FLUORINE CONTENT OF TWO SUBMERGED PLANT SPECIES IN FOUR WARTA RIVER OXBOW LAKE RESERVOIRS NEAR POZNAŃ, POLAND

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SUMMARY: Studies were conducted on the bioconcentration of fluoride (F) in two submerged (underwater) plant species of four Warta River oxbow lake reservoirs near Poznań, Poland: milfoil (Myriophyllum spicatum L.) and hornwort (Ceratophyllum demersum L.). Water samples collected from the reservoirs varied in F content from 0.3 to 6 mg/L. In the plant tissue the mean F levels ranged from 22 mg/kg dry matter to 1060 mg/kg dm. The results showed that elevated F concentrations in water directly affected the F content of the submerged plants.

Keywords: Fluoride bioconcentration; Hornwort; Milfoil; Oxbow lake reservoirs; Submerged plants; Warta River, Poland.

INTRODUCTION

The purpose of this study was to determine the degree of accumulation (bioconcentration) of fluorine (F, as fluoride ion) in two submerged (underwater) plant species growing in the four oxbow lake reservoirs of the Warta River in northern Poland: milfoil (Myriophyllum spicatum L.) and hornwort (Ceratophyllum demersum L.). One of the reservoir lakes (S1) has considerably F contamination,1-5 while the other three lakes (S2, S3, S4) are relatively free of industrial F effluents. In this study our aim was to establish the extent these two plant species, which inhabit all four of the lakes, accumulate F under contaminated and uncontaminated environment conditions.

MATERIALS AND METHODS

Nature of study area: These investigations were conducted on the oxbow lake reservoirs of the Warta River near the city of Poznań, Poland. The first of these reservoirs, designated as S1, bears a considerably load of fluoride originating from the post-crystallization lye discharge of the “Luboń” SA chemical plant located several hundred meters from the reservoir. In the years 1997–2004 elevated concentrations of fluorine (F, as fluoride ion) were found in the water (1.4–6 mg/L) and bottom deposits (150 mg/kg dry matter to 186,000 mg/kg dm).

Oxbow lake reservoirs S2, S3, and S4, which are not subjected to anthropogenic contamination, are located 10–12 km south of S1. The concentration of F in these reservoirs was 0.3 mg/L. Owing to the relatively small amounts of F in their water, these reservoirs were treated as reference values for oxbow lake reservoir S1.

Material samplings and analysis: A total of 30 vegetation samples of both milfoil and hornwort species were collected uniformly from the whole surface of all four reservoirs. Each sample was dried, homogenized, and analyzed for F according to the method described previously for common reeds.3 F ion concentrations were determined (in the presence of TISAB IV buffer) using the

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potentiometric method with an Orion Research ion-selective Ionplus electrode and an A 720 Orion reference electrode.

RESULTS

As seen in the Table, the milfoil *Myriophyllum spicatum* L. in the F-contaminated oxbow lake reservoir S1 had a mean value of accumulated F of 778 mg/kg dm, and in the hornwort *Ceratophyllum demersum* L. it was 1,060 mg/kg dm. In the other three reservoirs containing 0.3 mg F/L these plants accumulated considerably lower amounts of F as shown in the Table and the Figure.

<table>
<thead>
<tr>
<th>Species</th>
<th>Oxbow lake reservoir</th>
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<tbody>
<tr>
<td>Milfoil (<em>Myriophyllum spicatum</em> L.)</td>
<td>S1: 611-898   S2: 19.6-30   S3: 21.1-33.6   S4: 15.4-28.3</td>
</tr>
<tr>
<td>Hornwort (<em>Ceratophyllum demersum</em> L.)</td>
<td>S1: 911-1299   S2: 21.4-36.9   S3: 27.1-35.6   S4: 24.1-35.5</td>
</tr>
</tbody>
</table>

![Figure. Dry matter fluoride content in tissues of plants collected from 4 oxbow lake reservoirs of the Warta River.](image)

During preliminary examination the analyzed plants did not exhibit morphological changes described in the literature\(^3,6\) for F-contaminated environments.

DISCUSSION

F may adversely affect aquatic vegetation, causing stunting of growth or even death.\(^7,9\) The toxic action of F on plants is manifested chiefly by its effect on primary physiological functions such as photosynthesis\(^10,11\) or metabolic cycles.\(^12,13\) On the other hand, in certain instances growth-stimulating effects of F on some plants are also known.\(^14\)

In the course of studies on the common reed (*Phragmites australis*) in the Warta River oxbow lake reservoirs S1 and S2, we confirmed a relationship between F concentrations in water and bottom deposits of these reservoirs and
bioaccumulation of F in the reeds. At the same time, we observed changes in macroscopic images of tissues of plants growing in reservoir S1.

In contrast, neither of the plant species in the present study, i.e., milfoil (Myriophyllum spicatum L.) and hornwort (Ceratophyllum demersum L.), exhibited any detectable macroscopic differences between the F-contaminated reservoir S1 and the uncontaminated reservoirs S2–S4.

Considerable F accumulation in plant samples collected from oxbow lake reservoir S1 along with a lack of distinct disease symptoms may indicate high tolerance of Myriophyllum spicatum and Ceratophyllum demersum to bioaccumulation of F. However, this is only a hypothesis that needs to be verified.

REFERENCES