium chloride) more present in tusk and ling than in haddock and saithe. The overall carbohydrates levels are merely anecdotal, and therefore individual sugars (galactose, glucose, fructose, lactose, maltose) remain below 0,5 g/100g in all samples.

| *STOCKFISH HADDOCK* | **Mean (n=5)** |
|---|---|
| *Humidity (%)* | 19,7 ± 1,0 |
| *Fat (%)* | 0,92 ± 0,20 |
| *Protein (%)* | 72,2 ± 3,5 |
| *Ash (%)* | 6,6 ± 2,5 |
| *Carbohidrates (%)* | 0,5 ± 0,3 |
| *Energy (Kj / 100 g)* | 1270 ± 52 |
| *Energy (Kcal / 100 g)* | 299 ± 12 |
| *Salt (g NaCl / 100g)* | 1,63 ± 0,50 |

| **Nutritional information** | **Stockfish Haddock** | |
|---|---|---|
| | **Per 100g** | |
| **Energy** | **1270 KJ** | **299 kcal** |
| **Fat** | **0,9** | **g** |
| of which | | |
| **saturates** | **0,3** | **g** |
| **monounsatured** | **0,2** | **g** |
| **polyunsaturated** | **0,3** | **g** |
| **Carbohydrates** | **<0,5** | **g** |
| of which | | |
| **sugars** | **<0,5** | **g** |
| **Protein** | **72** | **g** |
| **Salt** | **1,6** | **g** |

| Nutritional information | Stockfish Ling | |
|---|---|---|
| | Per 100g | |
| **Energy** | **1269** | **299 kcal** |
| **Fat** | **0,7** | **g** |
| of which | | |
| **saturates** | **0,3** | **g** |
| **monounsatured** | **0,3** | **g** |
| **polyunsaturated** | **0,1** | **g** |
| **Carbohydrates** | **<0,5** | **g** |
| of which | | |
| **sugars** | **<0,5** | **g** |
| **Protein** | **73** | **g** |
| **Salt** | **3,4** | **g** |

| *STOCKFISH LING* | **Mean (n=5)** |
|---|---|
| *Humidity (%)* | 20,0 ± 2,3 |
| *Fat (%)* | 0,74 ± 0,29 |
| *Protein (%)* | 72,6 ± 3,6 |
| *Ash (%)* | 6,2 ± 1,7 |
| *Carbohidrates (%)* | 0,4 ± 0,2 |
| *Energy (Kj / 100 g)* | 1269 ± 68 |
| *Energy (Kcal / 100 g)* | 299 ± 16 |
| *Salt (g NaCl / 100g)* | 3,42 ± 1,66 |

| *STOCKFISH SAITHE* | **Mean (n=5)** |
|---|---|
| *Humidity (%)* | 20,1 ± 1,3 |
| *Fat (%)* | 1,33 ± 0,44 |
| *Protein (%)* | 72,6 ± 1,5 |
| *Ash (%)* | 5,4 ± 0,4 |
| *Carbohidrates (%)* | 0,6 ± 0,2 |
| *Energy (Kj / 100 g)* | 1293 ± 30 |
| *Energy (Kcal / 100 g)* | 305 ± 7 |
| *Salt (g NaCl / 100g)* | 1,28 ± 0,48 |

| Nutritional information | Stockfish Saithe | |
|---|---|---|
| | Per 100g | |
| **Energy** | **1293 KJ** | **305 kcal** |
| **Fat** | **1,3** | **g** |
| of which | | |
| **saturates** | **0,9** | **g** |
| **monounsatured** | **0,3** | **g** |
| **polyunsaturated** | **0,1** | **g** |
| **Carbohydrates** | **<0,5** | **g** |
| of which | | |
| **sugars** | **<0,5** | **g** |
| **Protein** | **73** | **g** |
| **Salt** | **1,3** | **g** |

| Nutritional information | Stockfish Tusk | |
|---|---|---|
| | Per 100g | |
| **Energy** | **1180 KJ** | **272 kcal** |
| **Fat** | **0,8** | **g** |
| of which | | |
| **saturates** | **0,4** | **g** |
| **monounsatured** | **0,3** | **g** |
| **polyunsaturated** | **0,1** | **g** |
| **Carbohydrates** | **<0,5** | **g** |
| of which | | |
| **sugars** | **<0,5** | **g** |
| **Protein** | **67** | **g** |
| **Salt** | **4,6** | **g** |

| *STOCKFISH TUSK* | **Mean (n=5)** |
|---|---|
| *Humidity (%)* | 23,3 ±1,6 |
| *Fat (%)* | 0,77 ± 0,33 |
| *Protein (%)* | 67,0 ± 2,3 |
| *Ash (%)* | 8,2 ± 1,2 |
| *Carbohidrates (%)* | 0,7 ± 0,1 |
| *Energy (Kj / 100 g)* | 1180 ± 50 |
| *Energy (Kcal / 100 g)* | 272 ± 22 |
| *Salt (g NaCl / 100g)* | 4,57 ± 0,75 |

*Table 5: Nutritional results and regular labels in stockfish (haddock, saithe, ling & tusk).*

As occurred to sodium (salt), phosphorus and potassium levels are similar between haddock and saithe on one side, and ling and tusk to the other. As it can be seen in table below, a four-fold difference for potassium and two-fold for phosphorus was found.

| | Potassium (g/100g) (n=5) | Phosphorus (g/100g) (n=5) |
|---|---|---|
| STOCKFISH HADDOCK | 1,16 ± 0,07 | 0,70 ± 0,29 |
| STOCKFISH LING | 0,20 ± 0,16 | 0,32 ± 0,15 |
| STOCKFISH SAITHE | 1,27 ± 0,08 | 0,69 ± 0,15 |
| STOCKFISH TUSK | 0,34 ± 0,10 | 0,32 ± 0,15 |

*Table 8: Potassium and phosphorus levels in stockfish (haddock, saithe, ling & tusk).*

The fatty acid profile in this low fat material leans towards a higher saturated fat content. This is more prominent for the case of saithe; meanwhile the polyunsaturated fatty acids are proportionally more present in haddock. Nevertheless, the analysis of the fatty acids revealed high disparity between replicates. Resulted profiles seem affected by the fat degradation during drying and storage leading to unusual fatty acid profiles in some of the replicates, and thus affecting mean values and more dramatically the composition of the polyunsaturated fraction. Where fat degradation took place, tricosanoic acid (C23:0) and palmitic acid (C16:0) became of a bigger importance.

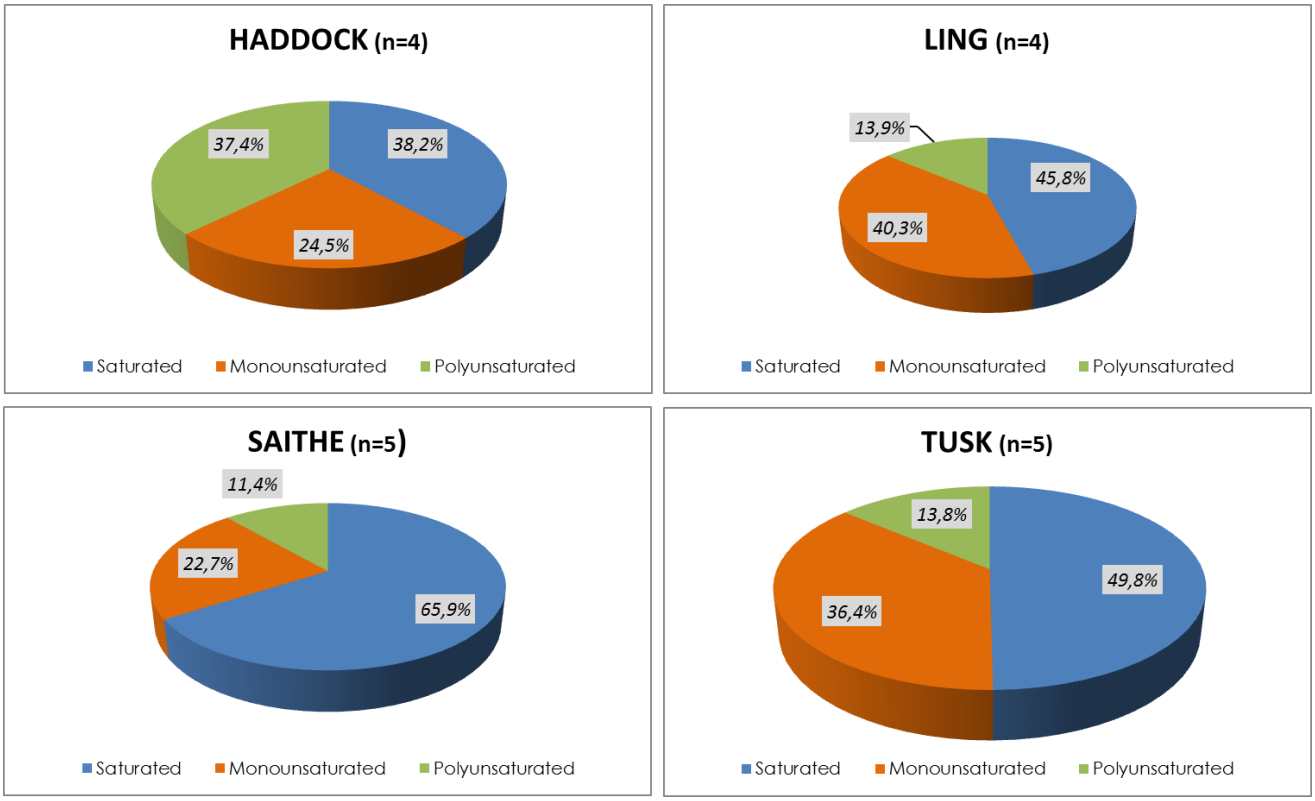


*Fig.7: Mean fatty acid profile of stockfish (haddock, saithe, ling & tusk).*

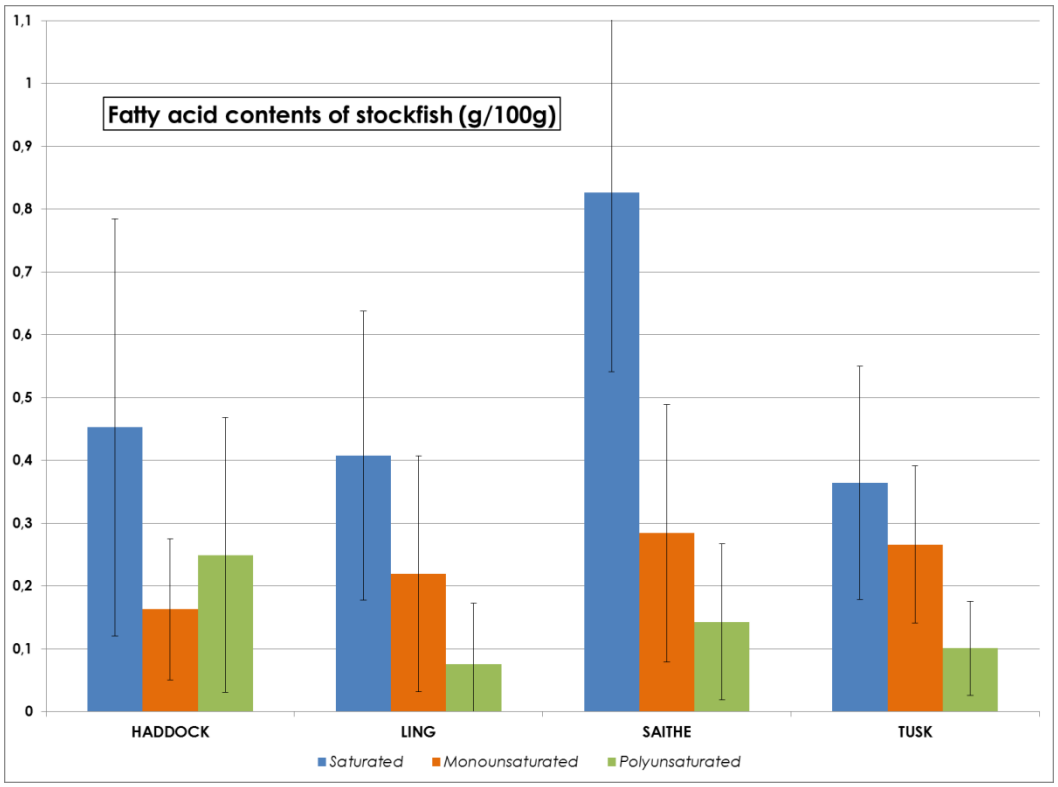


*Fig.8: Fatty acid group contents (g/100g) of stockfish (haddock, saithe, ling & tusk).*

### 3.4. REHYDRATED STOCKFISH COD.

The 9 samples results received from three different suppliers are shown in Table 9 below. As well as stockfish, it is not mandatory to include the nutritional information in the label whenever there is only one ingredient (rehydrating water is not an ingredient). If any additive is used, then the inclusion of the nutritional information becomes mandatory.

| | Mean (n=9) |
|---|---|
| *Humidity (%)* | 79,9 ± 1,8 |
| *Fat (%)* | 0,04 ± 0,02 |
| *Protein (%)* | 19,1 ± 1,6 |
| *Ash (%)* | 0,32 ± 0,13 |
| *Carbohydrates (%)* | 0,15 ± 0,14 |
| *Energy (kJ / 100 g)* | 339 ± 34 |
| *Energy (kcal / 100 g)* | 79 ± 8 |
| *Fat Energy (KJ / 100 g)* | <37 |
| *Fat Energy (kcal / 100 g)* | <9 |
| *Salt (g NaCl / 100g)* | 0,09 ± 0,01 |

| **Nutritional information** | **Rehydrated Stockfish Cod.** | |
|---|---|---|
| | **Per 100g** | |
| **Energy** | **1294 KJ** | **305 kcal** |
| **Fat** | **<0,5** | **g** |
| of which | | |
| **saturates** | **<0,1** | **g** |
| **monounsatured** | **<0,1** | **g** |
| **poyunsaturated** | **<0,1** | **g** |
| **Carbohydrates** | **<0,5** | **g** |
| of which | | |
| **sugars** | **<0,5** | **g** |
| **Protein** | **19** | **g** |
| **Salt** | **0,09** | **g** |

*Table 9: Mean nutritional and potential label of rehydrated stockfish cod.*

With around 80% humidity content, the product can be considered as *high protein* and *no fat*. One of the nine replicates was clearly an outlier since it showed 1,23% fat content, so it was withdrawn from

calculation of the mean fat. We should be careful with this because some species may vary their nutritional status through the year with fat as the most varying parameter. Maybe this fish corresponds to a different time of the year or contains some kind of variance that should have been included into sampling.

Rehydrated stockfish is ideal for weigh reduction diets due to its low energy support. In addition, it can be considered as *low salt* and almost *very low salt*. The water activity (n=1) was very high (0,992). Since fat levels are extremely low, the fatty acid profile, nearly the same data as previous stockfish, is of no importance.

As it has been introduced before, the rehydration leads to a very prominent loss of minerals, specially phosphorus and potassium. None of the elements analyzed show significant values which could motivate any nutritional claim in labelling.

| *Potassium (mg/100g) (n=9)* | *Phosphorus (mg/100g) (n=9)* | *Calcium (mg/100g) (n=6)* | *Magnesium (mg/100g) (n=6)* | *Zinc (mg/100g) (n=6)* |
|---|---|---|---|---|
| 54 ± 18 | 40 ± 13 | 35 ±35 | 19 ± 5 | <0,80 |

*Table 10: Mean mineral results in rehydrated stockfish.*

The calcium values, again, lead to very varying results, meanwhile zinc levels remain below the quantification limit in nearly all the replicates analyzed. One of the replicates was selected for the determination of selenium showing 17,8 µg/100g which represent *high selenium* as determined from legislation, so not only nutritional claims but any of the six selenium health claims could be used from Reg. UE 432/2012 (positive list of permitted health claims).

### 3.5. LUTEFISK.

Eight replicates of lutefisk were analyzed for basic nutritional analysis. Mean results are shown in table 10 below.

| | **Mean (n=8)** |
|---|---|
| *Humidity (%)* | 94,3 ± 0,8 |
| *Fat (%)* | 0,04 ± 0,04 |
| *Protein (%)* | 5,1 ± 0,8 |
| *Ash (%)* | 0,4 ± 0,3 |
| *Carbohydrates (%)* | 0,2 ± 0,2 |
| *Energy (kJ / 100 g)* | <160 |
| *Energy (kcal / 100 g)* | <40 |
| *Fat Energy (KJ / 100 g)* | <37 |
| *Fat Energy (kcal / 100 g)* | <9 |
| *Salt (g NaCl / 100g)* | 0,24 ± 0,07 |

| **Nutritional information** | **Lutefisk** |
|---|---|
| | **Per 100g** |
| **Energy** | **91 kJ 21 kcal** |
| **Fat** | **<0,5 g** |
| of which | |
| **saturates** | **<0,1 g** |
| **monounsatured** | **<0,1 g** |
| **poyunsaturated** | **<0,1 g** |
| **Carbohydrates** | **<0,5 g** |
| of which | |
| **sugars** | **<0,5 g** |
| **Protein** | **5,1 g** |
| **Salt** | **0,24 g** |

*Table 11: Mean nutritional results and proposed label of lutefisk samples.*

Lutefisk composition could be defined as very high water, leading to a little proportion of other nutritional elements like fat, which, as the case of rehydrated stockfish, remains at levels of **no fat** claiming. With only a 5% protein content, the obtained energy value remains at levels that EU food

legislation describes as low energy. **Water activity** was 0,996. The salt content is significantly higher than in stockfish. It should be reminded that NaCl content has been calculated assuming that all the existing sodium in the product corresponds to NaCl salt. The measurement of sodium is also the element considered in legislation to best interpret salt content. Nevertheless, in this case, and since the product has been treated with NaOH, we are not under this assumption. Different values could probably be obtained if the classic chloride method would have been applied for the determination of salt content.

| *Potassium (mg/100g) (n=8)* | *P hosphorus (mg/100g) (n=8)* | *Calcium (mg/100g) (n=2)* | *Magnesium (mg/100g) (n=2)* | *Zinc (mg/100g) (n=2)* |
|---|---|---|---|---|
| <30 | <40 | 20,9 | <30 | <1,3 |
| | | 73,6 | | |

*Table 12: Mean nutritional and mineral results of lutefisk samples.*

Potassium, phosphorus, magnesium and zinc levels are very low (below quantification limit in all the replicates analyzed). Calcium ad selenium contents (4,1 µg/100g) are low and do not undergo the chance to make any nutritional or health claim. The fatty acid composition lacks importance since fat is extremely low in this food commodity.

### 3.6. WET SALTED COD.

Ten replicates from three different producers of have been analyzed. Results are displayed in table 13 below. The **humidity** content is relatively high but within range of reference values for saltfish in Norm *Produksjon av saltfisk og klippfisk (Norsk Bransejenorm for fisk)* which defines saltfish as 55-58% content. This high humidity affects the salt content that remains at 18,0%, which is the minimum level admitted for fullsaltet fisk (*Standard Saltfisk-og klippfiskprodukter. Norsk Bransjestandard for fisk*). No significant differences have been found between producers.

| | **Mean (n=10)** |
|---|---|
| *Humidity (%)* | 57,8 ± 1,6 |
| *Fat (%)* | 0,15 ± 0,09 |
| *Protein (%)* | 21,5 ± 1,3 |
| *Ash (%)* | 20,1 ± 1,2 |
| *Carbohydrates (%)* | 0,46 ± 0,35 |
| *Energy (Kj / 100 g)* | 378 ± 20 |
| *Energy (Kcal / 100 g)* | 89 ± 5 |
| *Fat Energy (Kj / 100 g)* | < 37 |
| *Fat Energy (Kcal / 100 g)* | < 9 |
| *Salt (g NaCl / 100g)* | 18,0 ± 1,2 |

| **Nutritional information** | **Wet salted cod** | |
|---|---|---|
| | **Per 100g** | |
| **Energy** | **378 kJ** | **89 kcal** |
| **Fat** | **<0,5** | **g** |
| of which | | |
| **saturates** | **<0,1** | **g** |
| **monounsatured** | **<0,1** | **g** |
| **poyunsaturated** | **<0,1** | **g** |
| **Carbohydrates** | **<0,5** | **g** |
| of which | | |
| **sugars** | **<0,5** | **g** |
| **Protein** | **22** | **g** |
| **Salt** | **18,0** | **g** |

*Table 13: Mean nutritional results and proposed label for wet salted cod samples.*

The **fat** content has been very low in all samples, with replicates in the range of 0.08 – 0.37 g/100g. The **water activity** is very stable in the samples analyzed with a mean value of 0.756 ± 0.004 (n=3). Higher humidity but also higher salt content leads to water activity values lower than stockfish.

Attending to **mineral contents** (*table 14*) the obtained mean values seem to be typical of these products: It should be appointed that potassium and phosphorus could be affected by the use or not of phosphates additives, but as it has been reported in several studies, these does not lead to a remarked difference in final levels when desalted.

| | *Potassium (n=6)* | *P hosphorus (n=6)* | *Calcium (n=3)* | *Magnesium (n=3)* | *Zinc (n=3)* |
|---|---|---|---|---|---|
| **Minerals Mean (mg/100g)** | 238 ± 65 | 133 ± 45 | 28 ± 14 | 39 ± 5 | <0,8 |

*Table 14: Mean mineral results of wet-salted cod samples.*

Making use of the previous FHF project (number 900592) dataset, that also involved collection and analysis of wet salted cod, we can see that calculated mean results for calcium, magnesium and zinc are similar to the ones obtained in this study.

| | *Calcium (n=60)* | *Magnesium (n=60)* | *Zinc (n=55)* |
|---|---|---|---|
| **Minerals Mean (mg/100g)** | 37 ± 25 | 36 ± 9 | 0,42 ± 0,10 |

*Table 15: Ca, Mg, and Zn contents from a larger dataset of the FHF project 900592 from ANFACO-CECOPESCA.*

It can be seen that in both cases, the levels of calcium exceed the reference range for saltfish in Norm *Produksjon av saltfisk og klippfisk (Norsk Bransejenorm for fisk)* which seems to be rather short (15-20 mg/100g) if we consider high natural variance and analytical uncertainty.
The fat content is so low that has no nutritional interest taking into account that any nutritional claim should be based in the results from the product as it is consumed (desalted).

### 3.7. DRIED SALTED COD (7/8 – TYPE B).

A total of ten samples from three different producers were analyzed. Results are displayed in table 16 below. No significant differences have been found in humidity values between supplying companies.
The mean **water activity** in the samples analyzed was 0.751 ± 0.004 (n=3) is slightly lower than wet-salted cod values.

| | Mean (n=9) |
|---|---|
| *Humidity (%)* | 53,2 ± 1,6 |
| *Fat (%)* | 0,14 ± 0,07 |
| *Protein (%)* | 25,6 ± 0,9 |
| *Ash (%)* | 20,6 ± 0,9 |
| *Carbohydrates (%)* | 0,50 ± 0,35 |
| *Energy (Kj / 100 g)* | 448 ± 18 |
| *Energy (Kcal / 100 g)* | 106 ± 4 |
| *Fat Energy (Kj / 100 g)* | < 37 |
| *Fat Energy (Kcal / 100 g)* | < 9 |
| *Salt (g NaCl / 100g)* | 18,7 ± 1,1 |

| **Nutritional information** | **Per 100g** | |
|---|---|---|
| **Energy** | **448 kJ** | **106 kcal** |
| **Fat** | **<0,5** | **g** |
| of which | | |
| **saturates** | **<0,1** | **g** |
| **monounsatured** | **<0,1** | **g** |
| **poyunsaturated** | **<0,1** | **g** |
| **Carbohydrates** | **0,5** | **g** |
| of which | | |
| **sugars** | **<0,5** | **g** |
| **Protein** | **26** | **g** |
| **Salt** | **18,7** | **g** |

*Table 16: Mean nutritional results and proposed label for dried salted cod samples.*

The analyzed **mineral** levels are also similar to previous wet salted values, with the exception of calcium and magnesium which showed higher but also more varying results. The reason for this was the short number of replicates considered and an abnormal sample which showed unexpectedly higher values. If this sample is withdrawn the resulting mean values would be; Ca= 40 ± 8 mg/100g and Mg= 52 ± 7 mg/100g.

| | *Potassium (n=6)* | *Phosphorus (n=6)* | *Calcium (n=3)* | *Magnesium (n=3)* | *Zinc (n=3)* |
|---|---|---|---|---|---|
| **Minerals Mean (mg/100g)** | 218 ± 34 | 114 ± 20 | 72 ± 55 | 68 ± 28 | <0,8 |

*Table 16: Mean mineral results of dried-salted cod samples.*

### 3.8. DRIED SALTED COD (7/8 – TYPE A).

Ten samples from three different producers were analyzed. Results are displayed in table 17 below. The humidity values are bordering the 50%, and this value also represents the humidity threshold in the reference of the *Standard Saltfisk-og klippfiskprodukter. Norsk Bransjestandard for fisk*. As it has been represented below, significant differences have been found in this parameter within each supplier replicates and between suppliers.

| | Mean (n=10) |
|---|---|
| *Humidity (%)* | 50,5 ± 2,0 |
| *Fat (%)* | 0,24 ± 0,13 |
| *Protein (%)* | 28,9 ± 1,1 |
| *Ash (%)* | 20,2 ± 1,7 |
| *Carbohydrates (%)* | 0,50 ± 0,24 |
| *Energy (Kj / 100 g)* | 503 ± 18 |
| *Energy (Kcal / 100 g)* | 119 ± 4 |
| *Fat Energy (Kj / 100 g)* | < 37 |
| *Fat Energy (Kcal / 100 g)* | < 9 |
| *Salt (g NaCl / 100g)* | 18,3 ± 1,8 |

| **Nutritional information** | **Per 100g** | |
|---|---|---|
| **Energy** | **503 kJ** | **119 kcal** |
| **Fat** | **<0,5** | **g** |
| of which | | |
| **saturates** | **<0,1** | **g** |
| **monounsatured** | **0,1** | **g** |
| **poyunsaturated** | **<0,1** | **g** |
| **Carbohydrates** | **0,5** | **g** |
| of which | | |
| **sugars** | **<0,5** | **g** |
| **Protein** | **29** | **g** |
| **Salt** | **18,3** | **g** |

*Table 17: Mean nutritional results and proposed label for dried salted cod 7/8 (type A) samples.*

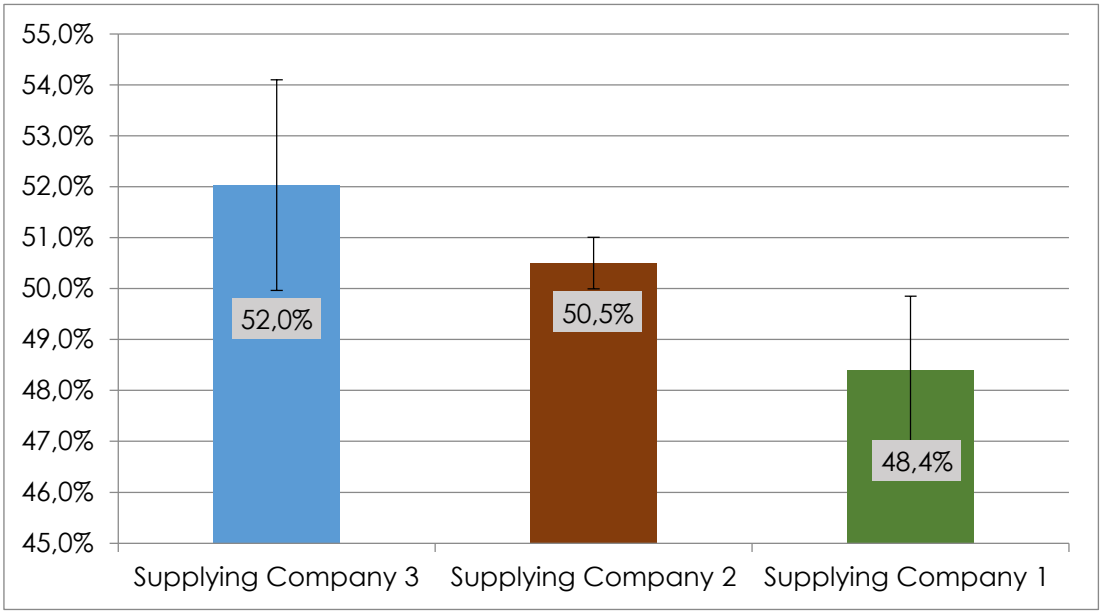


*Fig.9: Humidity variance in dried salted cod 7/8 (type A) products between suppliers.*

The mean **water activity** was 0,749 ± 0.002 very slightly reduced compared to 7/8 dried cod products. The **mineral** results were in the range but slightly higher than of 7/8 dried-salted cod values due to the effect of humidity loss.

| | *Potassium (n=6)* | *Phosphorus (n=6)* | *Calcium (n=3)* | *Magnesium (n=3)* | *Zinc (n=3)* |
|---|---|---|---|---|---|
| **Minerals Mean (mg/100g)** | 304 ± 40 | 139 ± 19 | 41 ± 2 | 61 ± 7 | <0,8 |

*Table 18: Mean mineral results of extra-dried salted cod samples.*

As expected, the fatty acid profile is very similar to reported values of dried unsalted products but with much lower absolute values due to lower total fat content.

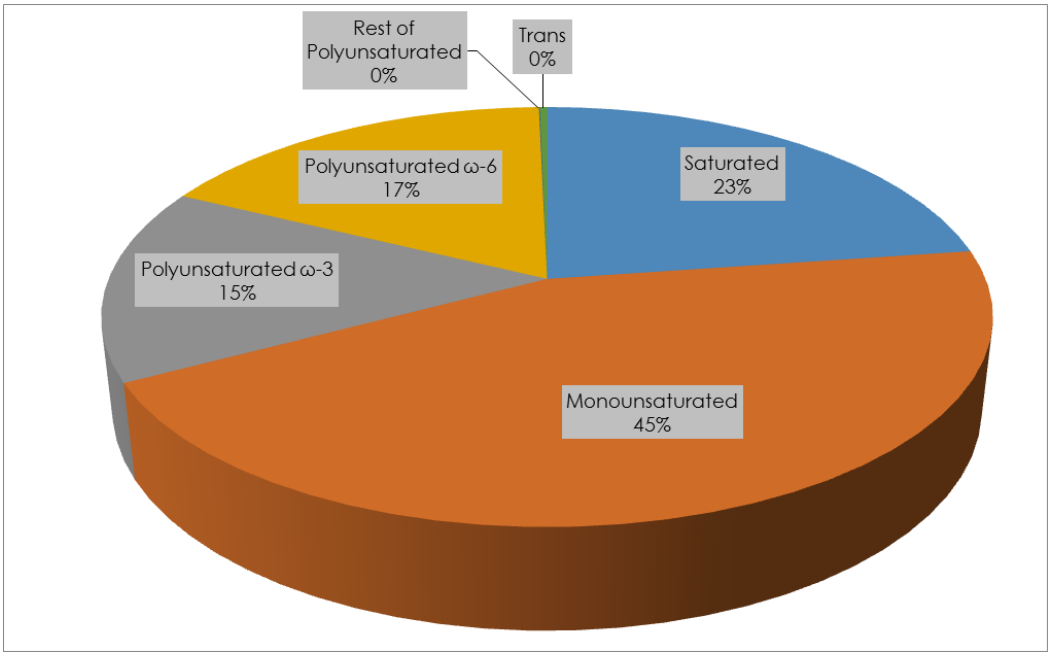


*Fig.10: General Fatty acid profile based on mean values (n=6).*

### 3.9. DRIED SALTED TUSK (7/8).

A total of ten samples from three different producers were analyzed. Results are displayed in table 19 below. The humidity values are lower than dried-salted cod for the same degree of drying probably due to the fact that fish is smaller and the drying process more efficient. Thus, the protein content increases up to 28,5 %. This species also shows very low fat values.

| | Mean (n=10) |
|---|---|
| *Humidity (%)* | 51,5 ± 1,7 |
| *Fat (%)* | 0,18 ± 0,06 |
| *Protein (%)* | 28,5 ± 1,9 |
| *Ash (%)* | 19,2 ± 1,2 |
| *Carbohydrates (%)* | 0,49 ± 0,39 |
| *Energy (kJ / 100 g)* | 504 ± 34 |
| *Energy (kcal / 100 g)* | 119 ± 8 |
| *Fat Energy (kJ / 100 g)* | < 37 |
| *Fat Energy (kcal / 100 g)* | < 9 |
| *Salt (g NaCl / 100g)* | 19,0 ± 1,7 |

| **Nutritional information** | **Per 100g** | |
|---|---|---|
| **Energy** | **504 kJ** | **119 kcal** |
| **Fat** | **<0,5** | **g** |
| of which | | |
| **saturates** | **<0,1** | **g** |
| **monounsatured** | **<0,1** | **g** |
| **poyunsaturated** | **<0,1** | **g** |
| **Carbohydrates** | **<0,5** | **g** |
| of which | | |
| **sugars** | **<0,5** | **g** |
| **Protein** | **29** | **g** |
| **Salt** | **19,0** | **g** |

*Table 19: Mean nutritional results and proposed label for dried salted tusk samples.*

As for the case of 7/8 dried-salted cod, and even though the number of replicates is limited, there are significant differences between humidity values in samples from different producers. Unlike of 7/8 dried salted cod, the differences attend to quality preferences of different countries to which fish is exported.

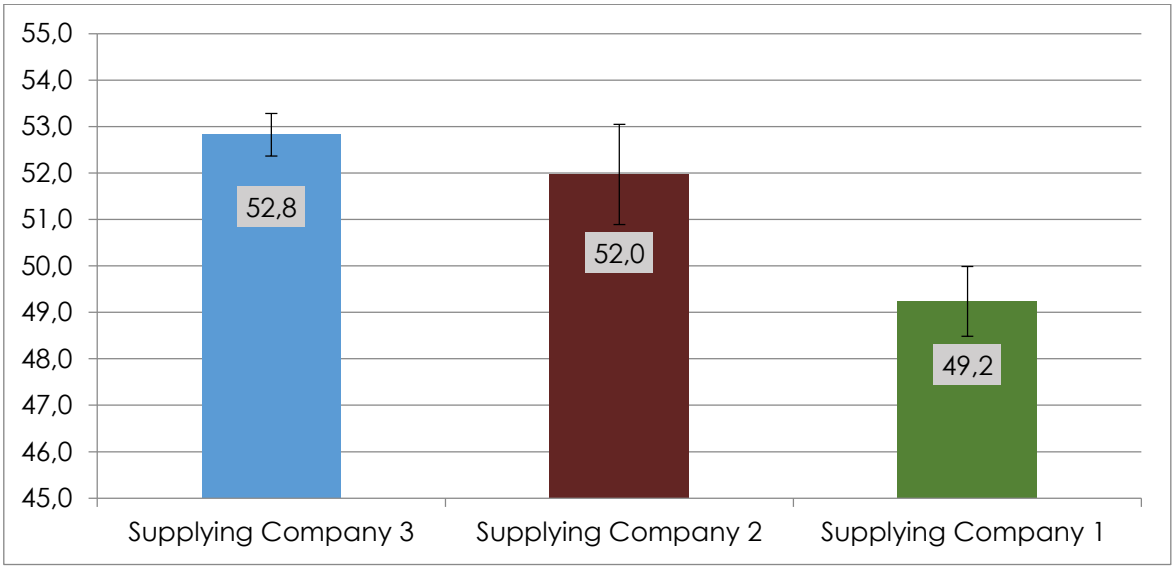


*Fig.11: Humidity variance in dried-salted tusk between suppliers.*

The mean **water activity** of the three replicates analyzed (0,748 ± 0.004) is also lower than dried- salted cod. The rest of the parameters, as well as minerals, are very similar to the previously commented 7/8 dried-salted cod.

| | *Potassium (n=6)* | *Phosphorus (n=6)* | *Calcium (n=2)* | *Magnesium (n=3)* | *Zinc (n=3)* |
|---|---|---|---|---|---|
| **Minerals mean (mg/100g)** | 249 ± 21 | 112 ± 30 | 81 ± 53 | 53 ± 16 | <0,8 |

*Table 20: Mean mineral results of extra-dried salted cod samples.*

### 3.10. DRIED SALTED LING (7/8).

Ten replicates were analyzed for basic nutritional composition. Results are shown in table 21 below.

| | Mean (n=10) |
|---|---|
| *Humidity (%)* | 51,2 ± 1,6 |
| *Fat (%)* | 0,21 ± 0,06 |
| *Protein (%)* | 29,2 ± 2,2 |
| *Ash (%)* | 18,8 ± 1,1 |
| *Carbohydrates (%)* | 0,54± 0,40 |
| *Energy (Kj / 100 g)* | 516 ± 40 |
| *Energy (Kcal / 100 g)* | 122 ± 9 |
| *Fat Energy (Kj / 100 g)* | < 37 |
| *Fat Energy (Kcal / 100 g)* | < 9 |
| *Salt (g NaCl / 100g)* | 17,8 ± 1,4 |

| **Nutritional information** | **Per 100g** | |
|---|---|---|
| **Energy** | **516 kJ** | **122 kcal** |
| **Fat** | **<0,5** | **g** |
| of which | | |
| **saturates** | **<0,1** | **g** |
| **monounsatured** | **<0,1** | **g** |
| **poyunsaturated** | **<0,1** | **g** |
| **Carbohydrates** | **0,5** | **g** |
| of which | | |
| **sugars** | **-** | **g** |
| **Protein** | **29** | **g** |
| **Salt** | **17,8** | **g** |

*Table 21: Mean nutritional results and proposed label for dried salted tusk samples.*

Humidity values are in the same range as similar products. In this case, the mean salt content is lower than previous values, due to an outlier sample with a salt content of 14,9%. If this sample gets withdrawn from calculation the mean result would be 18,1 ± 1,0. Again, the obtained results do not comply with reference data laid down in Norwegian clipfish production norms.
It should be reminded that the level of carbohydrates is estimated as the difference from the other basic components so this result is more uncertain from an analytical point of view. It is not possible to determine the level of free sugars in the sample since the analysis was not included in this project because it was expected very low values.

The **water activity** was 0.751 ± 0.004, exactly the same results as dried-salted cod (7/8). **Mineral** contents in dried- salted ling are show in table below. Calcium results of the three replicates were highly variable (<24 mg/100g, 280 mg/100g, <24 mg/100g), so the mean value was not calculated.

| | *Potassium (n=3)* | *Phosphorus (n=3)* | *Calcium (n=3)* | *Magnesium (n=3)* | *Zinc (n=3)* |
|---|---|---|---|---|---|
| **Minerals Mean (mg/100g)** | 283 ± 62 | 163 ± 69 | - | 56 ± 24 | <0,8 |

*Table 22: Mean mineral results of dried - salted ling.*

### 3.11. DRIED SALTED SAITHE (7/8).

Twelve samples of dried salted saithe were supplied by three different companies. In this case, one of the companies shipped the materials sorted by three different fish sizes (13-15, 16-20, and 21-30). In table 20 below we can see nutritional values for the n= 12 sample set analyzed.

| | Mean (n=12) |
|---|---|
| *Humidity (%)* | 53,6 ± 0,9 |
| *Fat (%)* | 0,51 ± 0,33 |
| *Protein (%)* | 25,9 ± 0,7 |
| *Ash (%)* | 19,3 ± 0,5 |
| *Carbohidrates (%)* | 0,64 ± 0,52 |
| *Energy (Kj / 100 g)* | 472 ± 17 |
| *Energy (Kcal / 100 g)* | 111 ± 4 |
| *Fat Energy (Kj / 100 g)* | < 37 |
| *Fat Energy (Kcal / 100 g)* | < 9 |
| *Salt (g NaCl / 100g)* | 18,6 ± 1,1 |

| **Nutritional information** | **Per 100g** | |
|---|---|---|
| **Energy** | **472 kJ** | **111 kcal** |
| **Fat** | **0,5** | **g** |
| of which | | |
| **saturates** | **0,1** | **g** |
| **monounsatured** | **0,2** | **g** |
| **poyunsaturated** | **0,2** | **g** |
| **Carbohidrates** | **0,6** | **g** |
| of which | | |
| **sugars** | **-** | **g** |
| **Protein** | **26** | **g** |
| **Salt** | **18,6** | **g** |

*Table 23: Mean nutritional results and proposed label for dried salted saithe samples.*

The humidity in this product is slightly higher than in the other white fish species analyzed and very similar to dried-salted cod (7/8). No significant differences were found in the results between size categories. The high variation found in fat was due to the significantly different values of one of the companies, with replicates up to an unusual 1,1% fat content. As the previous case, the levels of sugars should be analyzed and included in the label as far as the carbohydrate mean values are higher than 0,5%.

The water activity (n=5) was 0.751 ± 0.001, the same value as dried-salted ling (7/8) and dried-salted cod (7/8). The minerals also show similarities to the other materials analyzed.

| | *Potassium (n=5)* | *Phosphorus (n=5)* | *Calcium (n=4)* | *Magnesium (n=5)* | *Zinc (n=5)* |
|---|---|---|---|---|---|
| **Minerals Mean (mg/100g)** | 236 ± 39 | 124 ± 17 | 36 ± 6 | 47 ± 11 | <0,8 |

*Table 24: Mean mineral results of dried - salted saithe.*

The fatty acid profile (Fig. 8) is similar to the previous fish species with only slightly higher ω-3 polyunsaturated fatty acids instead monounsaturated (mainly oleic acid).

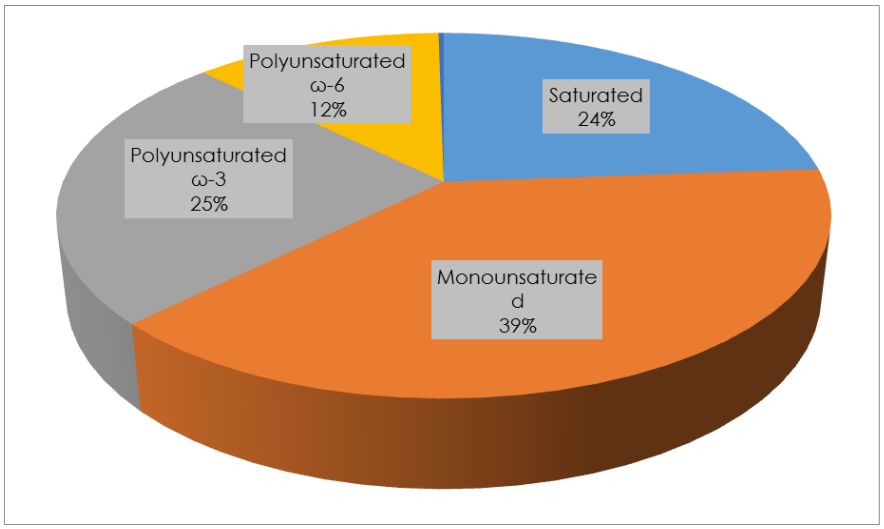


*Fig.12: General Fatty acid profile for saithe, based on mean values (n=12).*

## 4. DISCUSSION AND CONCLUSIONS.

Reg. UE 1169/2011 lays down the objectives, basics and requirements of the food information to consumers. The nutritional labelling of fish becomes mandatory in every product that is intended for the final consumer with some exceptions, like the ones included in Annex V.

Annex V exempts unprocessed products consisting in only one ingredient from the obligatory nature of including nutritional information. This is extended to processed products consisting in only one ingredient were only curing has taken place. Nevertheless, this information could be voluntarily included in the label.

Annex V, therefore, affects dried cod heads, stockfish and rehydrated stockfish whenever no more than cod and rehydrating water are used as ingredients. If any additive or ingredient is included, then the nutritional labelling becomes mandatory.

It should be reminded, especially for the case of stockfish, wet salted and dried-salted products, that the nutrients shall be those of the food as sold and, where appropriate, the information may relate to the food after preparation, provided that sufficiently detailed preparation instructions are given and the information relates to the food as prepared for consumption. This is very important in the cases where nutritional or health claims are included, since this should necessarily refer to the product as it is consumed.

Models of nutrition labels, including the EU minimum requirements for each one of the products, have been presented and expressed as required. The content of the mandatory nutrition declaration may be supplemented with an indication of the amounts of one or more of the following; monounsaturates; polyunsaturates; polyols; starch; fiber; vitamins and minerals from Annex XIII.

The Brazilian labelling regulation is significantly different and more complicated than the EU. Apart of the mandatory inclusion of trans-fatty acid values and fiber, the results should be expressed referred to doses instead of 100g, and this dose depends on the product considered. In addition, an extra column should be included with the relative contribution of the nutrient to a daily 2000 kcal diet.

In some cases, as the case of carbohydrates and fat in some of the materials, the obtained low levels permit the use of expressions as "< 0,5%" or even "0" .

The analysis of carbohydrates has been calculated indirectly as the difference from total (100%) of the sum of the rest of the major analyzed components. The analysis of sugars has only been performed on stockfish (ling, saithe, haddock and tusk), leading values below quantification limit in all cases. Despite this analysis has not been carried out in the rest of the samples, taking into account the low carbohydrates levels, that sugar would remain within the same range.

Some references to Norwegian Standards for saltfish and clipfish have been cited. Divergence between the mean reported data and reference values for saltfish and clipfish laid down in this norms regarding humidity, protein and some minerals has been found. Market requirements have changed significantly in the last 20-30 years, thus entailing the adaptation of products and industrial processes; and this seems to be the reason behind this divergence. A revision for updating Norwegian standards to present saltfish / clipfish might be necessary.

Natural variance or differences in processing that may cause change in the reported nutritional parameters shall also be taken into account. Significant differences between producers for the same product have been found, as well as some outlier values. Nevertheless, not only this uncertainty, but also making use of the standard deviation of the replicates analyzed, seems not to affect the compliance of the reported values in proposed labels to the maximum tolerances reported by the European Commission in its guidance document [1] (detailed below in table 22).

| | **Tolerances for foods and food supplements** | |
|---|---|---|
| | **Side 1 of tolerance (includes uncertainty of measurement to the side specified, + or -)** | **Side 2 of tolerance** |
| **Vitamins** | **+50%**** | **– measurement uncertainty** |
| **Minerals** | **+45%** | **– measurement uncertainty** |
| **Carbohydrate*,**<br>**Protein*,**<br>**Fibre*** | **<10 g per 100 g: +4g**<br>**10-40 g per 100 g: +40%**<br>**>40 g per 100 g: +16g** | **– measurement uncertainty**<br>**– measurement uncertainty**<br>**– measurement uncertainty** |
| **Sugars*** | **<10 g per 100 g: -4g**<br>**10-40 g per 100 g: -40%**<br>**>40 g per 100 g: -16g** | **+ measurement uncertainty**<br>**+ measurement uncertainty**<br>**+ measurement uncertainty** |
| **Fat*** | **<10 g per 100 g: -3g**<br>**10-40 g per 100 g: -40%**<br>**>40 g per 100 g: -16g** | **+ measurement uncertainty**<br>**+ measurement uncertainty**<br>**+ measurement uncertainty** |
| **Saturates*** | **<4 g per 100 g: -1.6 g**<br>**≥4g per 100 g: -40%** | **+ measurement uncertainty**<br>**+ measurement uncertainty** |
| **Mono-unsaturates*,**<br>**Polyunsaturates*** | **<4 g per 100 g: +1.6 g**<br>**≥4g per 100 g: +40%** | **- measurement uncertainty**<br>**- measurement uncertainty** |
| **Sodium** | **< 0.5 g per 100 g: -0.3 g**<br>**≥0.5 g per 100 g: -40%** | **+ measurement uncertainty**<br>**+ measurement uncertainty** |
| **Salt** | **<1.25 g per 100 g: -0.75 g**<br>**≥1.25 g per 100 g: -40%** | **+ measurement uncertainty**<br>**+ measurement uncertainty** |

*Table 22: Maximum tolerances for the nutritional parameters included in the label [1].*

From the analyzed minerals, only selenium has significant levels in the product (as consumed) that may lead to the inclusion of a nutritional claim and/or derived health claims accepted by the EU. The rest of the minerals, in wet / dried-salted products shall be re-analyzed after being desalted before making any interpretation, but it seems that remaining levels might not be important. This can also be applied to fat related nutrients (EPA&DHA).

[1] https://ec.europa.eu/food/sites/food/files/safety/docs/labelling_nutrition-vitamins_minerals-guidance_tolerances_1212_en.pdf