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THE SELENIUM CONTENT IN SOME NORWEGIAN FISH PRODUCTS

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ABSTRACT

Selenium has been analyzed in 43 samples of fresh, frozen, smoked and canned fish products by a method based on freeze drying, wet digestion, isolation of the element by hydride generation and atomic absorption spectrophotometer measurement. The contents varied between 0.03 and 1.42 mg Se per kg wet weight. Based on dry weight, the highest values were found among the samples of crustaceans (4.43 to 1.67 mg per kg) and a sample of canned, pressed cod roe (2.08 mg per kg). The lowest values were found in fish cakes and fish balls (0.58 to 0.19 mg per kg dry weight) and a marinated sample of sprat which contained 0.23 mg per kg dry weight. Different manufacturing procedures may explain some of the differences between related samples. Fish products should be considered as a source of selenium in the food.

INTRODUCTION

In the 1930's, several studies reported that certain plants growing on seleniferous soils accumulate considerable amounts of selenium. Furthermore, poisoning symptoms long known in livestock were shown to be caused by excessive selenium intake (Maag and Glenn, 1966). Increased research on trace elements during the last 20 years has shown that deficiency of selenium may constitute a greater problem than excessive intake. The first deficiency disease discovered could also be treated by vitamin E (Scott, 1971). Thompson and Scott (1969) showed that chickens fed a synthetic diet containing extremely low levels of selenium had poor growth and high mortality. High levels of vitamin E prevented mortality, but growth was inferior to that demonstrated with supplements of selenium even without addition of vitamin E, proving that selenium is an essential trace element. Underwood (1971) reviewed the problem of selenium as an essential trace element, and considered the dietary requirement to be in the order 0.1 to 0.3 mg Se per kg food, whereas the minimum toxic level might be close to 5 mg per kg. There is accordingly a need for studies

on the occurrence and the availability of the element in our food. While animal feeds have been analyzed extensively, very few data are available on human foods. The content of selenium may vary considerably in different samples of the same food, for vegetables related to the soil, and for animal products related to the feed.

This paper reports on contents of selenium in some Norwegian fish products sampled mainly from the retail markets. These samples were analyzed for their arsenic content as well, and these results are given in the following paper (EGAAS and BRÆKKAN, 1977).

MATERIALS AND METHODS

Fresh, frozen, smoked and canned products were obtained from the local fish market and from retail shops. Canned products were partly obtained from The Norwegian Quality Control Institute for Canned Fish Products, to ensure representative average samples. All samples were ground, freeze dried and homogenized. Dry matter was determined in connection with the freeze drying. The samples were stored in tightly closed plastic bottles until analyzed.

Two replicates of 0.5 to 1.5 g of each sample were digested for 15—20 minutes in a modified Betghe system (GORSUCH, 1951) with 20 to 30 ml of a mixture of concentrated nitric acid and sulfuric acid containing 1 g vanadium pentoxide per liter (MUNNS, 1972). After cooling and dilution with hydrochloric acid, selenium was liberated by the hydride generation technique and measured on a Perkin Elmer 403 atomic absorption spectrophotometer at 196 nm. Details of the method will be published elsewhere (EGAAS and JULSHAMN).

RESULTS AND DISCUSSION

The results are given in Table 1 and 2, where the contents of selenium are calculated on the basis of dry and wet weight. Altogether, 43 products were analyzed, representing common fish products in retail sale, and further some canned products mainly for export. The contents showed a total variation between 0.03 and 1.42 mg Se per kg wet weight. The highest values were found among the samples of lobster, crab and prawn. Based on dry weight, these samples showed contents of 4.43 to 1.67 mg per kg (1.42 to 0.40 mg per kg wet weight). Further, a sample of canned, pressed cod roe contained 2.08 mg per kg dry weight (0.67 mg per kg wet weight). The lowest values were found in fish cakes and fish balls, 0.58 to 0.19 mg per kg dry weight (0.09 to 0.03 mg per kg wet weight). These are typical composite products, with a minimum acceptable level of fish of

Table 1. The content of selenium in some fish products.

Sample of	Dry matter, %	Selenium Dry weight mg/kg	Wet weight mg/kg
Cod (Gadus morrhua)			
Frozen fillet	23.0	0.65	0.15
Smoked	23.5	1.21	0.29
Breaded-fillet	42.0	0.61	0.26
«Lutefisk»	14.4	1.40	0.20
Coalfish (Gadus virens)			
Frozen fillet	19.9	1.23	0.24
Breaded-fillet	35.5	0.66	0.23
Fish cakes	20.7	0.26	0.05
Halibut (Hippoglossus hippoglossus)			
Fillet	21.0	0.73	0.15
Greenland Halibut (Hippoglossus reinhardtius)			
Smoked	37.6	0.80	0.30
Plaice (Pleuronecta platessa)			
Fillet	18.0	0.75	0.13
Herring (Clupea harengus)			
Salt-cured	59.6	0.65	0.39
Mackerel (Scomber scombrus)			
Smoked	47.5	0.68	0.32
Salmon (Salmo salar)			
Smoked	38.7	1.25	0.48
Deep sea prawn (Pandalus borealis)			
Meat	31.9	1.67	0.53
Lobster(Homarus vulgaris)			
Meat	21.3	1.88	0.40
Roe	32.1	4.43	1.42
Whale meat	29.3	0.73	0.21

50%, flour and milk constituting the remaining major ingredients. Further a semipreserved sample of marinated sprat had the low level of 0.23 mg per kg dry weight (0.12 mg per kg wet weight).

Some of the differences in Table 1 and 2 may easily result from the greatly different manufacturing procedures used. It must be stressed that

Table 2. The concentration of selenium in some canned and preserved fish products.

Sample of	Dry matter, %	Selenium Dry weight mg/kg	Selenium Wet weight mg/kg
Cod			
Pressed cod roe	32.2	2.08	0.67
Cod milt	14.4	0.91	0.13
Smoked cod roe and liver	56.7	1.21	0.69
Roe/liver paste	51.8	0.63	0.32
Cod liver paste	58.2	0.88	0.51
Cod roe caviar	70.0	0.50	0.35
Coalfish			
Smoked fillets in soya-sauce	51.4	0.63	0.32
Fish balls in bouillon	16.8	0.19	0.03
" " " "	14.9	0.58	0.09
Haddock			
Fishpudding	19.8	0.73	0.14
Mackerel			
Fillet in onion sauce	46.1	0.88	0.41
" " chili sauce	41.8	0.63	0.26
" " orignon sauce	42.5	0.73	0.31
" " estragon sauce	37.2	0.85	0.32
" " curry sauce	45.3	0.60	0.27
" " mustard sauce	43.7	0.75	0.33
" " worchester sauce	41.9	1.03	0.43
" " dill sauce	43.8	0.58	0.28
" " tomato sauce	52.4	0.56	0.29
" " norwegian oil	49.6	0.50	0.25
Herring			
Kippered	46.3	0.81	0.37
Semi-preserved	53.0	2.53	1.34
Brisling (sprat)			
Smoked in oil	89.7	0.71	0.64
«Anchovies» (semi-preserved)	51.0	0.23	0.12
Crab			
Natural crab	21.7	2.77	0.53
Crab paste	26.7	2.25	0.60

this study does not aim at a comparison of biological distribution, but at providing some values for dietary evaluations.

The occurrence of selenium in food has been reviewed by SCHLETTWEIN-GSELL and MOMMSEN-STRAUB (1972). They have considered reports from 1961 and on. Different analytical methods have

been used which make a comparative evaluation difficult. MORRIS and LEVANDER (1970) determined the selenium content on wet weight basis in a wide range of American foods. They found seafoods to have the highest contents, from 0.4 to 0.7 mg per kg, whereas different meat products ranged from 0.2 to 0.5 mg per kg. Grain products varied from 0.025 to 0.66 mg per kg, whereas fruit and vegetables usually showed values less than 0.1 mg per kg. LUNDE (1970) applied the neutron activation method to the determinations of selenium in dehydrated fillets from cod, coalfish, haddock and whale meat and found values between 0.13 and 1.5 mg per kg. The present contents calculated on dry weight for the corresponding samples were in general agreement with values between 0.65 and 1.23 mg per kg dry weight. JULSHAMN et al. analyzed several minerals in samples of different fish species and byproducts. In a total of 85 different samples the selenium content varied from 0.1 to 1.3 mg per kg wet weight.

Although selenium deficiency so far has not been shown in humans, the recent discovery that selenium is a component of the enzyme glutathion peroxidase underlines that it is an essential trace element (ROTRUCK, 1973), and several nutritional effects of selenium can now be explained on this basis. Of special interest regarding fish products is the demonstration that naturally occurring selenium may reduce accompanying methylmercury toxicity (GANTHER et al., 1972).

UNDERWOOD (1971) claims that a diet should supply 0.1—0.3 mg Se per kg diet. Fish products constitute an important source of selenium to attain this dietary level.

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