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Evaluation of the level of contaminants, Mercury and Arsenic in fiddleheads, New Brunswick

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Maliseet Nation Conservation Council

Contents

	Page
Summary	3
Introduction	4
Methodology	5
Outcome of the study	7
Concluding remarks	9
Acknowledgement	9
Literature cited	10

Summary

In spring 2010, Maliseet Nation Conservation Council (MNCC) has conducted a study to test fiddleheads for contaminants. As Fiddleheads are important traditional foods of Maliseet Indians of the Saint John River Valley and widely consumed veggie in the province of New Brunswick we decided to test fiddleheads for contaminants. Though it was initially planned to test fiddlehead samples from entire province of New Brunswick, due to unavoidable circumstances the study has to be restricted to the Fredericton and suburbs. In accordance with the revised experimental plan, twenty five fiddlehead samples collected from Jemseg, Sugar Island, Mactaquac and Nashwaaksis areas were analysed for Mercury, Arsenic, Nickel and Cadmium at the Research and Productive Council laboratory, Fredericton. According to the outcome of the study, our samples contained insignificant amounts of Mercury and Arsenic. However, estimated Nickel (0.4 – 3.8ppm) and Cadmium (0.013 – 0.195ppm) levels were slightly higher than the recommended levels by different international organizations such as CODEX, FAO etc. As the final leg of the current phase of the study, a workshop was held in Fredericton to collect traditional knowledge of fiddleheads and disseminate the outcome of the study. It was a well attended meeting and the views and inputs of participants to our traditional knowledge study were very useful especially to formulate future studies to test more traditional foods of aboriginals for contaminants.

Introduction

Fiddlehead is an unfurled fronds of a young fern harvested for consumption as a food. It unrolls as the fern emerges from the ground with new growth. As fiddleheads are harvested early in the season before the frond has opened and reached its full height, they are cut fairly close to the ground. Early spring signals the arrival of "Fiddlehead season," when aficionados begin combing the riverbanks and forest floor. Because Fiddlehead ferns are delicious, with a remarkable wild flavour, they can easily be prepared in a variety of ways resulting in a delicious side dish or as the "main event." It has been described as similar to green beans with a hint of artichoke (Nash, 1995).

The Maliseet Indians of the Saint John River Valley in New Brunswick have traditionally harvested fiddleheads and have eaten and sold them at local markets. Even before there was any written record, the Maliseet and Micmac Indians marked their birch bark canoes, wigwams, clothing and artefacts with this symbol. The fiddleheads are low in calories and rich in vitamins A and C, manganese and niacin as well as good sources of iron, zinc, protein and riboflavin. It is a good spring tonic that helped cleanse and prepare them for the new season (Nash, 1995).

Deterioration of water quality as a result of the disposal of untreated organic and toxic wastes into the Saint John River basin began when the river was first settled in 1604, and the amount of waste entering the river has increased substantially over the past few decades (Dominy, 1973). The watershed is historically used for agriculture and forestry and the current major sources of effluents in the river were urbanization, industrialization and agriculture. Although fiddleheads have been considered to be nontoxic, these contaminants in the river may have an impact on its suitability for human consumption. The accumulation of heavy metals such as arsenic and mercury in fronds and roots of the ferns grown in contaminated soils is fairly well documented (Anderson and Walsh, 2007; Zang et al. 2002). As these contaminants are capable of adversely impacting the human health, it is advisable to determine the heavy metal contents in fiddleheads that are heavily consumed by the Maliseet First nations and non-natives living in the province. The present investigation was therefore, conducted to evaluate the mercury, arsenic, nickel and cadmium contents in fiddleheads grown in the Saint John River Valley. Also included is the traditional knowledge of Maliseet First Nation, New Brunswick on fiddleheads.

Methodology

Twenty five fiddlehead samples were collected from four different fiddlehead gathering locations (Jemseg, Sugar Island, Mactaquac and Nashwaaksis) in Fredericton (Fig. 1). As revealed during the present study, these were the major fiddlehead gathering locations of the Maliseet First Nation communities, Kingsclear, St. Mary's and Oromocto. The samples were frozen till they were transported to the laboratory for analysis. They were then analyzed for mercury, arsenic, nickel and cadmium at the laboratory of Research and Productivity Council (RPC), Fredericton in January, 2011. In the RPC laboratory, the samples were homogenized and portions were prepared by Microwave Assisted Digestion in Nitric Acid. The resulting solutions were analyzed for Arsenic, Cadmium and Nickel by ICP-MS. Mercury was analysed by Cold Vapour AAS. Results are reported on an "as received" (wet weight) basis.

Information was also gathered to investigate the utilization of fiddleheads of different areas by different First Nation communities along the river. In addition to that aboriginal traditional knowledge (ATK) was gathered to evaluate the traditional usage, historical distribution and the nutrition aspects of fiddleheads. The mercury, arsenic, nickel and cadmium contents of the samples from different localities were used to evaluate the level of contamination in different areas. In March (2011), a workshop was held in Fredericton to disseminate the outcome of the study. In addition to that results of the study were also disseminated using the newsletter and the website of MNCC.



Fig. 1 Map of the study area and sampling sites

Outcome of the study

As revealed during the present investigation, the arsenic content of the fiddlehead samples collected from all four localities were less than 0.2 parts per million (ppm). Apart from that the mercury contents were estimated to be less than 0.01ppm for fiddlehead samples from all four localities. However, the estimated cadmium content for the fiddlehead samples collected during the present investigation varied from 0.013 – 0.195ppm. The lowest estimated average cadmium contents were reported for the samples collected from Jemseg (0.0596ppm) while the highest cadmium contents for the samples from Nashwaak (0.1398ppm) (Table 1). In addition, the estimated nickel content for the samples collected during the present study varied from 0.4 – 3.8ppm. The lowest mean nickel content was estimated for the samples collected from Sugar Island (0.73ppm) while the highest for the samples from Jemseg (1.86ppm).

Table 1 – Estimated mean cadmium and nickel contents for different sampling locations

Sampling location	Mean cadmium content (ppm)	Mean nickel content (ppm)
Nashwaak	0.1398	1.11
Mactaquac	0.0888	1.26
Sugar Island	0.0792	0.73
Jemseg	0.0596	1.86

Maliseet Indians traditionally gathered many plant species in the Saint John River valley for consumption and also for medicinal purposes. These include calamus roots, wild onions, sweet hay, fiddleheads and wild rice. Of the above calamus roots were used to prepare medicine while most of the other plants were gathered for consumption. Traditionally gathering of plants has been a group activity in different localities of the upper and the lower Saint John River (SJR) valley. The historical fiddlehead picking areas in Fredericton were upper islands from Little Bear to Big Bear and down the Gilbert Islands. The Maliseet name for fiddleheads was “Mosos” and fiddleheads were gathered by Maliseets for both consumption and trade.

Fiddlehead is a perennial seasonal plant (fern) appears in the SJR valley in early spring. In accordance with the present study, it is a rich source of vitamin A and C which also contains magnesium, iron, potassium, zinc and phosphorus. It is boiled with butter or prepared as soup for consumption. In accordance with a few participants of the traditional knowledge study, they have developed health conditions such as constipation, running stomach, nausea and vomiting due to heavy consumption of fiddleheads. Apart from that fiddleheads are heavily rated as a frequently available vegetable which helps clean their system after long winter on the east coast.

Fiddleheads are historically abundant in most parts of the SJR watershed. The present investigation indicated that there is a relationship between the deteriorated environmental health of the watershed and the depleted fiddlehead populations. As revealed during the present study, agriculture and construction of the Mactaquac Dam for hydro electric power generation have

severely impacted the existence of fiddleheads. In particular the two large islands above the dam, Little Bear and Big Bear which had been rich fiddlehead grounds in the past went under water after construction of the dam. In addition a few rich fiddlehead grounds in the valley have also been impacted due to animal husbandry and the heavy machinery used for agriculture. The participants of the traditional knowledge study were also highly concerned about the impact of effluents from different industries and agriculture operations. Although there have been no evidence of historical infestations of pests in the SJR valley, there may have been a few exotic plants that would have had a reasonable impact on existence of fiddleheads in the area. They also confirmed that the sampling locations during the present investigation (Nashwaak, Mactaquak, Sugar Island and Jemseg) have been the major fiddlehead picking centers of the First Nation communities, Kingsclear, Saint Mary's and Oromocto.

Concluding Remarks

The heavy metal toxicity in human diet and the impacts on human health are very well understood. The common health issues of low level arsenic exposure includes irritation of stomach, lungs and intestine, increased risk of lung cancer, brain damage and reduced productions of Red Blood Cells (RBC) and White Blood Cells (WBC). Exposure to high level of Methyl mercury can lead to permanent brain and kidney damage. It can also cause personality changes, deafness and damage to stomach and intestine (Chowdhury and Chandra, 1987).

Present study indicated that the estimated arsenic content for the fiddlehead samples from all four localities was less than 0.2 parts per million (ppm). Apart from that the mercury contents were estimated to be less than 0.01ppm for samples collected during the present investigation. Above compares favorably with the permissible levels of these metals in grains, vegetables, potato products and fruits by different countries and organizations around the world (CODEX, FAO and Peoples Republic of China guidelines) (Gawalko et al. 2009). On the other hand the estimated cadmium and nickel levels were slightly higher than the standards adopted by different organizations. Maximum limits for permissible cadmium levels in grains were 0.2mg/kg (CODEX) and 0.05mg/kg (FAO) (Gawalko et al. 2009). Though the adverse health effects of heavy metals in food were adequately documented, it is advisable to conduct a comprehensive study to confirm the outcome of the present investigation prior to make any conclusion about the suitability of fiddleheads for consumption.

Despite the intentions during the present study to map the sources of pollution in the watershed, due to unforeseen circumstances, it was not possible to collect adequate information to link the above to the levels of heavy metals recorded for the samples from different areas. As the traditional knowledge study indicated that fiddleheads has historically been and continue to be staple in the diet of First Nations and most of other people living in the province, it is advisable to include above aspects in any future study to investigate fiddleheads from around the province. The findings of the present investigation provide the basis for such a comprehensive study programme.

Acknowledgement

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