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THE FLUORIDE CONTENTS IN SOME NORWEGIAN FISH PRODUCTS AND OTHER MARINE PRODUCTS

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ABSTRACT

The content of fluoride was determined by ion specific electrode measurements in samples of marine origin comprising edible fresh, frozen, smoked and canned fish products, whole fish species for industrial use, fishing industry offal products and fish meals. With the exception of canned kippered herring and «brisling» sardines, both containing skin and bones, all edible food products had low fluoride contents, range 0.16 to 2.06 mg/kg, average 0.8 mg/kg. Offal products, consisting mainly of skin and bones, had high fluoride contents, 30–110 mg/kg, ave. 60 mg/kg. Industrially exploited fish species had contents of 10 to 60 mg fluoride per kg, ave. 30 mg/kg, and fish meals of the same species gave values of 70 to 300 mg/kg, ave. 160 mg/kg, corresponding well with the fat-free dry matter content of whole fish. It is concluded that normal sea foods do not contribute much to the fluoride intake of the population, whereas industrial offall products and fish meals, when mixed in feeds or foods, may contribute substancially to the fluoride intake. Products of shark may have high fluoride contents, and some crustacean products, but not all, may have very high fluoride levels. The fluoride content of fish is concentrated mainly in skin and bones.

INTRODUCTION

Fluorine has a fairly universal occurrance in foods. It has been found beneficial for humans related to its cariostatic effect and possibly also for the maintenance of the bone tissue (NIELSEN, 1976). The study of fluorine deficiencies is difficult as a completely fluorine free diet has not been found (SCHWARZ, 1964). Sea foods are mentioned among fluorine rich foods (UNDERWOOD, 1971) but systematic analyses of fluorine in fish products are few compared to those of other elements. The extensive food tables of SOUCI et al. (1969) give flourine values for 15–20 fish species and products.

Fish meals mixed in feeds may be a source of fluorine for domestic animals. Special qualities of fish meal are introduced as fish protein concentrate (FPC) for human consumption. For such products, Food and Drug Administration in USA (1969) recommended an upper limit of 100 mg/kg as sodium fluoride.

This paper reports fluoride levels in samples of marine origin comprising edible fresh, frozen, smoked and canned fish products, fishing industry offal

products, whole fish species used for the production of meal and oil as well as fish meals from different fish species.

SAMPLES AND METHODS

All samples analyzed except the fish meals were available as homogenized freeze dried flours from two other studies of nutrient contents. EGAAS and BRAEKKAN (1977) analyzed the contents of selenium and arsenic in Norwegian edible fish products, and JULSHAMN et al. (1978) analyzed contents of 14 elements in Norwegian fish species and offall products from the fishing industry. The fish meals were obtained from the Norwegian Research Institute of the Herring Meal and Oil Industry (S.S.F.).

Fat was extracted from the samples using ethyl ether in a Soxhlet procedure. The fat-free samples were digested in 15 ml capped test tubes using hot concentrated nitric and perchloric acids (1:1, v/v). Fluoride ions in the digest were extracted into an alkaline phase using diphenyl silanediol in toluene. The pH was adjusted to 5.3 and the fluoride concentration measured by a fluoride selective electrode (RADIOMETER, COPENHAGEN). The procedure was a modification of a method proposed by VENKATESWARLU (1974). A further discussion of the method is given by SOEVIK and BRÆKKAN (1981).

Table 1. Fluoride contents in some edible fresh, frozen and smoked fish and marine products.

Sample	Fluoride mg/kg	Dry matter in sample g/kg
Halibut fillet, fresh	0,29	210
Plaice fillet, frozen	0.90	180
Saithe fillet, frozen	0.19	199
Saithe fish "fingers", frozen	0.52	355
Cod fish "fingers", frozen	0.51	420
Cod fillet, smoked	1.01	235
Salmon fillet, smoked	0.42	387
Mackerel fillet, smoked	0.81	475
Greenl. halibut fillet, smoked	1.11	376
Cod fillet, dried and lyed	0.18	144
Herring fillet, salt cured	2.06	596
Whale meat	0.39	293
Lobster meat	0.84	213
Average	0.71	
Range	0.2–2.0	

RESULTS AND DISCUSSION

Tables 1 and 2 give the fluoride contents in some edible marine products. All samples were obtained in the open market, and are normally consumed in Norwegian households.

With a few exceptions, all results fell within a range of 0.16 to 2 mg per kg, averaging 0.8 mg/kg, corresponding well with the values given by SOUCI et al. (1969), and KE et al. (1970), but appr. one tenth of the values given for canned fish products by WIERZCHOWSKI and WITUSZYNSKA (1965). According to these values, sea foods cannot be taken as a good source of fluoride in the food, and the values are far below levels which could be hazardous to human health.

Three herring products had fluoride levels in the high range from 1.6 to 3.9 mg/kg. These products include some bone and skin which may account for the elevated values. FINCH (1970) referred to analytical data showing that the fluoride content in fish was concentrated in bones, followed by the scales, whereas only a minor part of the total content was found in the fillets.

An exceptionally high value, 29.3 mg/kg was found for a sample of canned «brisling sardines» in oil, consisting of small, whole sprats.

Table 3 shows the much higher fluoride contents in offall products from the fishing industries, consisting mainly of skin and bones. The values ranged between 30 and 110 mg/kg, i.e. appr. a hundred times the values in the edible products given in Table 1 and 2. It may be noted that whereas fillet of saithe had 0.2 mg/kg of fluoride, a sample of saithe skin gave 105 mg/kg.

Such offall products when mixed in feeds, e.g. to furproducing animals, will contribute substantially to the total fluoride content of the feed.

Table 4 gives fluoride contents in whole fish. These were all samples of small, pelagic fish species caught for the production of fish meal and oil. An average value of 30 mg/kg, and a range of 10–60 mg/kg was found. The samples of small gadoid species with low fat content were in the high range, whereas mackerel and herring with high fat content (see dry matter values) were in the low range. It seems reasonable to conclude that the major part of the fluoride in whole fish is concentrated in skin and bones.

Lastly, some values for fluoride in fish meals are collected in Table 5. The range of 70–300 mg/kg, and an average of 160 mg/kg, corresponded well with the values for whole fish (Table 4), assuming a fat-free dry matter content of 20%. The range of 1:4 is, however, quite wide if the average should be used in estimating the fluoride content of a mixed feed. The highest value for fluoride content was found in whole fish as well as in meal of blue whiting (*Micromesistius potassou*). More samples must be analyzed to warrant a general conclusion regarding this species. Table 5 shows that fish meals used as fish protein concentrate (FPC) for human consumption may easily have fluoride contents above 100 mg/kg, the upper limit set for sodium fluoride by FDA (1969). Fish meals of mackerel and capelin were within the given limit. Values

Table 2. Fluoride contents in some canned fish and marine products.

Sample	Fluoride mg/kg	Dry matter in sample g/kg
Fish cakes,saithe	0.16	168
Fish cakes, cod/haddock	0.63	200
Fish pudding, haddock	0.75	198
Cod roe (pressed)	0.43	322
Cod roe, "caviar"	0.66	700
Cod soft roe (milt)	0.67	330
Cod roe/liver paste	0.29	518
Cod liver paste	0.80	582
Saithe, smoked fillet	0.38	514
Salmon, smoked fillet	0.42	387
Mackerel, fillet in sauce	0.89	445
Mackerel, fillet in oil	1.37	496
Herring, marinated	1.57	530
Herring, "kippered"	3.87	463
Sprat ("brisling") in oil	29.3⋆	899
Crab, meat	0.30	217
Average	0.88	
Range	0.16–3.90	

⋆ Excluded from average.

Table 3. Fluoride contents in some offall products from fishing industry.

Sample	Fluoride mg/kg sample	Dry matter in sample g/kg
Skin and bones, saithe	54.0	237
Skin and bones, ling	60.5	220
Skin and bones, greenl. halibut	38.7	376
Skin, cod	29.0	220
Skin, saithe	105.0	251
Backbones, ling	42.2	201
Heads, cod	31.8	209
Heads, ling	55.0	221
Heads, dogfish	111.0	211
Average	59	
Range	30–110	

Table 4. Fluoride contents in some fish species used for the production of fish meal and oil.

Sample	Fluoride mg/kg sample	Dry matter in sample g/kg
Herring, North Sea	24.0	352
Herring, Atlantic Ocean	12.5	320
Herring, Norw. fjords	20.9	366
Sprat	20.7	295
Mackerel	24.0	363
Horse mackerel	29.7	319
Greater sand eel	41.2	271
Great silver smelt	21.5	250
Norway pout	38.9	254
Blue whiting	62.7	247
Saithe (small)	26.0	245
Capelin	23.3	256
Polar cod	25.9	240
Average	29	290
Range	10–60	

Table 5. Fluoride contents in some Norwegian fish meals.

Samle from	Fluoride mg/kg
Herring, extracted	114
Mackerel	73
Mackerel, food quality	77
Whitefish, unspec., fillet	141
Blue whiting, sandeel, mixed	240
Same, food quality	260
Sandeel	101
Blue whiting	264
Same, food quality	294
Norway pout	71
Capelin	84
Average	156
Range	70–300

Dry matter contents of the samples: 900–960 g/kg.

for fluoride in fish meals corresponding with those in Table 5 were reported by FINCH (1970), KE et al. (1970), SPENCER et al. (1970) and ZIPKIN et al. (1970).

KE et al. (1970) report values suggesting that sharks accumulate more fluoride that teleosts. The present analysis of dogfish heads (Table 3), and a further analysis of an Indonesian sample of dried shark meat (unpublished, 218 mg/kg) support this. WALDBOTT (1963) suggested that all crustaceans tend to accumulate more fluoride than other sea food, due to their high calcium content. The values for fluoride in lobster meat (Table 1) and canned crab meat (Table 2) does not support this, nor do analyses of red feed (*Calanus finmarchicus*) and of prawn meat, given by SOEVIK and BRAEKKAN (1979).

However, SOEVIK and BRAEKKAN (1979) reported very high fluoride contents in samples of krill. Further values of 800 mg/kg in a samples of whole planktonic crustaceans and of 42 mg/kg in the meat of the same sample (Indonesian samples, unpublished) were clearly above the general levels found in the present report.

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