Stabilizing quality of light and heavy salted cod

Industrial scale trials with phosphate additives

Authors: Ingebrigt Bjørkevoll, Rodrigo G. Reboredo, Trygg Barnung, Kristine Kvangarsnes, Lorena Formoso, Turid Standal Fylling, Sjurdur Joensen og Bjørn Gundersen.

Contents

1. Objectives and project plan:

The main objective of this project was to document the effects phosphates have on light salted and salt-cured fish during processing and storage**. The specific work packages that have been addressed were:**

- Work package 1: Large scale light and heavy salting of cod.

In this part of the project, split cut fresh cod caught with net and long line was heavy salted. For the production of light salted cod, frozen and thawed long line and trawler caught cod were used. This work package was carried out the first and second half of 2012.

- Work package 2: Large scale heavy salting of good and poor bled cod raw materials.

Split cod from a frozen trawler catch was heavy salted. Raw materials were poorly (direct slaughtered) or normally bled prior to processing onboard for the evaluation of quality and how the two raw material qualities was affected by phosphate. This work package was carried out the second half of 2012.

- Work package 3: Sensorial testing of raw and cooked cod loins

Heavy salted cod loins were submitted to sensorial testing by a taster panel. Visual appearance of heavy salted loins and sensorial features of desalted and cooked samples were determined. This sensorial testing was carried out at ANFACO-CECOPESCA facilities in October 2012.

2. Materials, processing and sampling.

Materials in this project consisted on fillets or split cod, either fresh or frozen raw materials, heavy salted, light-salted, and brines. Heavy salting was carried out by injection of 17% brine added 0, 2 or 4% phosphate followed by pickle salting with the addition of approximately 100 l brine containing 0, 2 or 4% phosphate with a ratio of 1 part brine to 6 parts fish.

Work package 1:

For the study of heavy salted cod, fresh raw materials were caught off the coast of Northern Norway by coastal vessels in February 2012 using long-line and net catching methods. Freshly split cod was submitted to heavy salting, and a five sample set of raw materials was directly frozen and stored in deep-freeze for chemical analysis. Heavy salted groups consisted of a control sample set (without the use of phosphates) and two levels of CARNAL 2110 treatment (2% and 4% w/w). For each one of the 6 heavy salted cod groups, 5 samples were analyzed chemically. After 14 days of pickle salting, brine samples were also collected for each of the 6 heavy salted groups from WP1. Each of the groups was composed of three replicates.
For the light salted experiments, at sea frozen cod, caught by trawler or long-line, was filleted

after thawing. The experiments consisted of a control sample set (without the use of phosphates) and two levels of CARNAL 2110 treatment (1% and 2% w/w). Each one of the 6 groups included 5 samples of raw materials and light salted cod for chemical analysis.

Work package 2:

Cod harvested in March 2012 by a net trawler were poorly or well bled before being gutted and directly after frozen on-board. After thawing, cod materials were industrially heavy salted and stored in chilled conditions up to 7 months. Heavy salted groups consisted of a control sample set (without the use of phosphates) and two levels of CARNAL 2110 treatment (2% and 4% w/v). Brines from each one of the 6 heavy salted groups in WP2 were also collected. For the chemical determination 3 samples of raw materials and heavy salted cod from each group were analyzed.

Immediately after the shipment arrival at ANFACO-CECOPESCA facilities, samples were identified and internally codified. Materials were stored in freezing chambers (-20^{o}C) (raw materials and light salted) or chilled conditions (2^{o}C) (heavy salted and brines) prior to physical-chemical analysis. Sample set and codification is showed in detail in *Annex I.*

Figure 2.1: Sampling and codification of brines and cod products.

Work package 3:

Heavy salted loins from well bled raw materials of cod were selected for the sensorial testing. A preliminary desalting experiment was carried out in order to determine the appropriate conditions to achieve a 2-3% salt content. Desalting yield was also registered.

Loins were cut in small cubes (4-5 cm) and placed in a bowl. Samples were desalted following a standard procedure for 48 hours in chilled conditions (4^{o}C), in a 1:9 fish:water ratio, without including water change, and shaking the bowl 2-3 times during the desalting period to mix the salt and water (to disrupt the stagnant layer of salt brine around the fish). Results showed still high contents of salt.

Desalting preliminary test	Yield (%)	ClNa (%)
Salted cod (4% P)	121,1%	4,5 (%)

Salted cod (control 0% P)	120,3%	5,8 (%)

One water renewal was introduced at 24h, but salt residuals were still high.

Desalting preliminary test	Yield (%)	ClNa (%)
Salted cod (2% P)	116,2%	4,8%

In order not to change total desalting time, a second water change was performed at 32 h. The final residuals were optimal (2-3%).

Desalting preliminary test	Yield (%)	ClNa (%)
Salted cod (2% P)	120,1%	3,1%

Finally selected desalting procedure was 48 hours desalting time at 5°C, with two water changes (after 24 and 32 hours), 2-3 times of stirring and a fish:water ratio of 1:9.

For the cooking of cod samples for sensorial testing, the cube-samples were steamed putting them individually into aluminum foil trays, placed on the oven tray, which contained water for making steam. Temperature during the boiling process was 200 °C for about 8 minutes, until the core temperature of the product was 60-65°C. Note that the samples were cooked in their own juice, with no salt or any other ingredient added.

3. Analytical methods.

3.1 Physical – chemical methods:

- **Fat oxidation.**

Primary and secondary fat oxidation in the samples was determined using Peroxides and TBARS indexes. The method used for peroxides quantification is based on the iodine titration with a sodium thiosulfate solution, and starch as indicator (AOAC Official method 965.33 (1965); Cox, H.E. & Pearson, D. (1962)). Fat extraction from fish tissue was carried out using chloroform in the presence of sodium sulfate and propyl gallate to prevent further oxidation during analytical procedure. Peroxide value (PV) is considered to represent the quantity of active oxygen (milliequivalents O2) contained in 1 kg of lipid and which could oxidize the potassium iodide.

Within the wide variety of options for TBARS analysis, the method used was the one proposed by Vyncke (1970), including some modifications by Cervantes et al. (1984). This method consists of a reaction between the lipid material and the 2-thiobarbituric acid to create a red-pink color which is measured at 532 nm in a UV/VIS spectrophotometer (Perkin Elmer Lambda 25). TBA-results are expressed as µmol malonaldehyde (MAD) in 1 Kg of muscle tissue.

- **Analysis of minerals.**

Mineral determinations of cod samples involved a complete digestion of the samples in pressurized vessels with HNO_3 ((65%) *(Trace analysis grade:Scharlau)* and H_2O_2 *(30% Suprapur:Merck)* as oxidizing agent. Samples underwent an 18 min. heating program in a microwave-oven. After complete mineralization, samples were accurately dissolved in the desired final volume in volumetric flasks with Milli-Q water. All minerals were analyzed by ICP-OES (Varian Vista MPX) with the exception of copper which was determined by GF-AAS *(Varian SpectrAA 220)* in order to improve detection limits. Details are show in table below.

		Used Emission Lines (*nm*)	Quant. Limit	Analytical details.
ICP-OES	Na	588,995 - 589,592	0,02 g /100g	On-line addition of Internal Standard (Y) and Ionization Buffer (CsCl).
	K	766,491 - 769,987	0,02 g /100g	
	Ca	317,933 - 393,366 - 396,847	20 mg/kg	
	Mg	379,553 - 280,270	20 mg/kg	
	Fe	238,204 - 239,563 - 259,940	2 mg/Kg	
	P	213,618 - 214,914	100 mg P/Kg 0,022 g P_2O_5/100g	
	Zn	202,548 - 206,200	2 mg/Kg	

		Absorption line (*nm*)	Quant. Limit	Analytical details.
GF - AAS	Cu	324,8	0,16 mg/kg	Ammonium nitrate as matrix modifier and Zeeman Correction.

Table 3.1: Instrumental conditions for mineral determinations by ICP-OES and GF-AAS.

- **<u>Determination of polyphosphates.</u>**

Semi-quantification of diphosphate and tripolyphosphate was carried out by High Performance Thin Layer Chromatography (HPTLC) with an internal adaptation of standard ISO 5553-1980 for the detection of polyphosphates in meat products. The method consists of a separation of trichloroacetic (TCA) fish extracts on a cellulose layer. After elution with a mixture of 2-propanol/TCA/1,4-dioxane/NH_3 and chromogenic developing to blue spots with two different reagents ((1) tartaric acid in a solution of nitric acid and ammonium molybdate tetrahydrate, (2) 4-amino-3-hydroxy-1-naphthalenesulfonic acid in sodium metabisulphite and sodium sulphite solution mixture). The detection and quantification was performed by densitometry at 586 nm*. (CAMAG Linomat 5 injector, Automatic Developing Chamber (ADC2), TLC Scanner 3, WINCATS software).*

3.2 Sensorial testing.

Sensorial testing consisted of a **descriptive test**, a **duo-trio test (***UNE-EN ISO 10399:2010 Standard),* and **ranking (***UNE-ISO 8587:2010 Standard)* of cod samples. The experiment was carried out in the sensorial testing laboratory placed in ANFACO-CECOPESCA, equipped with seven individual cabins and meeting the requirements of the *UNE-EN ISO 8589:2010 Standard*. The tests were conducted by the responsible of Technical Sensory Analysis, working with a panel formed by twelve assessors trained in sensory evaluation of fish. The number of assessors was chosen based on the sensitivity desired for the test (significance level α was 0,20, β was 0,20, and p_d was 50%). Sensory analysis were carried out on three samples of **raw**

and steamed (previously desalted) cod, processed with different concentrations of polyphosphates, in order to describe and to characterize the samples.

- **Descriptive test.**

The *Descriptive Test* allows characterizing samples by evaluating the intensity of different quality parameters by the assessors using a scale from 1 to 9 points. The tests were conducted by the responsible of Technical Sensory Analysis, working with a panel of twelve assessors trained in sensory evaluation of fish.
For the performance of tests, assessors were provided with a set of each of the samples. The preparation of various sets of samples was treated identically, with the same approximated amount of product and the same provision in aluminium trays for single use. The samples were identified with a 3 digit code chosen at random, so that the assessors could not obtain information that could affect the results *(Table 3.2).*

PRODUCT	REFERENCE	
Boiled cod	501	0% polyphosphates
Boiled cod	397	2% polyphosphates
Boiled cod	263	4% polyphosphates

Table 3.2: Sample codification in the descriptive test.

The samples were presented simultaneously to testers so that the person consulted could punctuate the evaluated quality parameters. Once tested by each assessor, the results were processed by the assessor team management for the application of consequent data processing.

- **Duo-trio test.**

Analysis carried out with samples of steamed (previously desalted) cod, processed with different concentrations of polyphosphates, in order to determine whether a perceptible sensory difference exists between samples of two products. As the products were familiar for the assessors, it was used the constant reference technique.

Assessors received a set of three samples (i.e. a triad), one sample of which was labelled as a reference and the other two samples had different codes. The assessors were informed that one of the coded samples was the same as the reference and that one was different. Based on the instructions given prior to the test, the assessors reported either which of the coded samples they believed to be different from the reference.

The products considered and evaluated in the test were the following:

PRODUCT	CODIFICATION	
Boiled (previously desalted) cod	856	0% polyphosphates
Boiled (previously desalted) cod	132	4% polyphosphates

Table 3.3: Sample codification for the duo-trio test.

The preparation of samples was treated identically, with the same approximated amount of product and the same provision in aluminium trays for single use. The samples were identified with a 3 digit code chosen at random, so that the assessors could not obtain information that could alter the results.

The samples were presented simultaneously to assessors so that the person consulted could point out the sample that was identified as different. Once tested by each assessor, the results were processed by the assessor team management for the application of consequent data processing.

- **Ranking test.**

The *Ranking Test* determines whether there are significant differences among the samples submitted, also defining an order among the different samples. Applied procedure has been based on the *UNE-ISO 8587:2010 Standard.*

The samples considered and evaluated in the test were the following:

PRODUCT	REFERENCE		Nº UNITS
Salt fish loins	713	0% polyphosphates	3 units
Salt fish loins	456	2% polyphosphates	3 units
Salt fish loins	980	4% polyphosphates	3 units

Table 3.4: Sample codification for the ranking test.

For performance of tests, testers were provided with a set of each of the samples (coded 713, 456 and 980). The different sets of samples were made up of subsamples of salted fish loins samples. The preparation of various sets of samples was treated identically, with the same approximated amount of product and the same provision in plastic dishes for single use. The samples were identified with a 3 digit code chosen at random, so that the assessors could not obtain information that could alter the results.

The samples were presented simultaneously to testers so that the person consulted could classify the order of each sample. Once tested by each assessor, the results were processed by the assessor team management for the application of consequent data processing. Various tests were developed for the statistical treatment of data as follows:

- **Comparison between samples: Friedman Test**

This test allows establishing the significance of the differences detected by the assessors among the three samples tested.

F value of the Friedman test is determined as follows:

$$F= (12/(J*P*(P+1)))*(R_a^2 + R_b^2 + R_c^2) - (3*J*(P+1))$$

Where:

J is the number of assessors (10)

P is the number of samples (3)

R is the sums of the rankings assigned to the set P of samples for the J assessors.

Comparing the F value of Friedman test calculated for each attribute, with the critical value tabulated for a significance level of 0.05 and 0.01, it may be concluded with a risk of error of 5% and 1%, whether there are significant differences among the samples for this attribute or not. Critical Values for ten assessors and three samples for a significance level of 0.05 and 0.01 are respectively **6,200** and **9,600**.

- **Signification of differences (Test of minimal significant differences-MDS)**

If there are significant differences among samples, it is possible to identify the pairs of samples that differ significantly from each other based on the values of their sums of orders. So, with two samples i and j, and Ri and Rj their sums of orders, using a normal approximation the two samples will be different if:

$$|R_i - R_j| \geq MSD = 1{,}96 * [(J*P*(P+1))/6]^{1/2}$$ (level 0,05) - INDIVIDUAL RISK (considering each pair of samples)

$$|R_i - R_j| \geq MDS = 2{,}91 * [(J*P*(P+1))/6]^{1/2}$$ (level 0,05) - GLOBAL RISK (considering the whole test)

Comparing the different pairs of samples with the calculated value MDS for a significance level of 0.05, we have the pairs of samples that differ.

Thus, for a significance level of 0.05, if there are 3 samples and 10 assessors to carry out the test, it must be satisfied that **|Ri - Rj| ≥ 8.77** (considering each pair of samples) to conclude that there are differences in a determined attribute in that pair of samples. Moreover, if it is considered the whole test, it must be satisfied that **|Ri – Rj|≥ 13.01**.

- **Page Test**

To assess whether there is a natural order among the three sets of samples for one attribute or not, there must be performed the Page test, which compares a value L calculated with the tabulated value for a significance level of 0.05 or, where appropriate, 0,01.

$$L = R_a + (2*R_b) + (3*R_c)$$

For one attribute, comparing the sum of ordinations L with the tabulated value for a significance level of 0.05 or 0.01, we can determine if there is a natural order among samples. For significance level of 0.05, tabulated value for 10 assessors and 3 samples is **128**, and for a significance level of 0.01, tabulated value is **131**. To conclude that there is a natural order among the three sets of samples for one attribute, it must be satisfied that **calculated L ≥ tabulated L.**

4. Results and discussion.

4.1 Work package 1: Trials with heavy salting of fresh raw material and light salting of frozen and thawed raw material.

The aim of this work package was to determine differences during and after processing between fish from different catching methods and whether the use of additives affected quality characters during storage.

4.1.1 Heavy salting.

Results from analytical determinations were in general not significant based on the objectives proposed. The absorption of the additives was not effective in any of the samples studied, so **no particularities in the results among groups were observed** apart from variation from raw to heavy salted fish.

		ClNa (g/100g)	P2O5 (g/100g)	K (g/100g)	Ca (mg/Kg)	Mg (mg/Kg)	Zn (mg/Kg)	Cu (mg/Kg)
Raw material (n=10)	Average	0,29	0,34	0,40	76	243	3,1	0,11
	SD	0,2	0,08	0,05	22	54	1,5	0,07
Heavy salted (n=30)	Average	18,3	0,30	0,26	247	328	4,0	0,18
	SD	2,4	0,12	0,05	109	104	1,1	0,16

Table 4.1: Chemical composition of raw materials and untreated heavy salted samples (average of both raw materials and sd. shown).

Levels of final **salt content** in all processed materials showed almost no differences with an average salt content of 18,3%. Replicates from net-caught raw materials show a natural higher sodium content (0,44%) than long-line raw materials (0,13%). Similarly the **calcium** levels increase during heavy salting not only because of a weight effect but clearly influenced by the uptake of salt. No variation was detected between groups or raw materials. Raw materials show average levels of 75±21 mg/kg meanwhile processed samples reached 247±110 mg/kg. **Magnesium** also slightly and not significantly increased during heavy salting from 243±54 mg/kg to 328±104 and probably only influenced by the weight effect and not by incoming salt. Results from **zinc** and especially **iron** (< 5 mg/kg) showed great variation becoming difficult to interpret to meet the objectives of this project, as was the case for **copper**.

As it has been mentioned above, the uptake of **phosphate** additives was not efficient considering residual levels of total phosphate. Besides, the typical natural phosphate loss after heavy salting seems not to be present from the comparison of control and raw material samples, despite the weight loss during this process. Besides, **polyphosphate additives** were not detected by HPTLC in any of the tested samples. The answer to this might be in the absence of absorption apart more than in the degradation of polyphosphates, as it can also be interpreted from the drop of **potassium** from raw materials to heavy salted samples (CARNAL 2110 contains significant amount of potassium).

Neither primary nor secondary **oxidation** were detected in any of the samples since almost the full data set show peroxides and TBARS values below or close to the quantification limit.

Results from the analysis of brines collected from the pickle salting step showed an increasing phosphate level with the amount of CARNAL 2110 used in each group, but final contents were lower than expected. This could be explained by the dilution of phosphates by the liquid loss from the cod during salting. Calcium and magnesium in brines were in the same range as muscle samples showing that diffusion ending up in a balance among both phases has taken place for these elements. No trend in the amount of iron and zinc present in brines was detected. Again, variation in the data and the low number of replicates does not allow making any conclusion concerning the effect of phosphates on sequestering of these metals from fish tissues.

Group		Sample		P2O5 mg P2O5/L	Ca mg/L	Mg g/L	Fe mg/L	Zn mg/L
G1 - Net caught cod. (poor quality)	BRINE	G1.1.	Average	1513	207	237	1,5	0,38
			SD	56	4	6	0,2	0,04
		G1.2	Average	3728	194	140	2,3	0,34
			SD	177	9	10	1,2	0,03
		G1.3	Average	4787	176	137	1,4	0,42
			SD	498	18	31	0,1	0,06
G2 - Long-line caught cod (high quality).		G2.1	Average	1058	405	577	1,1	0,26
			SD	70	4	15	0,2	0,05
		G2.2	Average	2337	314	383	1,2	0,21
			SD	61	6	6	0,1	0,01
		G2.3	Average	3077	308	447	1,6	0,37
			SD	25	3	12	0,0	0,01

Table 4.2: Mineral results from pickle salting brines.

4.1.2 Light salting.

Light salted samples undergo an internal diffusion of the brine injected into the cod muscle, leading to a yield gain (weight) which affects the contents of the elements in fish muscle. The more evident was the increase in **salt** levels (ClNa) from 0,55±0,19 % in raw materials to 1,13 ±0,17 % in light salted fillets. To the contrary, **phosphates** and **potassium** levels were slightly reduced because of the total weight increase in control samples, but the inclusion of CARNAL 2110 seemed to compensate this effect (not statistically significant). **Calcium** and **magnesium** were also slightly reduced because of the yield increase meanwhile iron contents varied too much between groups and replicates to make any interpretation. **Zinc** levels remained constant with 2,5 ± 0,5 mg/Kg as an average for all samples. All samples showed **copper** levels below 0,20 mg/kg.

				ClNa (g/100g)	P_2O_5 (g/100g)	K (g/100g)	Ca (mg/Kg)	Mg (mg/Kg)	Fe (mg/Kg)	Zn (mg/Kg)
LIGHT SALTiNG	Frozen raw materials from net trawling.	Unprocessed raw material	Average	0,54	0,39	0,36	87	322	7,7	2,5
			SD	0,15	0,05	0,06	45	90	9,2	0,8
		L1.1.	Average	0,96	0,32	0,28	67	252	14,4	2,5
			SD	0,13	0,05	0,04	22	73	13,3	0,6
		L1.2	Average	1,13	0,37	0,31	78	262	10,8	2,4
			SD	0,16	0,06	0,03	29	75	6,1	0,6
		L1.3	Average	1,20	0,45	0,35	85	280	12,9	2,3
			SD	0,21	0,08	0,06	28	71	6,8	0,5
	Frozen raw materials from Long-line	Unprocessed raw material	Average	0,56	0,36	0,34	90	293	8,4	2,5
			SD	0,24	0,04	0,08	42	72	6,4	0,7
		L.2.1	Average	1,04	0,32	0,30	89	251	7,3	2,3
			SD	0,13	0,07	0,04	48	89	5,2	0,8
		L.2.2	Average	1,11	0,34	0,30	97	291	8,4	2,6
			SD	0,09	0,06	0,03	30	85	5,8	0,1
		L.2.3	Average	1,32	0,42	0,33	90	286	10,0	2,1
			SD	0,10	0,10	0,05	33	76	7,5	0,4

Table 4.3: Mineral results from light salted samples.

Trace levels of tripolyphosphate *(below the quantification limit)* were detected in light salted samples both for all 1% and 2% CARNAL 2110 addition groups.

As well as for the heavy salted samples, **practically no oxidation was observed in any of the samples.** PV in all groups and raw material were below quantification limit (<2 meq.O_2/Kg fat) and TBARS showed values under 3,2 µmol MAD/Kg muscle.

4.2 Work package 2: Trials with frozen raw material of poor and good bleeding.

The objective of this work package was to determine the effect of phosphate additives in fish from different bleeding practices. It was expected that residual blood in muscle from direct slaughtered raw materials developed a more intense oxidative effect than in optimal bled samples, and the protection of phosphates could be therefore detected.

4.2.1 Heavy salting.

Concerning the levels of minerals, almost no differences were observed between well bled and directly slaughtered cod. Results mainly varied from raw materials to fully salted cod and among groups (Control, 2%, 4% CARNAL 2110 addition).

Levels of **salt** rose from 0.7% in raw material to 18.0% in the heavy salted product. Salt contents almost equal the first trial values for fully salted cod, but it was observed an unexpected increase in raw material levels with values 2 times first trial results. Alike, **calcium** significantly increased from raw materials to heavy salted samples, meanwhile **magnesium**, which remained still in the first trial, slightly drops in this case when processed. As in the first trial, **iron**, **copper** and **zinc** levels were low and values do not allow to obtain any information of significance.

		ClNa (g/100g)	Ca (mg/Kg)	Mg (mg/Kg)	Fe (mg/Kg)	Zn (mg/Kg)
Raw material (n=10)	Average	0,7	198	502	2,3	4,3
	SD	0,1	63	33	0,4	0,4
Heavy salted (n=30)	Average	18,0	443	383	2,9	4,3
	SD	1,2	83	70	1,2	0,9

Table 4.4: Mineral content in heavy salted samples. Average and sd. shown.

In contrast to first trial results, there was a significant absorption of the additive in the samples observed by the total phosphate and potassium residuals. These results were very similar between bled and direct slaughtered cod, so they have been pooled together in the next figure:

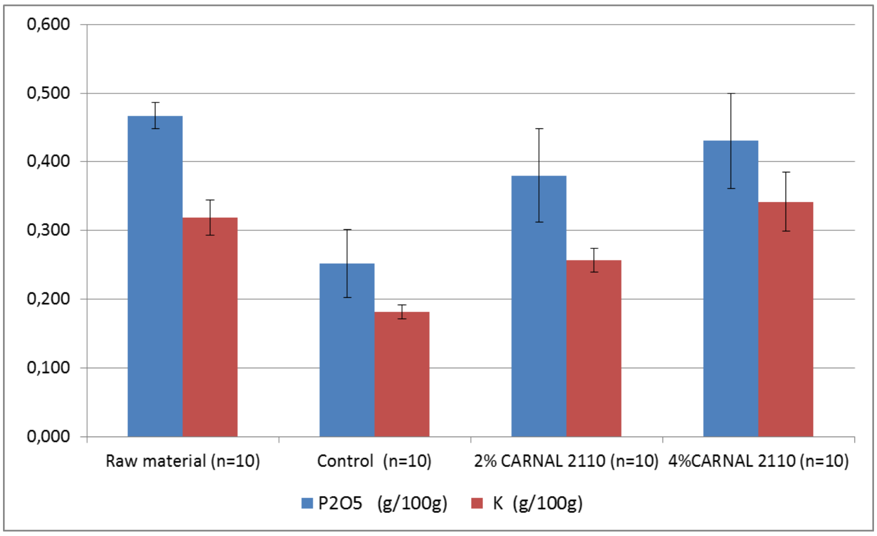

Figure 4.1: Total phosphate and potassium levels in poor and well bled heavy salted samples.

As it has been previously reported in literature *(Schröder (2010); Thorarinsdottir,* et al. *(2001)*), and in our own previous trials (Bjørkevoll et al. (2012)), the natural levels of **phosphate** and **potassium** in raw materials drop when processed due to diffusion with the brine phase. The use of phosphate additives partially neutralizes this effect with the incorporation of polyphosphates to the product, ending up in levels close to natural when 4% CARNAL 2110 is used.

Only **tripolyphosphate** residuals were detected in cod samples from 2% and 4% CARNAL 2110 addition groups. Average quantified residuals were 0.08 g P_2O_5/100g in the 2% group and 0.11 g P_2O_5/100g in the 4% group.

Almost no **oxidation** was detected in raw materials meanwhile only small levels were registered in heavy salted fish. PV in all groups was below the quantification limit (<2 meq.O_2/Kg fat). TBARS showed values of 1.9 and 3.0 µmol MAD/Kg muscle tissue respectively for bled cod and direct slaughtered raw materials, giving some evidence for the lack of oxidation in the bled group. After processing, TBARS values were not significantly different among control and phosphate addition groups, with 5.0 µmol MAD/Kg muscle tissue as an average.

The analysis of brines from pickle salting showed some interesting points. Levels of dissolved phosphates were, as well as for the first trial, far below the expected values; even though they increased with the additive addition. As explained above, this might be caused by the dilution from the drained liquid from fish muscle.

				P_2O_5 (mg /L)	*K* *(g/L)*	Ca (mg/L)	Mg (g/L)
BRINE	G3 - BLED COD	CONTROL	Average	1160	1,45	333	488
			SD	252	0,22	32	23
		2% CARNAL 2110	Average	3161	3,20	275	377
			SD	321	0,04	16	14
		4% CARNAL 2110	Average	3451	4,54	184	153
			SD	161	0,03	8	16
	G4 - DIRECT SLAUGHTER	CONTROL	Average	1237	1,60	309	454
			SD	46	0,10	26	29
		2% CARNAL 2110	Average	2153	3,11	213	276
			SD	317	0,03	22	25
		4% CARNAL 2110	Average	3512	4,65	170	113
			SD	531	0,09	27	24

Table 4.5: Minerals levels from pickle salting brines of poor and well bled heavy salted samples.

Although it has not been statistically validated, it seems that, both in brine and heavy salted fish muscle, that final amounts of calcium and magnesium are inversely correlated with the concentration of phosphate additive used. This effect is contradictory since a reduction in the levels in muscle should have caused an increase in brine and the other way around. No explanation to this has been proposed apart from validate this occurrence in future trials.

4.3 Work package 3: Sensorial testing.

4.3.1 Descriptive test.

Results of the descriptive test are summarized in the table below:

QUALITY PARAMETER	0% CARNAL 2110		2% CARNAL 2110		4% CARNAL 2110	
	AVERAGE	SD	AVERAGE	SD	AVERAGE	SD
Whiteness	7,1	0,8	6,1	1,4	7,5	1,4
Flakiness	6,4	1,2	5,3	1,9	7,0	1,4
Salt taste	2,7	1,1	4,3	1,8	4,3	1,7
Abnormal (irregular) taste	2,0	1,2	1,9	1,4	1,4	0,5

Juiciness	5,2	1,4	5,2	1,9	7,1	1,3
Texture	4,4	1,7	2,2	1,0	5,8	1,8
Cured, characteristic saltfish smell	4,1	1,5	5,6	1,7	5,4	1,8
Cured, characteristic saltfish taste	5,6	1,6	5,6	1,9	5,6	1,8

Table 4.6: Results from the descriptive test of cooked desalted cod.

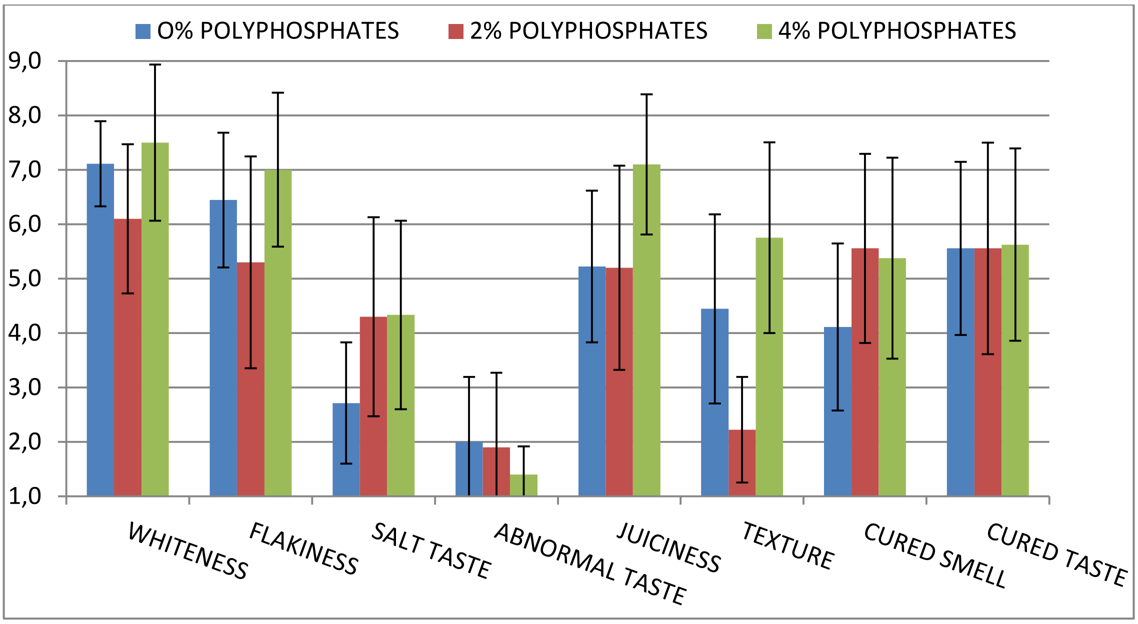

Figure 4.2: Results from the descriptive test.

Taking into account the three samples, it may be affirmed that sample 4% polyphosphate was the best valuated sample by the assessors. In this way, it is important to underline that scores for whiteness, juiciness and texture were higher in this sample than in the others.

As showed in Figure 4.2, only abnormal taste, juiciness and cured taste were similar between 0 and 2 %. Samples of 4 % treatment scored the highest for most of the parameters, while 2 % scored similar or lower than 0 %, especially concerning salt taste and texture (more fibrous and dry) .

It is also important to highlight the following points:

- The panel of assessors highlights the colour presented by the 4% polyphosphate sample, qualifying it as "whitest of the three samples".
- In general, texture of the 4% polyphosphate sample was qualified by the panel of assessors as "juicy".
- There was not found any abnormal (irregular) taste in any of the evaluated samples.

4.3.2 Duo-Trio test.

According to the results of the Duo-Trio test performed, it was possible to confirm with a confidence interval of 80% **that there are no perceptible differences between the samples subjected to the test**.

QUESTION	ANSWERS		RESULT	
	Reference Sample	Different sample	Signification Level	Perceptibly differences
Which sample do you think that is different from the reference sample?	5	7	0.20	NO

Table 4.7: Results from the duo-trio test with cooked desalted cod.

However, it is important to highlight the following points:

- Several assessors commented that **texture** and **juiciness** were the most important differences found in quality parameters between the two products. In this sense, some assessors described texture of sample 4% polyphosphate as *juicy,* and sample 0% polyphosphate as *fibrous* and *dry.*
- It is also important to highlight that some assessors commented that they found that samples were not homogeneous at all (there were found differences mainly in taste among the three samples). This situation may be taken into account as duo-trio test is a forced-choice procedure and because selection could have been only a guess by the assessors.

4.3.3 Ranking.

Results from ranking test of heavy salted loins are displayed in table below:

NUMBER OF RESPONSES BY OPTION									ASSESSMENT				
Sample 713			*Sample 456*			Sample 980			Sum of R Attributes			F	Significant Differences
1st opt.	2nd opt.	3rd opt.	1st opt.	2nd opt.	3rd opt.	1st opt.	2nd opt.	3rd opt.	R (713)	R (456)	R (980)		
3	2	5	0	5	5	7	3	0	**22**	**25**	**13**	**7.800**	**YES**

(*) Reflected significant differences correspond to a significance level of 0.05.

Table 4.8: Results from the ranking test of heavy salted loins.

These data allows us to conclude the following:

- According to the Ranking test performed, and after application of Friedman test, it is possible to confirm with a confidence interval of 95% that **there are significant differences** among the samples subjected to the test.
- Comparing the different pairs of samples together with the calculated value for a significance level of 0.05, it is possible to conclude that the following pairs of samples **differ from each other**:
    - Sample 0% phosphate and sample 4% phosphate

- Sample 2% phosphate and sample 4% phosphate

- Comparing the critical value of Page test tabulated with the calculated value, we can conclude that, with a confidence interval of 99%, **there is a natural order** among the individual samples, being this:

$$R_{\text{Sample 4\% P}} \leq R_{\text{Sample 0\% P}} \leq R_{\text{Sample 2\% P}}$$

- It means that Sample 4% polyphosphate is considered the best sample of this ranking by the assessors, and that Sample 2% polyphosphate is considered the least preferred sample of this ranking by the assessors.

It is also important to highlight the following points:

- The panel of assessors highlights the colour presented by the sample 4% polyphosphate, describing it as "*whitest of the three samples*".
- In general, texture and smell were qualified by the panel of assessors as "*quite similar in the three samples*".

5. Conclusions.

The lack of chemical oxidation in light salted and heavy salted samples limited considerably the possibilities to access the effect of phosphates on fish fat preservation during processing and storage. In addition, the apparent absence of absorption of additives in the first trial, also limited the study of the effects of phosphates in products from fresh raw materials of a different catch method (long-line/ net), and salted samples from these raw materials. The results show that the phosphate uptake is considerably higher in frozen raw materials than fresh raw materials after heavy salting. We find no good explanation for this observation. Calcium present in heavy salted cod depends on levels present in salt and the final salt level in the product. Evidences have been detected concerning an existing balance between brine and muscle contents due to diffusion in calcium and magnesium.

The utilization of total iron contents as a marker of residual blood is not effective since results are low and varying, and not corresponding to visual evaluation of blood content in the muscle. Other markers should be studied in the future to measure the blood level and evaluate the influence of residual blood on oxidation and surface discolouration. Copper contents are also very low and it seems not feasible to correlate copper contents with quality grading of the product after processing, if a real influence from these low copper contents exist on fish surface yellowing.

The comparison of levels in brines and muscle seems to show that if any chelation effect from phosphates on oxidizing elements is present it does not lead these elements to leak out from muscle tissue to brine.

In light salted samples, since diffusion takes place only internally, the levels of minerals and residual phosphates are only conditioned by the final weight increase and the amount of salt and additives used in injection. Degradation of phosphate additives is present during frozen storage due to lack of pyrophosphate and only trace residuals of tripolyphosphate.

When diffusion from muscle to brine and vice versa is present, natural levels of phosphates are reduced far below natural levels. Only the addition of significant amounts of phosphate additives compensates this loss.

The utilization of CARNAL 2110 in brines during processing (injection + pickle salting brines) in 4% concentration seems to improve sensorial quality of cod products. Colour and more intensely texture were the attributes underlined by the sensorial panel as more affected. Additions of a 2% concentration did not lead to significant differences to control samples, and even a reduction in quality was detected for some sensorial parameters.

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7. Annexes.

ANNEX I: WP1- Sampling

RAW MATERIAL HEAVY SALTED

GROUP	A/C internal code	Raw material (Frozen)
G1 - Net caught.	1206509	G1.0.C1
	1206510	G1.0.C2
	1206511	G1.0.C3
	1206512	G1.0.C4
	1206513	G1.0.C5
G2 - Long-line caught.	1206529	G2.0.C1
	1206530	G2.0.C2
	1206531	G2.0C3
	1206532	G2.0.C4
	1206533	G2.0.C5

HEAVY SALTED

GROUP	A/C internal code	Carnal 2110 (0%) - 1	A/C internal code	Carnal 2110 (2%) - 2	A/C internal code	Carnal 2110 (4%) - 3
G1 - Net caught.	1206514	G1.1.C1	1206519	G1.2.C1	1206524	G1.3.C1
	1206515	G1.1.C2	1206520	G1.2.C2	1206525	G1.3.C2
	1206516	G1.1.C3	1206521	G1.2.C3	1206526	G1.3.C3
	1206517	G1.1.C4	1206522	G1.2.C4	1206527	G1.3.C4
	1206518	G1.1.C5	1206523	G1.2.C5	1206528	G1.3.C5
G2 - Long-line caught.	1206534	G2.1.C1	1206539	G2.2.C1	1206544	G2.3.C1
	1206535	G2.1.C2	1206540	G2.2.C2	1206545	G2.3.C2
	1206536	G2.1.C3	1206541	G2.2.C3	1206546	G2.3.C3
	1206537	G2.1.C4	1206542	G2.2.C4	1206547	G2.3.C4
	1206538	G2.1.C5	1206543	G2.2.C5	1206548	G2.3.C5

BRINE

GROUP	A/C internal code	Carnal 2110 control (0%) - 1	A/C internal code	Carnal 2110 (2%) - 2	A/C internal code	Carnal 2110 (4%) - 3
G1 - Net caught.	1206549	G1.1.B1	1206552	G1.2.B1	1206555	G1.3.B1
	1206550	G1.1.B2	1206553	G1.2.B2	1206556	G1.3.B2
	1206551	G1.1.B3	1206554	G1.2.B3	1206557	G1.3.B3
G2 - Long-line caught.	1206558	G2.1.B1	1206561	G2.2.B1	1206564	G2.3.B1
	1206559	G2.1.B2	1206562	G2.2.B2	1206565	G2.3.B2
	1206560	G2.1.B3	1206563	G2.2.B3	1206566	G2.3.B3

RAW MATERIAL LIGHT SALTED

GROUP	A/C internal code	Raw material (Frozen)
L1 - Net caught.	1216860	L1.0.C1
	1216861	L1.0.C2
	1216862	L1.0.C3
	1216863	L1.0.C4
	1216864	L1.0.C5
L2 - Long-line caught.	1216865	L2.0.C1
	1216866	L2.0.C2
	1216867	L2.0C3
	1216868	L2.0.C4
	1216869	L2.0.C5

LIGHT SALTED

GROUP	A/C internal code	Carnal 2110 (0%) - 1	A/C internal code	Carnal 2110 (1%) - 2	A/C internal code	Carnal 2110 (2%) - 3
L1 - Net caught.	1216870	L1.1.C1	1216875	L1.2.C1	1216880	L1.3.C1
	1216871	L1.1.C2	1216876	L1.2.C2	1216881	L1.3.C2
	1216872	L1.1.C3	1216877	L1.2.C3	1216882	L1.3.C3
	1216873	L1.1.C4	1216878	L1.2.C4	1216883	L1.3.C4
	1216874	L1.1.C5	1216879	L1.2.C5	1216884	L1.3.C5
L2 - Long-line caught.	1216885	L2.1.C1	1216890	L2.2.C1	1216895	L2.3.C1
	1216886	L2.1.C2	1216891	L2.2.C2	1216896	L2.3.C2
	1216887	L2.1.C3	1216892	L2.2.C3	1216897	L2.3.C3
	1216888	L2.1.C4	1216893	L2.2.C4	1216898	L2.3.C4
	1216889	L2.1.C5	1216894	L2.2.C5	1216899	L2.3.C5

ANNEX II: WP1 - Oxidation results.

		SMP	ANFACO CODE	*PEROXIDES INDEX* (meq.O2/Kg.fat)	*TBA INDEX* (µmol MAD/Kg muscle tissue)
G1 - Net caught cod. (poor quality)	RAW MATERIAL	G1.0.C1	1206509	<2,0	3,6
		G1.0.C2	1206510	<2,0	2,7
		G1.0.C3	1206511	<2,0	1,8
		G1.0.C4	1206512	<2,0	<1,8
		G1.0.C5	1206513	<2,0	<1,8
	HEAVY SALTED	G1.1.C1	1206514	<2,0	3,2
		G1.1.C2	1206515	<2,0	4,1
		G1.1.C3	1206516	<2,0	3,6
		G1.1.C4	1206517	<2,0	3,2
		G1.1.C5	1206518	<2,0	2,7
		G1.2.C1	1206519	<2,0	3,2
		G1.2.C2	1206520	<2,0	3,2
		G1.2.C3	1206521	<2,0	2,7
		G1.2.C4	1206522	<2,0	1,8
		G1.2.C5	1206523	<2,0	1,8
		G1.3.C1	1206524	<2,0	2,7
		G1.3.C2	1206525	<2,0	3,2
		G1.3.C3	1206526	<2,0	2,7
		G1.3.C4	1206527	<2,0	2,7
		G1.3.C5	1206528	<2,0	3,2
G2 - Long-line caught cod (high quality).	RAW MATERIAL	G2.0.C1	1206529	<2,0	<1,8
		G2.0.C2	1206530	<2,0	<1,8
		G2.0C3	1206531	<2,0	<1,8
		G2.0.C4	1206532	<2,0	4,1
		G2.0.C5	1206533	<2,0	<1,8
	HEAVY SALTED	G2.1.C1	1206534	<2,0	4,1
		G2.1.C2	1206535	<2,0	3,2
		G2.1.C3	1206536	<2,0	2,7
		G2.1.C4	1206537	<2,0	2,7
		G2.1.C5	1206538	<2,0	3,6
		G2.2.C1	1206539	<2,0	5,4
		G2.2.C2	1206540	<2,0	3,2
		G2.2.C3	1206541	<2,0	5,0
		G2.2.C4	1206542	<2,0	2,7
		G2.2.C5	1206543	<2,0	5,0
		G2.3C1	1206544	<2,0	3,6
		G2.3C2	1206545	<2,0	3,2
		G2.3.C3	1206546	<2,0	2,3
		G2.3.C4	1206547	<2,0	2,7
		G2.3C5	1206548	<2,0	1,8

		SMP	ANFACO CODE	*PEROXIDES INDEX* (meq.O2/Kg.fat)	*TBA INDEX* (µmol MAD/Kg muscle tissue)
G1 - Net caught cod. (poor quality)	RAW MATERIAL	L1.0.C1	1216860	<2,0	<1,8
		L1.0.C2	1216861	<2,0	3,2
		L1.0.C3	1216862	<2,0	1,8
		L1.0.C4	1216863	<2,0	2,3
		L1.0.C5	1216864	<2,0	2,3
	LIGHT SALTED	L1.1.C1	1216870	<2,0	2,3
		L1.1.C2	1216871	<2,0	<1,8
		L1.1.C3	1216872	<2,0	1,8
		L1.1.C4	1216873	<2,0	1,8
		L1.1.C5	1216874	<2,0	2,3
		L1.2.C1	1216875	<2,0	1,8
		L1.2.C2	1216876	<2,0	<1,8
		L1.2.C3	1216877	<2,0	2,3
		L1.2.C4	1216878	<2,0	1,8
		L1.2.C5	1216879	<2,0	2,3
		L1.3.C1	1216880	<2,0	<1,8
		L1.3.C2	1216881	<2,0	<1,8
		L1.3.C3	1216882	<2,0	2,3
		L1.3.C4	1216883	<2,0	1,8
		L1.3.C5	1216884	<2,0	1,8
G2 - Long-line caught cod (high quality).	RAW MATERIAL	L2.0.C1	1216865	<2,0	<1,8
		L2.0.C2	1216866	<2,0	2,7
		L2.0C3	1216867	<2,0	<1,8
		L2.0.C4	1216868	<2,0	<1,8
		L2.0.C5	1216869	<2,0	1,8
	LIGHT SALTED	L2.1.C1	1216885	<2,0	<1,8
		L2.1.C2	1216886	<2,0	1,8
		L2.1.C3	1216887	<2,0	<1,8
		L2.1.C4	1216888	<2,0	1,8
		L2.1.C5	1216889	<2,0	1,8
		L2.2.C1	1216890	<2,0	<1,8
		L2.2.C2	1216891	<2,0	<1,8
		L2.2.C3	1216892	<2,0	1,8
		L2.2.C4	1216893	<2,0	<1,8
		L2.2.C5	1216894	<2,0	1,8
		L2.3C1	1216895	<2,0	<1,8
		L2.3C2	1216896	<2,0	<1,8
		L2.3.C3	1216897	<2,0	2,3
		L2.3.C4	1216898	<2,0	1,8
		L2.3C5	1216899	<2,0	1,8

ANNEX III: WP1 - Minerals results.

Group	Type	SMP	ANFACO CODE	Na (g/100g)	ClNa (g/100g)	P (g/100g)	P2O5 (g/100g)	K (g/100g)	Ca (mg/Kg)	Mg (mg/Kg)	Fe (mg/Kg)	Zn (mg/Kg)	Cu (mg/Kg)
G1 - Net caught cod. (poor quality)	RAW MATERIAL	G1.0.C1	1206509	0,26	0,66	0,12	0,27	0,37	98	276	1,4	2,4	0,13
		G1.0.C2	1206510	0,22	0,56	0,14	0,32	0,41	269	332	1,7	2,6	0,07
		G1.0.C3	1206511	0,14	0,36	0,16	0,37	0,47	82	278	2,8	2,9	0,12
		G1.0.C4	1206512	0,15	0,38	0,16	0,37	0,44	67	257	30,6	36,3	0,08
		G1.0.C5	1206513	0,10	0,25	0,12	0,27	0,37	57	231	5,1	6,6	0,3
	HEAVY SALTED	G1.1.C1	1206514	7,32	18,6	0,14	0,32	0,21	195	313	<2	<2	0,16
		G1.1.C2	1206515	7,70	19,6	0,18	0,41	0,21	245	422	<2	3,8	0,10
		G1.1.C3	1206516	8,66	22,0	0,1	0,23	0,3	211	220	1,9	<2	0,16
		G1.1.C4	1206517	6,21	15,8	0,1	0,23	0,21	365	395	<2	4,6	0,41
		G1.1.C5	1206518	6,33	16,1	0,14	0,32	0,22	172	406	<2	5,1	0,2
		G1.2.C1	1206519	7,35	18,7	0,22	0,50	0,24	666	357	<2	4,9	0,12
		G1.2.C2	1206520	6,42	16,3	0,1	0,23	0,21	197	155	<2	2,3	0,12
		G1.2.C3	1206521	8,09	20,6	0,12	0,27	0,25	166	207	1,2	3	0,09
		G1.2.C4	1206522	6,59	16,8	0,1	0,23	0,26	244	241	<2	<2	0,15
		G1.2.C5	1206523	6,75	17,2	0,14	0,32	0,24	196	237	<2	<2	0,18
		G1.3.C1	1206524	7,73	19,6	0,16	0,37	0,28	134	198	<2	<2	0,14
		G1.3.C2	1206525	6,86	17,4	0,16	0,37	0,28	197	230	1,8	4,1	0,23
		G1.3.C3	1206526	7,91	20,1	0,12	0,27	0,35	138	181	0,97	3,5	0,07
		G1.3.C4	1206527	6,08	15,5	0,3	0,69	0,26	146	248	1,3	4,5	0,36
		G1.3.C5	1206528	6,29	16,0	0,16	0,37	0,25	260	255	<2	5,4	0,12
G2 - Long-line caught cod (high quality).	RAW MATERIAL	G2.0.C1	1206529	0,04	0,10	0,10	0,23	0,29	31	131	1,2	1,7	0,03
		G2.0.C2	1206530	0,05	0,13	0,16	0,37	0,40	75	215	1,4	2,4	0,08
		G2.0C3	1206531	0,06	0,15	0,22	0,50	0,43	83	275	<2	<2	0,12
		G2.0.C4	1206532	0,05	0,13	0,14	0,32	0,40	89	222	1,6	3	0,06
		G2.0.C5	1206533	0,06	0,15	0,16	0,37	0,43	99	211	1,3	2,8	0,14
	HEAVY SALTED	G2.1.C1	1206534	6,78	17,2	0,1	0,23	0,17	455	570	<2	5,2	0,17
		G2.1.C2	1206535	8,00	20,3	0,1	0,23	0,21	283	413	1,1	3,7	0,19
		G2.1.C3	1206536	8,30	21,1	0,08	0,18	0,25	303	374	2,7	3,3	0,10
		G2.1.C4	1206537	6,69	17,0	0,06	0,14	0,2	270	339	6,1	2,7	0,13
		G2.1.C5	1206538	6,27	15,9	0,12	0,27	0,19	267	521	<2	4,1	0,16
		G2.2.C1	1206539	6,29	16,0	0,24	0,55	0,24	273	470	<2	5,9	0,15
		G2.2.C2	1206540	7,17	18,2	0,1	0,23	0,27	177	293	3	3,2	0,07
		G2.2.C3	1206541	8,94	22,7	0,1	0,23	0,36	163	298	<2	3,7	0,08
		G2.2.C4	1206542	7,62	19,4	0,08	0,18	0,33	187	268	5,9	3,3	0,08
		G2.2.C5	1206543	5,81	14,8	0,12	0,27	0,23	250	367	<2	5,5	0,24
		G2.3C1	1206544	7,02	17,8	0,14	0,32	0,26	417	467	<2	5,3	0,08
		G2.3C2	1206545	7,52	19,1	0,1	0,23	0,3	202	323	<2	2,4	0,93
		G2.3.C3	1206546	8,55	21,7	0,1	0,23	0,35	225	385	<2	2,5	0,04
		G2.3.C4	1206547	9,00	22,9	0,1	0,23	0,35	208	291	4,5	3,4	0,23
		G2.3C5	1206548	5,99	15,2	0,12	0,27	0,26	208	400	<2	4,6	0,17

ANNEX III: WP1 - Minerals results.

	GROUP	A/C internal code	ANFACO CODE	P g P/L	P2O5 g P2O5/L	Ca mg/L	Mg g/L	Fe mg/L	Zn mg/L	Cu mg/L
G1 - Net caught cod. (poor quality)	BRINE	G1.1.B1	1206549	0,66	1,51	209	0,24	1,31	0,34	<0,4
		G1.1.B2	1206550	0,64	1,46	203	0,23	1,61	0,39	<0,4
		G1.1.B3	1206551	0,69	1,57	210	0,24	1,66	0,42	<0,4
		G1.2.B1	1206552	1,65	3,77	201	0,15	3,62	0,38	<0,4
		G1.2.B2	1206553	1,69	3,88	198	0,14	1,88	0,33	<0,4
		G1.2.B3	1206554	1,54	3,53	184	0,13	1,44	0,32	<0,4
		G1.3.B1	1206555	1,98	4,54	165	0,13	1,41	0,41	<0,4
		G1.3.B2	1206556	1,95	4,46	196	0,17	1,37	0,36	<0,4
		G1.3.B3	1206557	2,34	5,36	166	0,11	1,5	0,48	<0,4
G2 - Long-line caught cod (high quality).		G2.1.B1	1206558	0,45	1,02	405	0,58	1,26	0,32	<0,4
		G2.1.B2	1206559	0,50	1,14	408	0,56	1,03	0,25	<0,4
		G2.1.B3	1206560	0,44	1,01	401	0,59	0,91	0,22	<0,4
		G2.2.B1	1206561	1,05	2,41	321	0,38	1,24	0,22	<0,4
		G2.2.B2	1206562	1,01	2,31	312	0,38	1,17	0,2	<0,4
		G2.2.B3	1206563	1,00	2,29	309	0,39	1,11	0,22	<0,4
		G2.3.B1	1206564	1,34	3,08	306	0,46	1,67	0,36	<0,4
		G2.3.B2	1206565	1,33	3,05	307	0,44	1,62	0,38	<0,4
		G2.3.B3	1206566	1,35	3,10	312	0,44	1,59	0,36	<0,4

ANNEX III: WP1 - Minerals results.

		SMP	ANFACO CODE	Na (g/100g)	ClNa (g/100g)	P (g/100g)	P2O5 (g/100g)	K (g/100g)	Ca (mg/Kg)	Mg (mg/Kg)	Fe (mg/Kg)	Zn (mg/Kg)	Cu (mg/Kg)
G1 - Net caught cod. (poor quality)	RAW MATERIAL	L1.0.C1	1216860	0,15	0,38	0,18	0,41	0,35	60,7	282,4	24,0	3,7	0,17
		L1.0.C2	1216861	0,31	0,79	0,14	0,32	0,45	42,2	202,1	1,2	1,6	<0,16
		L1.0.C3	1216862	0,18	0,46	0,16	0,37	0,32	67,3	316,6	3,8	2,1	0,21
		L1.0.C4	1216863	0,21	0,53	0,18	0,41	0,30	154,7	367,5	5,0	2,5	<0,16
		L1.0.C5	1216864	0,22	0,56	0,20	0,46	0,36	109,8	443,0	4,5	2,8	<0,16
	LIGHT SALTED	L1.1.C1	1216870	0,36	0,92	0,14	0,32	0,25	65,6	266,1	10,3	3,0	0,22
		L1.1.C2	1216871	0,38	0,97	0,12	0,27	0,26	66,0	220,9	37,1	2,8	0,16
		L1.1.C3	1216872	0,42	1,07	0,12	0,27	0,32	31,7	143,0	2,8	1,7	<0,16
		L1.1.C4	1216873	0,3	0,76	0,16	0,37	0,25	79,8	308,5	13,6	2,2	<0,16
		L1.1.C5	1216874	0,43	1,09	0,16	0,37	0,32	91,1	323,9	8,3	3,0	<0,16
		L1.2.C1	1216875	0,35	0,89	0,18	0,41	0,33	63,7	241,3	15,1	2,8	0,17
		L1.2.C2	1216876	0,49	1,25	0,14	0,32	0,27	81,7	278,0	17,5	2,2	0,18
		L1.2.C3	1216877	0,49	1,25	0,12	0,27	0,34	35,8	141,4	2,9	1,5	0,18
		L1.2.C4	1216878	0,42	1,07	0,18	0,41	0,30	109,2	325,4	12,3	2,2	0,17
		L1.2.C5	1216879	0,48	1,22	0,18	0,41	0,32	100,1	321,5	6,3	3,1	0,16
		L1.3.C1	1216880	0,47	1,19	0,16	0,37	0,34	67,4	228,0	19,5	2,7	<0,16
		L1.3.C2	1216881	0,34	0,86	0,2	0,46	0,25	119,7	358,5	14,3	2,9	0,16
		L1.3.C3	1216882	0,57	1,45	0,16	0,37	0,36	48,3	185,4	19,1	2,2	<0,16
		L1.3.C4	1216883	0,5	1,27	0,22	0,50	0,37	88,2	311,2	5,1	1,5	<0,16
		L1.3.C5	1216884	0,49	1,25	0,24	0,55	0,41	99,1	315,4	6,7	2,4	<0,16
G2 - Long-line caught cod (high quality).	RAW MATERIAL	L2.0.C1	1216865	0,11	0,28	0,14	0,32	0,23	62,0	249,2	17,4	3,5	0,18
		L2.0.C2	1216866	0,30	0,76	0,14	0,32	0,45	41,7	200,7	1,7	1,9	<0,16
		L2.0C3	1216867	0,16	0,41	0,16	0,37	0,34	80,0	294,8	11,8	1,7	<0,16
		L2.0.C4	1216868	0,21	0,53	0,16	0,37	0,30	141,9	334,3	3,4	2,4	<0,16
		L2.0.C5	1216869	0,33	0,84	0,18	0,41	0,37	124,5	386,6	7,7	2,9	<0,16
	LIGHT SALTED	L2.1.C1	1216885	0,40	1,02	0,12	0,27	0,25	56,8	193,5	11,9	2,2	0,21
		L2.1.C2	1216886	0,42	1,07	0,14	0,32	0,31	357,0	212,0	2,6	2,0	<0,16
		L2.1.C3	1216887	0,38	0,97	0,1	0,23	0,29	44,0	158,6	1,8	1,6	0,17
		L2.1.C4	1216888	0,36	0,92	0,16	0,37	0,31	147,8	334,3	13,2	3,6	<0,16
		L2.1.C5	1216889	0,49	1,25	0,18	0,41	0,35	107,3	357,8	6,9	2,1	<0,16
		L2.2.C1	1216890	0,40	1,02	0,12	0,27	0,26	76,2	238,1	18,5	2,5	0,16
		L2.2.C2	1216891	0,47	1,19	0,12	0,27	0,32	53,8	171,5	4,0	2,5	<0,16
		L2.2.C3	1216892	0,40	1,02	0,16	0,37	0,28	111,8	344,4	5,8	2,6	0,17
		L2.2.C4	1216893	0,45	1,14	0,16	0,37	0,31	121,0	319,7	6,6	2,8	<0,16
		L2.2.C5	1216894	0,46	1,17	0,18	0,41	0,34	120,2	379,5	7,2	2,6	<0,16
		L2.3C1	1216895	0,47	1,19	0,16	0,37	0,28	68,0	239,3	20,4	2,1	<0,16
		L2.3C2	1216896	0,54	1,37	0,12	0,27	0,30	46,5	175,1	1,0	1,6	0,18
		L2.3.C3	1216897	0,54	1,37	0,20	0,46	0,30	129,3	349,5	5,1	2,2	<0,16
		L2.3.C4	1216898	0,56	1,42	0,22	0,50	0,36	102,1	321,8	10,1	2,0	<0,16
		L2.3C5	1216899	0,49	1,25	0,22	0,50	0,39	104,1	345,0	13,4	2,6	<0,16

ANNEX IV: WP1 – Polyphosphate residuals results.

		SMP	ANFACO CODE	DIPHOSPHATE (gP/100g)	DIPHOSPHATE (gP2O5/100g)	TRIPHOSPHATE (gP/100g)	TRIPHOSPHATE (gP2O5/100g)	HEXAMETAPHOSPHATE (gP/100g)	HEXAMETAPHOSPHATE (gP2O5/100g)	COMMENTS
G1 - Net caught cod. (poor quality)	RAW MATERIAL	G1.0.C1	1206509	<0,03	<0,07	<0,03	<0,07	<0,09	<0,04	No detected phosphates
		G1.0.C2	1206510	<0,03	<0,07	<0,03	<0,07	<0,09	<0,04	No detected phosphates
		G1.0.C3	1206511	<0,03	<0,07	<0,03	<0,07	<0,09	<0,04	No detected phosphates
		G1.0.C4	1206512	<0,03	<0,07	<0,03	<0,07	<0,09	<0,04	No detected phosphates
		G1.0.C5	1206513	<0,03	<0,07	<0,03	<0,07	<0,09	<0,04	No detected phosphates
	HEAVY SALTED	G1.1.C1	1206514	<0,03	<0,07	<0,03	<0,07	<0,09	<0,04	No detected phosphates
		G1.1.C2	1206515	<0,03	<0,07	<0,03	<0,07	<0,09	<0,04	No detected phosphates
		G1.1.C3	1206516	<0,03	<0,07	<0,03	<0,07	<0,09	<0,04	No detected phosphates
		G1.1.C4	1206517	<0,03	<0,07	<0,03	<0,07	<0,09	<0,04	No detected phosphates
		G1.1.C5	1206518	<0,03	<0,07	<0,03	<0,07	<0,09	<0,04	No detected phosphates
		G1.2.C1	1206519	<0,03	<0,07	<0,03	<0,07	<0,09	<0,04	No detected phosphates
		G1.2.C2	1206520	<0,03	<0,07	<0,03	<0,07	<0,09	<0,04	No detected phosphates
		G1.2.C3	1206521	<0,03	<0,07	<0,03	<0,07	<0,09	<0,04	No detected phosphates
		G1.2.C4	1206522	<0,03	<0,07	<0,03	<0,07	<0,09	<0,04	No detected phosphates
		G1.2.C5	1206523	<0,03	<0,07	<0,03	<0,07	<0,09	<0,04	No detected phosphates
		G1.3.C1	1206524	<0,03	<0,07	<0,03	<0,07	<0,09	<0,04	No detected phosphates
		G1.3.C2	1206525	<0,03	<0,07	<0,03	<0,07	<0,09	<0,04	No detected phosphates
		G1.3.C3	1206526	<0,03	<0,07	<0,03	<0,07	<0,09	<0,04	No detected phosphates
		G1.3.C4	1206527	<0,03	<0,07	<0,03	<0,07	<0,09	<0,04	No detected phosphates
		G1.3.C5	1206528	<0,03	<0,07	<0,03	<0,07	<0,09	<0,04	No detected phosphates
G2 - Long-line caught cod (high quality).	RAW MATERIAL	G2.0.C1	1206529	<0,03	<0,07	<0,03	<0,07	<0,09	<0,04	No detected phosphates
		G2.0.C2	1206530	<0,03	<0,07	<0,03	<0,07	<0,09	<0,04	No detected phosphates
		G2.0C3	1206531	<0,03	<0,07	<0,03	<0,07	<0,09	<0,04	No detected phosphates
		G2.0.C4	1206532	<0,03	<0,07	<0,03	<0,07	<0,09	<0,04	No detected phosphates
		G2.0.C5	1206533	<0,03	<0,07	<0,03	<0,07	<0,09	<0,04	No detected phosphates
	HEAVY SALTED	G2.1.C1	1206534	<0,03	<0,07	<0,03	<0,07	<0,09	<0,04	No detected phosphates
		G2.1.C2	1206535	<0,03	<0,07	<0,03	<0,07	<0,09	<0,04	No detected phosphates
		G2.1.C3	1206536	<0,03	<0,07	<0,03	<0,07	<0,09	<0,04	No detected phosphates
		G2.1.C4	1206537	<0,03	<0,07	<0,03	<0,07	<0,09	<0,04	No detected phosphates
		G2.1.C5	1206538	<0,03	<0,07	<0,03	<0,07	<0,09	<0,04	No detected phosphates
		G2.2.C1	1206539	<0,03	<0,07	<0,03	<0,07	<0,09	<0,04	No detected phosphates
		G2.2.C2	1206540	<0,03	<0,07	<0,03	<0,07	<0,09	<0,04	No detected phosphates
		G2.2.C3	1206541	<0,03	<0,07	<0,03	<0,07	<0,09	<0,04	No detected phosphates
		G2.2.C4	1206542	<0,03	<0,07	<0,03	<0,07	<0,09	<0,04	No detected phosphates
		G2.2.C5	1206543	<0,03	<0,07	<0,03	<0,07	<0,09	<0,04	No detected phosphates
		G2.3C1	1206544	<0,03	<0,07	<0,03	<0,07	<0,09	<0,04	No detected phosphates
		G2.3C2	1206545	<0,03	<0,07	<0,03	<0,07	<0,09	<0,04	No detected phosphates
		G2.3.C3	1206546	<0,03	<0,07	<0,03	<0,07	<0,09	<0,04	No detected phosphates
		G2.3.C4	1206547	<0,03	<0,07	<0,03	<0,07	<0,09	<0,04	No detected phosphates
		G2.3C5	1206548	<0,03	<0,07	<0,03	<0,07	<0,09	<0,04	No detected phosphates

ANNEX IV: WP1 – Polyphosphate residuals results.

		SMP	ANFACO CODE	DIPHOSPHATE (gP/100g)	DIPHOSPHATE (gP2O5/100g)	TRIPHOSPHATE (gP/100g)	TRIPHOSPHATE (gP2O5/100g)	HEXAMETAPHOSPHATE (gP/100g)	HEXAMETAPHOSPHATE (gP2O5/100g)	COMMENTS
G1 - Net caught cod. (poor quality)	RAW MATERIAL	L1.0.C1	1216860	<0,03	<0,07	<0,03	<0,07	<0,09	<0,04	No detected phosphates
		L1.0.C2	1216861	<0,03	<0,07	<0,03	<0,07	<0,09	<0,04	No detected phosphates
		L1.0.C3	1216862	<0,03	<0,07	<0,03	<0,07	<0,09	<0,04	No detected phosphates
		L1.0.C4	1216863	<0,03	<0,07	<0,03	<0,07	<0,09	<0,04	No detected phosphates
		L1.0.C5	1216864	<0,03	<0,07	<0,03	<0,07	<0,09	<0,04	No detected phosphates
	LIGHT SALTED	L1.1.C1	1216870	<0,03	<0,07	<0,03	<0,07	<0,09	<0,04	No detected phosphates
		L1.1.C2	1216871	<0,03	<0,07	<0,03	<0,07	<0,09	<0,04	No detected phosphates
		L1.1.C3	1216872	<0,03	<0,07	<0,03	<0,07	<0,09	<0,04	No detected phosphates
		L1.1.C4	1216873	<0,03	<0,07	<0,03	<0,07	<0,09	<0,04	No detected phosphates
		L1.1.C5	1216874	<0,03	<0,07	<0,03	<0,07	<0,09	<0,04	No detected phosphates
		L1.2.C1	1216875	<0,03	<0,07	<0,03	<0,07	<0,09	<0,04	Triphosphate levels below qunatification limit are detected
		L1.2.C2	1216876	<0,03	<0,07	<0,03	<0,07	<0,09	<0,04	Triphosphate levels below qunatification limit are detected
		L1.2.C3	1216877	<0,03	<0,07	<0,03	<0,07	<0,09	<0,04	Triphosphate levels below qunatification limit are detected
		L1.2.C4	1216878	<0,03	<0,07	<0,03	<0,07	<0,09	<0,04	No detected phosphates
		L1.2.C5	1216879	<0,03	<0,07	<0,03	<0,07	<0,09	<0,04	No detected phosphates
		L1.3.C1	1216880	<0,03	<0,07	<0,03	<0,07	<0,09	<0,04	Triphosphate levels below qunatification limit are detected
		L1.3.C2	1216881	<0,03	<0,07	<0,03	<0,07	<0,09	<0,04	Triphosphate and diphosphate levels below qunatification limit are detected
		L1.3.C3	1216882	<0,03	<0,07	<0,03	<0,07	<0,09	<0,04	Triphosphate and diphosphate levels below qunatification limit are detected
		L1.3.C4	1216883	<0,03	<0,07	<0,03	<0,07	<0,09	<0,04	Triphosphate levels below qunatification limit are detected
		L1.3.C5	1216884	<0,03	<0,07	<0,03	<0,07	<0,09	<0,04	Triphosphate levels below qunatification limit are detected
G2 - Long-line caught cod (high quality).	RAW MATERIAL	L2.0.C1	1216865	<0,03	<0,07	<0,03	<0,07	<0,09	<0,04	No detected phosphates
		L2.0.C2	1216866	<0,03	<0,07	<0,03	<0,07	<0,09	<0,04	No detected phosphates
		L2.0C3	1216867	<0,03	<0,07	<0,03	<0,07	<0,09	<0,04	No detected phosphates
		L2.0.C4	1216868	<0,03	<0,07	<0,03	<0,07	<0,09	<0,04	No detected phosphates
		L2.0.C5	1216869	<0,03	<0,07	<0,03	<0,07	<0,09	<0,04	No detected phosphates
	LIGHT SALTED	L2.1.C1	1216885	<0,03	<0,07	<0,03	<0,07	<0,09	<0,04	No detected phosphates
		L2.1.C2	1216886	<0,03	<0,07	<0,03	<0,07	<0,09	<0,04	No detected phosphates
		L2.1.C3	1216887	<0,03	<0,07	<0,03	<0,07	<0,09	<0,04	No detected phosphates
		L2.1.C4	1216888	<0,03	<0,07	<0,03	<0,07	<0,09	<0,04	No detected phosphates
		L2.1.C5	1216889	<0,03	<0,07	<0,03	<0,07	<0,09	<0,04	No detected phosphates
		L2.2.C1	1216890	<0,03	<0,07	<0,03	<0,07	<0,09	<0,04	No detected phosphates
		L2.2.C2	1216891	<0,03	<0,07	<0,03	<0,07	<0,09	<0,04	Triphosphate levels below qunatification limit are detected
		L2.2.C3	1216892	<0,03	<0,07	<0,03	<0,07	<0,09	<0,04	Triphosphate levels below qunatification limit are detected
		L2.2.C4	1216893	<0,03	<0,07	<0,03	<0,07	<0,09	<0,04	No detected phosphates
		L2.2.C5	1216894	<0,03	<0,07	<0,03	<0,07	<0,09	<0,04	No detected phosphates
		L2.3C1	1216895	<0,03	<0,07	<0,03	<0,07	<0,09	<0,04	Triphosphate levels below qunatification limit are detected
		L2.3C2	1216896	<0,03	<0,07	<0,03	<0,07	<0,09	<0,04	Triphosphate levels below qunatification limit are detected
		L2.3.C3	1216897	<0,03	<0,07	<0,03	<0,07	<0,09	<0,04	Triphosphate levels below qunatification limit are detected
		L2.3.C4	1216898	<0,03	<0,07	<0,03	<0,07	<0,09	<0,04	Triphosphate levels below qunatification limit are detected
		L2.3C5	1216899	<0,03	<0,07	<0,03	<0,07	<0,09	<0,04	Triphosphate levels below qunatification limit are detected

ANNEX V: WP2 – Sampling.

	GROUP	A/C internal code	Raw material
RAW MATERIAL HEAVY SALTED	G3 - BLED COD	1210106	G3.0.C1
		1210107	G3.0.C2
		1210108	G3.0.C3
		1210109	G3.0.C4
		1210110	G3.0.C5
	G4 - DIRECT SLAUGHTER	1210111	G4.0.C1
		1210112	G4.0.C2
		1210113	G4.0C3
		1210114	G4.0.C4
		1210115	G4.0.C5

	GROUP	A/C internal code	Carnal 2110 control (0%) - 1	A/C internal code	Carnal 2110 (2%) - 2	A/C internal code	Carnal 2110 (4%) - 3
HEAVY SALTED	G3 - BLED COD	1210116	G3.1.C1	1210121	G3.2.C1	1210126	G3.3.C1
		1210117	G3.1.C2	1210122	G3.2.C2	1210127	G3.3.C2
		1210118	G3.1.C3	1210123	G3.2.C3	1210128	G3.3.C3
		1210119	G3.1.C4	1210124	G3.2.C4	1210129	G3.3.C4
		1210120	G3.1.C5	1210125	G3.2.C5	1210130	G3.3.C5
	G4 - DIRECT SLAUGHTER	1210131	G4.1.C1	1210136	G4.2.C1	1210141	G4.3.C1
		1210132	G4.1.C2	1210137	G4.2.C2	1210142	G4.3.C2
		1210133	G4.1.C3	1210138	G4.2.C3	1210143	G4.3C3
		1210134	G4.1.C4	1210139	G4.2.C4	1210144	G4.3.C4
		1210135	G4.1.C5	1210140	G4.2.C5	1210145	G4.3.C5

	GROUP	A/C internal code	Carnal 2110 control (0%) - 1	A/C internal code	Carnal 2110 (2%) - 2	A/C internal code	Carnal 2110 (4%) - 3
BRINES	G3 - BRINE BLED COD	1210146	G3.1.B1	1210149	G3.2.B1	1210152	G3.3.B1
		1210147	G3.1.B2	1210150	G3.2.B2	1210153	G3.3.B2
		1210148	G3.1.B3	1210151	G3.2.B3	1210154	G3.3.B3
	G4 - BRINE DIRECT SLAUGHTER	1210155	G4.1.B1	1210158	G4.2.B1	1210161	G4.3.B1
		1210156	G4.1.B2	1210159	G4.2.B2	1210162	G4.3.B2
		1210157	G4.1.B3	1210160	G4.2.B3	1210163	G4.3B3

ANNEX VI: WP2 – Oxidation and polyphosphate residuals results.

		SMP	ANFACO CODE	*PEROXIDES INDEX (meq.O2/Kg.fat)*	*TBA INDEX* (μmol MAD/Kg muscle tissue)	DIPHOSPHATE		TRIPHOSPHATE		HEXAMETAPHOSPHATE		COMMENTS
						(gP/100g)	(gP2O5/100g)	(gP/100g)	gP2O5/100g	(gP/100g)	(gP2O5/100g)	
G3 - BLED COD	RAW MATERIAL	G3.0.C1	1210106	<2,00	<1,8	<0,03	<0,07	<0,03	<0,07	<0,09	<0,04	No detected phosphates
		G3.0.C2	1210107	<2,00	2,7	<0,03	<0,07	<0,03	<0,07	<0,09	<0,04	No detected phosphates
		G3.0.C3	1210108	<2,00	1,8	<0,03	<0,07	<0,03	<0,07	<0,09	<0,04	No detected phosphates
		G3.0.C4	1210109	<2,00	<1,8	<0,03	<0,07	<0,03	<0,07	<0,09	<0,04	No detected phosphates
		G3.0. C5	1210110	<2,00	3,2	<0,03	<0,07	<0,03	<0,07	<0,09	<0,04	No detected phosphates
	HEAVY SALTED	G3.1.C1	1210116	<2,00	5,4	<0,03	<0,07	<0,03	<0,07	<0,09	<0,04	No detected phosphates
		G3.1.C2	1210117	<2,00	5,0	<0,03	<0,07	<0,03	<0,07	<0,09	<0,04	No detected phosphates
		G3.1.C3	1210118	<2,00	6,4	<0,03	<0,07	<0,03	<0,07	<0,09	<0,04	No detected phosphates
		G3.1.C4	1210119	<2,00	<1,8	<0,03	<0,07	<0,03	<0,07	<0,09	<0,04	No detected phosphates
		G3.1.C5	1210120	<2,00	5,0	<0,03	<0,07	<0,03	<0,07	<0,09	<0,04	No detected phosphates
		G3.2.C1	1210121	<2,00	4,1	<0,03	<0,07	<0,03	<0,07	<0,09	<0,04	Triphosphate below quantification limit is detected.
		G3.2.C2	1210122	<2,00	5,0	<0,03	<0,07	<0,03	<0,07	<0,09	<0,04	No detected phosphates.
		G3.2.C3	1210123	<2,00	4,5	<0,03	<0,07	<0,03	<0,07	<0,09	<0,04	No detected phosphates
		G3.2.C4	1210124	<2,00	3,2	<0,03	<0,07	<0,03	<0,07	<0,09	<0,04	Triphosphate below quantification limit is detected.
		G3.2.C5	1210125	<2,00	3,6	<0,03	<0,07	0,03	0,08	<0,09	<0,04	Only triphosphate is detected and quantified.
		G3.3.C1	1210126	<2,00	4,5	<0,03	<0,07	<0,03	<0,07	<0,09	<0,04	Triphosphate below quantification limit is detected.
		G3.3.C2	1210127	<2,00	5,4	<0,03	<0,07	<0,03	<0,07	<0,09	<0,04	Triphosphate below quantification limit is detected.
		G3.3.C3	1210128	<2,00	5,4	<0,03	<0,07	<0,03	<0,07	<0,09	<0,04	Triphosphate below quantification limit is detected.
		G3.3.C4	1210129	<2,00	6,8	<0,03	<0,07	0,04	0,09	<0,09	<0,04	Only triphosphate is detected and quantified.
		G3.3.C5	1210130	<2,00	4,5	<0,03	<0,07	0,04	0,1	<0,09	<0,04	Only triphosphate is detected and quantified.
G4 - DIRECT SLAUGHTER	RAW MATERIAL	G4.0.C1	1210111	<2,00	1,8	<0,03	<0,07	<0,03	<0,07	<0,09	<0,04	No detected phosphates
		G4.0.C2	1210112	<2,00	2,7	<0,03	<0,07	<0,03	<0,07	<0,09	<0,04	No detected phosphates
		G4.0.C3	1210113	<2,00	2,7	<0,03	<0,07	<0,03	<0,07	<0,09	<0,04	No detected phosphates
		G4.0.C4	1210114	<2,00	3,6	<0,03	<0,07	<0,03	<0,07	<0,09	<0,04	No detected phosphates
		G4.0. C5	1210115	<2,00	<1,8	<0,03	<0,07	<0,03	<0,07	<0,09	<0,04	No detected phosphates
	HEAVY SALTED	G4.1.C1	1210131	<2,00	5,0	<0,03	<0,07	<0,03	<0,07	<0,09	<0,04	No detected phosphates
		G4.1.C2	1210132	<2,00	5,4	<0,03	<0,07	<0,03	<0,07	<0,09	<0,04	No detected phosphates
		G4.1.C3	1210133	<2,00	5,9	<0,03	<0,07	<0,03	<0,07	<0,09	<0,04	No detected phosphates
		G4.1.C4	1210134	<2,00	6,4	<0,03	<0,07	<0,03	<0,07	<0,09	<0,04	No detected phosphates
		G4.1.C5	1210135	<2,00	4,5	<0,03	<0,07	<0,03	<0,07	<0,09	<0,04	No detected phosphates
		G4.2.C1	1210136	<2,00	4,1	<0,03	<0,07	<0,03	<0,07	<0,09	<0,04	Triphosphate below quantification limit is detected.
		G4.2.C2	1210137	<2,00	5,4	<0,03	<0,07	<0,03	<0,07	<0,09	<0,04	Triphosphate below quantification limit is detected.
		G4.2.C3	1210138	<2,00	<1,8	<0,03	<0,07	<0,03	<0,07	<0,09	<0,04	Triphosphate below quantification limit is detected.
		G4.2.C4	1210139	<2,00	5,9	<0,03	<0,07	0,03	0,08	<0,09	<0,04	Only triphosphate is detected and quantified.
		G4.2.C5	1210140	<2,00	5,9	<0,03	<0,07	0,03	0,07	<0,09	<0,04	Only triphosphate is detected and quantified.
		G4.3.C1	1210141	<2,00	4,5	<0,03	<0,07	0,05	0,12	<0,09	<0,04	Only triphosphate is detected and quantified.
		G4.3.C2	1210142	<2,00	4,5	<0,03	<0,07	0,04	0,1	<0,09	<0,04	Only triphosphate is detected and quantified.
		G4.3C3	1210143	<2,00	11,3	<0,03	<0,07	0,05	0,12	<0,09	<0,04	Only triphosphate is detected and quantified.
		G4.3.C4	1210144	<2,00	3,6	<0,03	<0,07	0,07	0,16	<0,09	<0,04	Only triphosphate is detected and quantified.
		G4.3.C5	1210145	<2,00	5,9	<0,03	<0,07	0,05	0,1	<0,09	<0,04	Only triphosphate is detected and quantified.

ANNEX VII: WP2 – Minerals results.

GROUP		SMP	ANFACO CODE	Na (g/100g)	ClNa (g/100g)	P (g/100g)	P2O5 (g/100g)	K (g/100g)	Ca (mg/Kg)	Mg (mg/Kg)	Fe (mg/Kg)	Zn (mg/Kg)	Cu (mg/Kg)
G3 - BLED COD	RAW MATERIAL	G3.0.C1	1210106	0,26	0,66	0,22	0,50	0,34	164	477	2,9	4,5	<0,16
		G3.0.C2	1210107	0,27	0,69	0,20	0,46	0,34	161	510	2,3	4,2	<0,16
		G3.0.C3	1210108	0,34	0,86	0,20	0,46	0,33	283	523	2,2	3,9	<0,16
		G3.0.C4	1210109	0,24	0,61	0,20	0,46	0,31	155	453	<2	4,8	<0,16
		G3.0.C5	1210110	0,33	0,84	0,20	0,46	0,31	174	530	<2	4,4	<0,16
	LIGHT SALTED	G3.1.C1	1210116	6,7	17,0	0,1	0,23	0,18	430	477	2	3,6	<0,16
		G3.1.C2	1210117	6,5	16,5	0,12	0,27	0,19	611	460	2,9	5,4	0,25
		G3.1.C3	1210118	6,6	16,8	0,12	0,27	0,17	588	494	2,4	4,9	0,17
		G3.1.C4	1210119	6,4	16,3	0,12	0,27	0,18	475	490	2,9	4,5	0,22
		G3.1.C5	1210120	6,3	16,0	0,1	0,23	0,17	510	544	4,2	4,3	0,2
		G3.2.C1	1210121	6,6	16,8	0,18	0,41	0,23	432	445	3	6,4	0,21
		G3.2.C2	1210122	6,3	16,0	0,16	0,37	0,25	428	371	3,9	5,2	0,23
		G3.2.C3	1210123	6,4	16,3	0,16	0,37	0,24	451	387	1,7	3,8	0,18
		G3.2.C4	1210124	6,6	16,8	0,18	0,41	0,25	404	452	3,9	4,1	0,37
		G3.2.C5	1210125	6,7	17,0	0,24	0,55	0,24	1022	517	3,2	4,1	0,22
		G3.3.C1	1210126	7,5	19,1	0,18	0,41	0,32	363	335	2,2	7,2	0,23
		G3.3.C2	1210127	7,1	18,0	0,18	0,41	0,35	371	349	2,7	4,9	0,22
		G3.3.C3	1210128	7,5	19,1	0,16	0,37	0,26	371	326	2,6	4,0	0,25
		G3.3.C4	1210129	7,4	18,8	0,14	0,32	0,31	391	275	4,5	3,9	0,19
		G3.3.C5	1210130	7,3	18,6	0,16	0,37	0,30	586	374	2,6	4,7	0,16
G4 - DIRECT SLAUGHTER	RAW MATERIAL	G4.0.C1	1210111	0,22	0,56	0,22	0,50	0,37	130	452	<2	4	<0,16
		G4.0.C2	1210112	0,27	0,69	0,20	0,46	0,31	300	482	2	3,6	<0,16
		G4.0C3	1210113	0,29	0,74	0,20	0,46	0,29	180	519	<2	4,2	<0,16
		G4.0.C4	1210114	0,33	0,84	0,20	0,46	0,29	280	546	<2	4,7	<0,16
		G4.0.C5	1210115	0,26	0,66	0,20	0,46	0,30	157	527	2	4,5	<0,16
	LAIGHT SALTED	G4.1.C1	1210131	7,7	19,6	0,08	0,18	0,17	460	352	4,8	3,9	<0,16
		G4.1.C2	1210132	6,9	17,5	0,1	0,23	0,18	467	359	2,2	3,3	0,21
		G4.1.C3	1210133	7,6	19,3	0,16	0,37	0,19	1874	389	6,1	4,0	0,20
		G4.1.C4	1210134	7,5	19,1	0,1	0,23	0,19	507	359	2,4	4,8	0,23
		G4.1.C5	1210135	7,9	20,1	0,1	0,23	0,2	480	358	1,8	4,9	0,22
		G4.2.C1	1210136	6,9	17,5	0,14	0,32	0,28	386	337	1,6	3,7	0,2
		G4.2.C2	1210137	7	17,8	0,16	0,37	0,26	341	385	1,7	3,9	0,23
		G4.2.C3	1210138	6,8	17,3	0,14	0,32	0,27	382	335	1,7	3,7	0,18
		G4.2.C4	1210139	7,3	18,6	0,16	0,37	0,28	455	380	3,4	3,3	0,17
		G4.2.C5	1210140	7,4	18,8	0,14	0,32	0,27	354	352	2,5	3,9	0,2
		G4.3.C1	1210141	7,2	18,3	0,22	0,50	0,39	380	318	1,8	3,8	0,21
		G4.3.C2	1210142	7,5	19,1	0,22	0,50	0,37	636	284	5,5	3,8	0,23
		G4.3C3	1210143	7,5	19,1	0,18	0,41	0,36	346	309	2	3,8	0,19
		G4.3.C4	1210144	7,5	19,1	0,22	0,50	0,37	439	345	3,1	3,5	0,2
		G4.3.C5	1210145	7,6	19,3	0,22	0,50	0,39	351	329	2,4	3,8	0,2

ANNEX VII: WP2 – Minerals results.

GROUP		Code	A/C	Na (g/L)	ClNa (g/L)	P (g/L)	P2O5 (g/L)	K (g/L)	Ca (mg/L)	Mg (mg/L)	Fe (mg/L)	Zn (mg/L)	Cu (mg/L)
G3 - BLED COD	BRINE	G3.1.B1	1210146	99,8	253,7	0,40	0,92	1,24	363	514	1,1	<0,20	0,06
G3 - BLED COD	BRINE	G3.1.B2	1210147	93,9	238,7	0,50	1,15	1,42	336	474	1,1	0,3	0,03
G3 - BLED COD	BRINE	G3.1.B3	1210148	94,5	240,2	0,62	1,42	1,68	300	475	1,2	0,22	0,02
G3 - BLED COD	BRINE	G3.2.B1	1210149	93,5	237,7	1,22	2,79	3,2	260	374	1,4	<0,20	0,02
G3 - BLED COD	BRINE	G3.2.B2	1210150	94	238,9	1,44	3,30	3,16	292	392	1,4	<0,20	0,02
G3 - BLED COD	BRINE	G3.2.B3	1210151	94,1	239,2	1,48	3,39	3,24	273	365	1,1	<0,20	0,02
G3 - BLED COD	BRINE	G3.3.B1	1210152	90,3	229,5	1,50	3,44	4,55	176	139	0,77	<0,20	0,02
G3 - BLED COD	BRINE	G3.3.B2	1210153	101,8	258,8	1,58	3,62	4,56	192	170	1,4	<0,20	<0,02
G3 - BLED COD	BRINE	G3.3.B3	1210154	93,3	237,2	1,44	3,30	4,5	186	149	1,4	<0,20	0,02
G4 - DIRECT SLAUGHTER	BRINE	G4.1.B1	1210155	91,7	233,1	0,52	1,19	1,5	322	459	0,89	<0,20	0,04
G4 - DIRECT SLAUGHTER	BRINE	G4.1.B2	1210156	99,9	253,9	0,56	1,28	1,7	326	480	1,1	<0,20	0,02
G4 - DIRECT SLAUGHTER	BRINE	G4.1.B3	1210157	97,2	247,1	0,54	1,24	1,59	279	423	0,71	<0,20	0,02
G4 - DIRECT SLAUGHTER	BRINE	G4.2.B1	1210158	104,2	264,9	0,78	1,79	3,14	191,3	247	1,7	0,34	0,02
G4 - DIRECT SLAUGHTER	BRINE	G4.2.B2	1210159	99,2	252,2	1,02	2,34	3,08	212	292	1,7	0,4	<0,02
G4 - DIRECT SLAUGHTER	BRINE	G4.2.B3	1210160	97,9	248,9	1,02	2,34	3,12	236	289	1	<0,20	<0,02
G4 - DIRECT SLAUGHTER	BRINE	G4.3.B1	1210161	104,7	266,1	1,38	3,16	4,74	159	93	1,5	0,59	<0,02
G4 - DIRECT SLAUGHTER	BRINE	G4.3.B2	1210162	99,7	253,4	1,80	4,12	4,57	201	140	1,8	0,66	0,02
G4 - DIRECT SLAUGHTER	BRINE	G4.3B3	1210163	108,4	275,6	1,42	3,25	4,63	151	105	1,2	0,58	0,07