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THE SELENIUM CONTENT IN SOME NORWEGIAN MARINE FISH SPECIES

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ABSTRACT

The selenium concentrations in fillets and livers of thirteen different marine fish species were analysed. Both hydride generation and graphite furnace atomic absorption spectrometry were used in the analyses, and the reliability of the methods were tested by standard reference materials. The fillets contained 0.12–0.52 mg Se/kg wet weight with an approximate mean of 0.3 mg/kg. The livers contained more than 1 mg Se/kg wet weight in most samples with 4 mg Se/kg in herring liver as the highest value recorded in this study. The average selenium content in the fish fillets gives approximately 60 microg selenium in a meal portion of 200 g, this would cover the Recommended Dietary Allowance (U.S. standards) for one day. Fish products should therefore be considered as a good source of this element.

INTRODUCTION

Fish and fish products account for about 25% of the total selenium intake in the Norwegian population when calculated from the food supply tables of 1978–1980, and only cereals give more selenium in the diet (STATENS ERNÆRINGSRÅD, 1984). Household and sport fishing, not registered in the food supply tables, further increase the selenium intake from fish products, especially in the coastal districts.

Methods for the analysis of selenium have developed rapidly during the last five to ten years, and earlier reports on selenium contents in foods should now be confirmed with new reliable analytical techniques. Reproducibility as well as detection limits have been improved to give more reliable results.

Selenium concentrations in the muscle tissues of most marine species vary between 0.4 and 0.9 mg per kg fresh weight. The liver concentrations vary more widely but are in general higher than in the fillets (EISLER, 1981). As compared to other food sources, fish products are generally high in selenium (JULSHAMN and RINGDAL, 1983) and are therefore a good dietary source of the element. The biological availability of selenium from fish, however, has been reported to be poor compared to vegetable sources (CANTOR et al., 1981), but little information is at yet available on the reason for this effect. The high mercury content in some fish species may influence the bioavailability of selenium in the fish products (DOUGLASS et al., 1981; RINGDAL et al., 1985; SCHREIBER, 1983).

The aim of this study was to collect new information on the selenium content of marine fish species by the use of new and more reliable analytical techniques.

MATERIALS AND METHODS

SAMPLING

The fish samples were obtained from coastal waters of Norway, from the Barents Sea and from fish farms located in Western Norway. Fish species, localities and year of catching are shown in Table 2. Fillets and livers were freeze-dried to constant weight, homogenized and stored in tightly closed bottles until analysis.

SELENIUM ANALYSIS

All samples were digested in a mixture of concentrated nitric and perchloric acids (suprapure, 9:1) as described by JULSHAMN et al. (1982). Both hydride generation (Perkin-Elmer MHS-20), HGAAS, and graphite furnace atomic absorption spectrometry, (Perkin-Elmer 5000 AAS-system), GFAAS, were used in the selenium analyses, the procedures, apparatus and instrument settings are described in details by JULSHAMN et al. (1982). The latest analyses with the GFAAS technique used the L'vov platform and the maximum power heating mode (Perkin-Elmer HGA 400) as described by RINGDAL et al. (1984). The methods were tested by analysis of reference materials from National Bureau of Standards (NBS), and the results are shown in Table 1.

Table 1. Comparative analyses of selenium in different NBS reference materials (dry matter $mgkg^{-1}$). n=3

Sample	HGAAS	GFAAS	GFAAS L'vov platform	Certified values
Oyster tissue (SRM 1566)	2.05±0.05	2.07±0.03	2.06±0.16	2.1±0. 5
Bovine liver (SRM 1577)	1.17±0.18	1.11±0.03	–	1.1±0. 1
Bovine liver (SRM 1577a)	–	–	0.64±0.06	0.71±0.07
Spinach (SRM 1570)	0.40±0.11	0.36±0.02	–	–

HGAAS: Hydride Generation Atomic Absorption Spectrometry.
GFAAS: Graphite Furnace Atomic Absorption Spectrometry.

RESULTS AND DISCUSSION

The selenium concentrations in the liver varied extensively among the species and exceeded 1 mg/kg in most of the samples. (Table 2). The herring liver had the highest concentrations recorded in this study (3.9 mg Se/kg). The liver concentrations within each species varied greatly, reflected by the relatively high standard deviation of the selenium concentrations in some of the species. The liver tissue of the investigated species differed in fat contents, «lean» fish species as cod, pollack and saithe have fatty livers whereas fat fish species as herring and trout have low fat contents in the livers. This may have influenced the selenium concentration as less selenium is found in the fat soluble fractions of fish tissues than in the protein fractions (CAPPON and SMITH, 1981; CAPPON and SMITH, 1982). LUNDE (1972) reported on lipid soluble selenium compounds from marine fish, but these results have not been confirmed later. Cod liver oil was analysed by VAN DE VEN (1978) who found a concentration of 0.14 mg/l, and this is considerably lower than the selenium concentrations in the liver reported in this study. Still, compared to most other food sources, fish liver oil is a rather good selenium source (JULSHAMN and RINGDAL, 1983).

The selenium concentration in the fillets varied between 0.12 and 0.52 mg/kg wet weight. This was somewhat lower than the values reported by EISLER (1981) but in good agreement with the results of LUTEN et al. (1980). The highest muscle concentrations were found in Norway haddock (0.52 mg/kg) and the lowest in cultured rainbow trout (0.12 mg/kg). An average concentration of approx. 0.3 mg/kg in the fillets of marine fish species is somewhat higher than the selenium concentrations found in several Norwegian freshwater fishes analysed by JULSHAMN et al. (1986). These species had muscle concentrations between 0.1 and 0.3 mg/kg. EGAAS and BRÆKKAN (1977) measured the selenium content of several Norwegian fish products. They reported values between 0.03–1.42 mg Se per kg wet weight, with the lowest selenium concentrations in composite products having reduced fish contents, e.g. fish cakes. The selenium concentrations of the analysed fish fillets were, however, in good agreement with the findings in our investigation.

The bioavailability of selenium from tuna fish has been reported to be low compared to vegetable food products (DOUGLASS et al., 1981; ALEXANDER et al., 1983). GABRIELSEN and OPSTVEDT (1980) reported the opposite when testing fish meal using another assay method of bioavailability. This relative high selenium bioavailability in fish meal has later been confirmed by AKSNES et al. (1983). The differing mercury contents in the tested diets could perhaps explain some of the differences reported in these studies. In a study on the utilization of selenium from trout RINGDAL et al. (1985) concluded that the selenium levels normally found in the fish are sufficient to satisfy the dietary need to animals having a normal selenium status.

Table 2. Selenium contents in some marine fish species (mean±standard deviation).

Species	Locality	Number of analysis	weight (g)	Liver (mg/kg wet weight)	Muscle (mg/kg wet weight)	Method of analysis
Herring (sild)						
Clupea harengus	MØRE (1985, jan.)[1]	3	357± 11	3.9±0.5	0.31±0.02	GFAAS platform
Cod (torsk)						
Gadus morhua	MASFJORD (1980)[1]	10	250±110	0.2±0.1	0.14±0.02	GFAAS
Gadus morhua	FRIERFJORD (1978–81)[2]	45	1304±1170	1.8±1.1	0.35±0.16	GFAAS
Pollack (lyr)						
Gadus pollachius	FRIERFJORD (1981)	10	2250±960	2.2±1.2	0.26±0.009	GFAAS
Gadus pollachius	MØRE (1980)[1]	10	–	–	0.31	GFAAS platform
Saithe (sei)						
Pollachius virens	HARDANGERFJORD (1984)[1]	6	1300± 89	–	0.30±0.01	GFAAS platform
Haddock (hyse)						
Gadus aeglefinus	MØRE (1980)[1]	10	–	–	0.45	GFAAS platform
Ling (lange)						
Molva molva	MØRE (1980)[1]	10	–	–	0.37	GFAAS platform
Ballan Wrasse (berggylte)						
Labrus berggylta	MØRE (1980)[1]	10	–	–	0.28	GFAAS platform
Norway Haddock (uer)						
Sebasters marinus	TROMS (1985)[3]	1	–	–	0.52	GFAAS platform
Plaice (rødspette)						
Pleuronectes platessa	FRIERFJORD (1981)[2]	18	430±130	1.4±0.7	0.34±0.14	GFAAS
Pleuronectes platessa	BARENTS SEA (1978)	10	–	–	0.27	GFAAS platform
Halibut (kveite)						
Hippoglossus hippoglossus ...	MØRE (1985)[1]	1	–	–	0.35	GFAAS platform
Sea Trout (sjøørret)						
Salmo trutta	FRIERFJORD (1981)[2]	1	800	3.2	0.30	GFAAS
Rainbow Trout (regnbueørret)						
Salmo gairdnerii	FISH FARM (1981)	30	69± 9	0.8±0.1	0.20±0.01	HGAAS
Salmo gairdnerii	FISH FARM (1982)	4	627±121	1.0±0.1	0.12±0.01	GFAAS
Atlantic Salmon (laks)						
Salmo salar	FISH FARM (1984)	5	1432±352	–	0.22±0.03	GFAAS platform
Salmo salar	FISH FARM (1984)	10	1639±467	2.3±0.5	–	GFAAS platform

[1] Western Norway [2] Southern Norway [3] Northern Norway

The selenium content in both fillet and liver of fish is generally high compared to other Norwegian food products (KARLSEN et al., 1981; JULSHAMN and RINGDAL, 1983). With an average concentration of 0.3 mg/kg selenium in the fillet a fish meal portion of 200 g gives 60 microg selenium. The U.S. Recommended Dietary Allowance is 50–200 microg per day and a fish meal therefore gives a significant supplement to the dietary selenium intake. Fish products should thus be recommended as a good dietary selenium source.

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