

NUTRIENT CONTENTS IN NORWEGIAN FROZEN FISH PRODUCTS MAJOR AND MINOR ELEMENTS

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ABSTRACT

Thirtyone frozen fish fillets and fish products available on the Norwegian market, were analysed by atomic absorption spectrophotometry for their contents of the major elements sodium, potassium, magnesium, calcium and phosphorus, the essential trace elements iron, copper, zinc, manganese and selenium, and of the non-essential elements for man, arsenic, cadmium, mercury and lead.

The results for the major and essential elements were discussed relative to the recommended daily allowances (RDA) as given by U.S. National Research Council. The sodium contents were 5-6 times higher than in corresponding fresh fillets, and a more reasonable ratio between sodium and potassium would be of nutritional advantage. Generally fish products are good sources for phosphorus and selenium, but low in magnesium, calcium, manganese, iron, copper and zinc.

The non-essential elements, cadmium, mercury and lead, were discussed relative to the provisional tolerable daily intake as given by a joint FAO/WHO expert committee. Low values for the contaminants were recorded in all products analysed.

INTRODUCTION

A wide variety of industrially produced frozen fish products are now available to the consumer. This warrants attention to the nutritional quality in the products and to the contents of micro-nutrients as vitamins, macro- and trace element. Food is the source not only of the essential elements but also of toxic elements such as lead, cadmium and mercury. Thus, information on the levels of these elements in various foods and in the diet is of value both from toxicological and nutritional points of view.

Most studies on the element composition of marine fish have been related to environmental pollution investigations, and have concentrated on the con-

tents of copper, zinc, cadmium, lead and mercury (LUNDE, 1970; JULSHAMN et al., 1978; ICES, 1977). In this paper the element composition of several frozen fish fillets and fish products available on the Norwegian market were analysed, aiming at establishing data for the intake of 5 major and 9 trace elements in these products. The products have also been analyzed for their general composition and for vitamins (LIED and JULSHAMN, 1986).

MATERIALS AND METHODS

Five samples each of 31 consumer-packed frozen fish products available on the Norwegian market were purchased in food stores. The samples were homogenized, freeze-dried and stored in closely capped containers. Care was taken to avoid metal contamination during the preanalytical treatment of the samples. Further details regarding the treatment of the samples are given by LIED and JULSHAMN (1986).

All elements were analysed by atomic absorption spectrophotometry (AAS), and with the exception of mercury, were determined in a digest of nitric acid and perchloric acid (JULSHAMN et al., 1982). Sodium and potassium were measured in the emission mode and calcium, magnesium, manganese, iron, copper and zinc by flame atomic absorption (JULSHAMN et al., 1978). Phosphorus, selenium, arsenic, cadmium and lead were measured by graphite furnace atomic absorption (GFAA) (LIN and JULSHAMN, 1984; JULSHAMN et al., 1982; JULSHAMN et al., 1986) and mercury was analyzed by cold vapour atomic absorption (EGAAS and JULSHAMN, 1978). The accuracy of the analyses was tested in an interlaboratory study arranged by ICES (1984) and also by analyzing the reference samples Oyster tissue (SRM 1566) and Bovine Liver (SRM 1577) (National Bureau of Standards) and all methods were found satisfactory (Table 1).

Table 1. Average and relative standard deviation (% in parenthesis) of trace elements based on data from ICES seventh round intercalibration for trace metals in biological tissue (mgkg⁻¹ dry matter).

Sample	Cu		Zn		As		Cd		Pb		Hg	
	ICES	IN ^{a)}	ICES	IN ^{a)}	ICES	IN ^{a)}	ICES	IN ^{a)}	ICES	IN ^{a)}	ICES	IN ^{a)}
Lobster												
hepatopancreas . . .	331(10)	332(0.7)	179(6)	179(4)	25(21)	28.9(7)	26(8)	33(10)	5.57(30)	7.94(14)	0.254(19)	0.263(2)
Scallops	3.7(16)	3.25(17)	58(5)	58.7(2)	7.1(29)	7.3(9)	0.75(13)	0.83(11)	0.29(41)	0.28(26)	0.08(10)	0.075(11)
Plaice muscle	31(27)	3.12(30)	93(10)	99.1(3)	4.1(35)	1.1(22)	0.06(38)	0.06(14)	1.98(41)	1.43(22)	0.056(16)	0.058(9)

^{a)} Institute of Nutrition, Directorate of Fisheries.

RESULTS AND DISCUSSION

Sodium, potassium, magnesium, calcium and phosphorus (Table 2). The sodium contents in the analysed products were in the range of 2.0 to 5.0 gkg⁻¹ except for higher values in smoked and salted products. Frozen fish fillets were up to ten times higher in sodium compared to the corresponding fresh fish fillets, which had concentrations from 0.40 to 0.80 gkg⁻¹ (JULSHAMN et al., 1978). The values for potassium were in the same range as sodium, from 1.7 to 4.6 mgkg⁻¹. This concentration range is in good agreement with data reported on Finnish sea fish by NUURTAMO, 1980). For adults the U.S. recommended daily allowances (RDA) of sodium and potassium are 1.1–3.3 g and 1.9–5.6 g, respectively. A meal size of 200 g fish would cover 16 to 160% of sodium for most of the products, except smoked and salted products, but not more than 6 to 47% of the RDA-value for potassium. From a nutritional point of view the sodium content should be substantially reduced in some of these fish products to give a more reasonable ratio between sodium and potassium.

Magnesium contents varied between 0.13 and 0.43 gkg⁻¹. Values reported by NUURTAMO (1980) on fish and fish products from Finland were in the same range (0.20–0.40 gkg⁻¹). These products would supply 7–25% of the recommended daily intake based on a serving size of 200 g.

The calcium contents were low and varied within the range 0.04 to 0.60 gkg⁻¹ with the exception of smoked haddock. It is known that fish fillets are poor sources of calcium. The daily intake from these products would cover only 0.8 to 16% of the U.S.A. RDA-value.

The phosphorus content of the products varied between 1.4 and 3.1 gkg⁻¹ in fillets and between 0.85 and 2.8 gkg⁻¹ in processed fish products. These results are in the same range as those reported by NUURTAMO et al. (1980). The phosphorus content in a portion of 200 g of the fish products would cover 21 to 81% of the RDA-value which is given as 0.8 g in the U.S.A.

Manganese, iron, copper, zinc and selenium (Table 3). The manganese contents were within the range 0.25 to 4.8 mgkg⁻¹. Natural contents of manganese in fish fillets are in the order of 0.5 mgkg⁻¹ (JULSHAMN et al., 1986) corresponding well with the data reported from Finland (NUURTAMO et al., 1980). All processed products showed values above 0.8 mgkg⁻¹, with the exception of fish balls (0.25 mgkg⁻¹) and fish cakes (0.68 mgkg⁻¹). U.S.A. has recommended a daily dietary intake for manganese of 2.5–5.0 mg for man, and calculated on a meal size of 200 the products would supply less than 20% of this RDA-value with the exception of one product (plaice, breaded fillet). Fish fillets of marine origin are thus poor sources of manganese, but still a better source than freshwater fish (JULSHAMN et al., 1986).

The contents of iron ranged from 1.2 to 6.2 mgkg⁻¹, with one exception (stew w/saithe) with 37.4 mgkg⁻¹. Iron contents in the fish products seemed not to increase through the processing. The iron concentrations in fish fillets from

the ocean as well as from freshwater are in the same range (NUURTAMO et al., 1980; JULSHAMN et al., 1986). The daily intake from the analysed products would cover only 2 to 12% of the RDA-value (10 mg) based on a meal size of 200 g. Fish fillets and fish products are generally poor sources of iron in human nutrition.

All fish products had copper contents below 1 mgkg^{-1} . The highest copper level was found in the products «saihte, breaded fillet» and «fish soufflé w/saihte» with 0.93 and 0.95 mgkg^{-1} , respectively, whereas a product of unprocessed cod fillet showed 0.08 mgkg^{-1} . In general, fish fillets are low in copper with values down to 0.1 mgkg^{-1} . The products analysed would supply 0.5 to 9.5% of the U.S.A. RDA-values of 2–3 mg.

The zinc contents in the samples were within a remarkably small range (2.2 to 5.9 mgkg^{-1}), corresponding with the Finnish material except for the values from herring ($10\text{--}11 \text{ mgkg}^{-1}$). The content in a meal size of 200 g will cover only 2 to 8% of the U.S.A. RDA-value of 15 mg/d.

As to selenium five samples of prepared food products had low contents ($<0.1 \text{ mgkg}^{-1}$) whereas the others ranged from 0.1 to 0.41 mgkg^{-1} . The U.S.A. has recommended a range for the dietary selenium intake from 0.05 mg/d to 0.2 mg/d for man. Thus, the analysed fish products would give selenium intakes between 3–12% and 44–176% of these RDA-values. The selenium contents seem to be somewhat reduced by the processing.

Arsenic, cadmium, mercury and lead (Table 4). These elements were included because of their possible toxicity in foods. The arsenic concentrations in the analysed fish products varied considerably between 0.63 and 8.7 mgkg^{-1} . The highest arsenic levels were found in products of cod, whereas products of saihte had lower values. Such species differences seem to be directly related to the level of arsenic in the food and this may also be responsible for differences in arsenic levels in the same species from different sampling areas (FALCONER et al., 1983). Fish products consisting only in part of fish, e.g. fish cakes, fish balls etc., have correspondingly lower arsenic contents.

The cadmium contents in the fish products varied between $<0.001 \text{ mgkg}^{-1}$ and 0.037 mgkg^{-1} . The overall levels of cadmium were low. Values in the low range were found for fillet samples ($<0.010 \text{ mgkg}^{-1}$). Finnish results ranged from $0.001\text{--}0.010 \text{ mgkg}^{-1}$ fish fillets (NUURTAMO et al., 1980). A FAO/WHO recommendation puts the tolerable weekly intake of cadmium to 0.47–0.59 mg/person/week. A portion of 200 g fish will give about 1% of this value. Cadmium intakes from frozen fish and fish products seem therefore not to be a problem from a nutritional point of view.

The mercury contents in the products were generally low and less than 0.05 mgkg^{-1} in all samples analysed. There were no differences in the mercury content between products from different fish species. Similar values have been reported elsewhere (ANDERSEN 1982; JULSHAMN et al., 1978). Mercury contents

Table 2. The contents of sodium, potassium, magnesium, calcium and phosphorus in Norwegian frozen fish products. The values are based on wet weight.

Product	Na		K		Mg		Ca		P	
	gkg ⁻¹	% RDA ^{a)}	gkg ⁻¹	% RDA ^{a)}	gkg ⁻¹	% RDA ^{a)}	gkg ⁻¹	% RDA ^{a)}	gkg ⁻¹	% RDA ^{a)}
Cod, smoked	7.43	45–135	3.55	12–37	0.23	13	0.64	16.0	2.54	64
Lettrøkt torsk										
Cod portions, lightly salted	6.37	38–115	3.44	12–36	0.23	13	0.37	9.3	3.05	76
Lettsprengt torsk										
Haddock, smoked	8.68	52–158	3.90	13–41	0.24	14	1.18	29.5	2.14	54
Lettrøkt kolje										
Cod fillets w/shrimps in dill sauce	3.25	19–59	2.48	8.7–26	0.16	9.1	0.10	2.5	1.58	40
Torskefilet m/reker i dillsaus										
Herring filet, cured/salted	32.1	194–538	1.68	6–17	0.43	25	0.60	15	1.38	35
Spekesild										
Saithe fillet in mussel sauce	3.09	18–56	4.38	15–46	0.38	22	0.19	4.8	2.10	53
Seifilet m/muslingsaus										
Saithe fillet in mustard sauce	2.12	13–38	4.20	14–44	0.28	16	0.13	3.8	1.98	50
Seifilet m/sennepssaus										
Cod, breaded sticks	3.71	22–67	2.86	10–30	0.21	12	0.04	1.0	2.61	65
Grilletter av torsk										
Cod, breaded fillet (raw)	3.82	23–69	3.75	13–89	0.26	15	0.19	4.8	2.14	54
Torskepanetter										
Cod, breaded fillet	3.70	22–67	4.73	16–49	0.31	18	0.03	0.8	2.82	71
Panert torsk										
Cod burgers, breaded portions	4.85	29–88	3.76	13–39	0.29	16	0.04	1.0	1.39	35
Fishburgers										
Cod, fish fingers (precooked)	4.14	27–75	3.86	13–40	0.28	16	0.06	15	2.64	66
Frityrstekt torsk										
Cod, fried	3.03	18–55	3.32	11–35	0.22	13	0.10	2.5	2.63	66
Steketorsk										
Cod, breaded portions	1.98	12–36	4.51	16–47	0.28	16	0.16	4.0	2.10	53
Rettt-i-panne torsk										

Fishcakes, breaded	3.71	22–67	2.86	10–30	0.21	12	0.09	2.3	1.97	50
Fiskekroketter										
Plaice, breaded fillet	2.63	16–47	1.64	5.7–17	0.37	21	0.85	21	1.47	37
Panert rødspette										
Saithe, breaded fillet	2.60	18–47	4.50	15–47	0.32	18	0.07	1.8	1.92	48
Panert sei										
Saithe, breaded portions	2.69	16–49	3.75	13–39	0.28	16	0.07	1.8	1.60	40
Grilletter av sei										
Saithe, breaded, w/paprika	4.58	27–83	4.56	16–48	0.30	17	0.57	14.3	2.35	59
Variantfisk med paprika										
Saithe, fish fingers (precooked)	3.68	22–67	4.57	16–48	0.34	19	0.08	2.0	2.32	58
Frityrstekt sei										
Saithe fillet w/onion	2.36	14–43	3.98	14–42	0.25	14	0.13	3.3	1.74	44
Seibiff med løk										
Fish balls	3.13	19–57	1.95	7–20	0.13	7.4	0.50	13	0.85	21
Fiskeboller										
Cod cakes w/leek	6.14	27–111	3.21	11–33	0.22	13	0.34	8.5	1.51	38
Torskekaker m/purre										
Fish cakes	4.68	28–85	2.41	8–25	0.14	8.0	0.50	13	3.22	81
Fiskekaker										
Fish cakes	n.d.		3.76	13–39	0.29	17	0.04	10	1.38	35
Fiskekarbonader										
Fish soup	6.49	39–118	2.67	9.3–28	0.18	10	0.50	13	1.22	31
Fiskesuppe										
Fish sufflé w/cod	3.13	19–57	2.40	8.4–25	0.21	12	0.77	19	1.06	27
Fiskegrateng										
Fish sufflé w/cod	4.35	26–79	2.63	9.2–27	0.19	11	0.46	12	2.34	59
Gammeldags fiskegrateng										
Fish sufflé w/saithe	4.17	25–75	4.49	15–47	0.28	16	0.48	12	2.63	66
Fin fiskegrateng										
Form-fish, cod w/lemon	4.40	26–80	4.98	10–31	0.39	17	0.10	2.5	2.19	55
Fisk i form m/sitron										
Stew w/saithe	2.78	16–50	3.11	11–32	0.16	9.1	0.57	14	1.23	31
Mormors beste seifrikassé										

^{a)} The percentage of the recommended daily allowances based on a serving size of 200 g.

Table 3. The contents of manganese, iron, copper, zinc and selenium in Norwegian frozen fish products. The values are based on wet weight.

Product	Mn		Fe		Cu		Zn		Se	
	mgkg ⁻¹	% RDA ^{a)}	mgkg ⁻¹	% RDA ^{a)}	mgkg ⁻¹	% RDA ^{a)}	mgkg ⁻¹	% RDA ^{a)}	mgkg ⁻¹	% RDA ^{a)}
Cod, smoked	0.50	2–4	2.67	5.4	0.26	1.7–2.6	3.48	4.6	0.41	41–164
Lettrøkt torsk										
Cod portions, lightly salted	0.33	1.3–2.6	1.19	2.4	0.08	0.5–0.8	3.32	4.4	0.16	15–60
Lettsprengt torsk										
Haddock, smoked	0.43	1.7–3.4	1.52	3.0	0.20	1.3–2	3.23	4.3	0.32	32–128
Lettrøkt kolje										
Cod fillets w/shrimps in dill sauce	0.50	2–4	3.33	6.6	0.37	2.5–3.7	2.24	1.5	0.11	11–44
Torskefilet m/reker i dillsaus										
Herring fillet, cured/salted	0.85	3.4–6.8	5.45	11	0.52	3.5–5.2	4.36	5.8	0.44	44–176
Spekesild										
Saithe fillet in mussel sauce	1.11	4.4–8.9	5.88	12	0.46	3.1–4.6	5.76	7.7	0.17	17–68
Seifilet m/muslingsaus										
Saithe fillet in mustard sauce	1.07	4.3–8.6	3.73	7.5	0.20	1.3–2	4.44	5.9	0.13	13–52
Seifilet m/sennepssaus										
Cod, breaded sticks	1.61	6.4–13	4.84	9.7	0.34	2.3–3.4	3.53	4.7	0.23	23–92
Grilletter av torsk										
Cod, breaded fillet (raw)	1.95	8–16	3.73	7.5	0.65	4.3–6.5	4.04	5.4	0.18	18–72
Torskepanetter										
Cod, breaded fillet	2.06	8–16	4.00	8.0	0.54	0.6–0.9	4.22	5.6	0.16	16–64
Panert torsk										
Cod burgers, breaded portions	1.48	6–12	4.95	9.9	0.35	2.3–3.5	3.36	4.5	0.18	18–72
Fishburgers										
Cod, fish fingers (precooked)	2.19	9–18	4.86	9.7	0.34	2.3–3.4	4.23	5.6	0.11	11–44
Frityrstekt torsk										
Cod, fried	1.48	6–12	3.31	6.6	0.72	4.8–7.2	3.63	4.8	0.10	10–40
Steketorsk										
Cod, breaded portions	0.98	3.9–7.8	2.43	4.9	0.36	2.4–3.6	3.52	4.7	0.12	12–48
Rett-i-panne torsk										

Fishcakes, breaded	1.55	6–12	2.89	5.8	0.31	2.1–3.1	4.42	5.9	0.26	26–104
Fiskekroetter										
Plaice, breaded fillet	4.80	19–38	5.17	10	0.55	3.7–5.5	5.91	7.9	0.21	21–84
Panert rødspette										
Saithe, breaded fillet	1.78	7–14	4.70	9.4	0.93	6.2–9.3	4.86	6.5	0.20	20–80
Panert sei										
Saithe, breaded portions	1.52	6–12	4.52	9.0	0.23	1.5–2.3	4.81	6.4	0.20	20–80
Grilletter av sei										
Saithe, breaded, w/paprika	2.28	9–18	4.04	8.1	0.84	5.6–8.4	5.64	7.5	0.08	8–32
Variantfisk m/paprika										
Saithe, fish fingers (precooked)	2.34	5.4–11	4.15	8.3	0.63	4.2–6.3	5.27	7.0	0.29	29–116
Fryrstekt sei										
Saithe, fillet w/onion	0.94	3.8–7.5	3.11	6.2	0.21	1.4–2.1	3.58	4.8	0.19	19–76
Seibiff m/løk										
Fish balls	0.25	1–2	1.44	2.9	0.16	1.1–1.6	2.34	3.1	0.03	3–12
Fiskeboller										
Cod cakes w/leek	2.17	8.7–1.7	4.84	9.7	0.67	4.5–6.7	3.82	3.7	0.28	28–112
Torskekaker m/purre										
Fish cakes	0.56	2.4–4.8	2.17	4.3	0.15	1–1.5	2.81	3.7	0.06	6–24
Fiskekaker										
Fish cakes	0.68	2.7–5.4	6.15	12	0.46	3.1–4.6	4.28	5.7	0.25	25–100
Fiskekarbonader										
Fish soup	1.41	5.6–11	4.12	8.2	0.30	2–3	3.41	4.5	0.20	20–80
Fiskesuppe										
Fish sufflé w/cod	1.27	5–10	2.72	5.4	0.33	2.2–3.3	4.44	5.9	0.22	22–88
Fiskegrateng										
Fish sufflé w/cod	1.35	5.4–11	4.84	9.7	0.63	4.2–6.3	4.58	6.1	0.20	20–80
Gammeldags fiskegrateng										
Fish sufflé w/saithe	0.96	3.8–7.7	2.87	5.7	0.95	6.3–9.5	4.97	6.6	0.08	8–32
Fin fiskegrateng										
Form-fish, cod w/lemon	1.01	4.1–8.1	2.32	4.6	0.40	2.7–4	3.32	4.4	0.07	7–28
Fisk i form m/sitron										
Stew w/saithe	0.90	3.6–7.2	37.4	75	0.44	2.9–4.4	3.60	4.8	0.15	15–60
Mormors beste seifrikassé										

^{a)} The percentage of the recommended daily allowances based on a serving size of 200 g.

Table 4. The contents of arsenic, cadmium, mercury and lead in Norwegian frozen fish products. The values are based on wet weight.

Product	As		Cd		Hg		Pb	
	mgkg ⁻¹	mg ^{a)}	mgkg ⁻¹	µg	mgkg ⁻¹	µg	mgkg ⁻¹	µg
Cod, smoked	7.11	1.42	0.002	0.4	0.026	5.2	0.33	66
Lettrøkt torsk								
Cod portions, lightly salted	8.68	1.74	0.004	0.8	0.030	6.0	0.02	4.0
Lettsprengt torsk								
Haddock, smoked	3.42	0.684	<0.001	<0.2	0.007	1.4	0.02	4.0
Lettrøkt kolje								
Cod fillets w/shrimps in dill sauce	3.71	0.742	0.004	0.8	0.019	3.8	0.12	24
Torskefilet m/reker i dillsaus								
Herring fillet, cured/salted	3.68	0.736	0.013	2.6	0.032	6.4	0.32	64
Spekesild								
Saithe fillet in mussel sauce	1.70	0.340	0.037	7.4	0.003	0.6	0.13	26
Seifilet m/muslingsaus								
Saithe fillet in mustard sauce	0.64	0.128	0.011	2.2	–	–	0.15	30
Seifilet m/sennepssaus								
Cod, breaded sticks	2.42	0.484	0.009	1.8	–	–	0.42	84
Grilletter av torsk								
Cod, breaded fillet (raw)	6.53	1.31	0.026	5.2	0.030	6.0	0.03	6.0
Torskepanetter								
Cod, breaded fillet	2.81	0.562	0.011	2.2	0.024	4.8	0.03	6.0
Panert torsk								
Cod burgers, breaded portions	1.17	0.234	0.025	5.0	0.003	0.6	0.38	76
Fishburgers								
Cod, fish fingers (precooked)	4.93	0.986	0.005	1.0	0.001	6.2	0.05	10
Frityrstekt torsk								
Cod, fried	3.99	0.798	0.008	1.6	0.010	2.0	0.03	6.0
Steketorsk								
Cod, breaded portions	4.60	0.920	0.007	1.4	0.016	3.2	0.02	4.0
Rett-i-panne torsk								

Fishcakes, breaded	4.09	0.818	0.010	2.0	0.024	4.8	0.37	74
Fiskekroetter								
Plaice, breaded fillets	1.64	0.328	0.012	2.4	0.030	6.0	0.07	14
Panert rødspette								
Saithe, breaded fillets	0.73	0.146	0.008	1.6	<0.001	<0.2	0.03	6.0
Panert sei								
Saithe, breaded portions	1.15	0.230	0.006	1.2	0.001	0.2	0.03	6.0
Grilletter av sei								
Saithe, breaded, w/paprika	1.04	0.208	0.025	5.0	0.015	3.0	0.03	6.0
Variantfisk m/paprika								
Saithe, fish fingers (precooked)	1.26	0.252	0.016	3.2	0.015	3.0	0.06	12
Frityrtekt sei								
Saithe fillet w/onion	0.28	0.056	0.011	2.2	0.028	5.6	0.03	6.0
Seibiff m/løk								
Fish balls	0.70	0.140	0.004	0.8	0.010	2.0	0.26	52
Fiskeboller								
Cod cakes w/leek	2.10	0.420	0.010	2.0	0.027	5.4	0.03	6.0
Torskekaker m/purre								
Fish cakes	1.78	0.356	0.003	0.6	0.017	3.4	0.07	14
Fiskekaker								
Fish cakes	1.06	0.212	0.004	0.8	0.003	0.6	0.26	52
Fiskekarbonader								
Fish soup	1.41	0.282	0.009	1.8	0.022	4.4	0.03	6.0
Fiskesuppe								
Fish sufflé w/cod	0.94	0.188	0.009	1.8	0.015	3.0	0.37	74
Fiskegrateng								
Fish sufflé w/cod	0.91	0.182	0.009	1.8	0.030	6.0	0.48	9.6
Gammeldags fiskegrateng								
Fish sufflé w/saithe	0.85	0.170	0.007	1.4	0.017	3.4	0.70	140
Fin fiskegrateng								
Form-fish, cod w/lemon	3.26	0.652	0.013	2.6	0.028	5.6	0.10	20
Fisk i form m/sitron								
Stew w/saithe	0.63	0.126	0.009	1.8	0.006	1.2	0.02	4.0
Mormors beste seifrikassé								

^{a)} The values are based on a serving size of 200 g.

in freshwater fishes showed values from 0.1 to 0.8 mgkg⁻¹ (JULSHAMN et al., 1986). The mercury intake with 200 g fish varies between 0.2 microg/d and 6.4 microg/d. This corresponds to a range of 0.5% to 15% of the provisional tolerable daily intake of 41 microg as recommended by a FAO/WHO expert committee (1972).

Lead contents varied substantially between 0.02 and 0.70 mgkg⁻¹. Ten values in the upper range (0.25–0.70 mgkg⁻¹) were found for samples of prepared food products, possibly because of the influence of processing. The lead intake with 200 g fish varied between 4 microg/d and 140 microg/d. This corresponds to 0.8 and 28% of the provisional tolerable daily intake of 0.5 mg as recommended by a joint FAO/WHO expert committee.

CONCLUSIONS

Several of the frozen fish products were rather high in sodium contents, and should preferably be reduced for nutritional reasons.

Frozen fish products are good sources of phosphorus and selenium, and poor sources of magnesium, calcium, manganese, iron, copper and zinc.

The contents of the non-essential elements were low in all products analysed.

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