Wild berry, seaweed and other plant health benefits in a changing Canadian Arctic

Lemire M [1], Harris CS [2], Lucas M [1], Kwan M [3], Cuerrier A [4], Ayotte P [1,5], Marette A [6], Tardif M [7], Gauthier MJ [8], Bouchard A [8], Labranche E [8], Déry S [8], Grey M [7], Dewailly E [1]

[1] Centre de recherche du CHU de Québec, U Laval, Québec
[2] University of Ottawa, Ottawa
[3] Nunavik Research Center, Makivik Corporation, Kuujjuaq
[4] Institut de Recherche en Biologie Végétale, U de Montréal, Montréal
[5] Institut national de santé publique du Québec, Québec
[6] Institut sur la nutrition et les aliments fonctionnels , U Laval, Québec
[7] Biopterre, Institut de technologie agroalimentaire, La Pocatière
[8] Nunavik Regional Board of Health and Social Services, Kuujjuaq

Introduction

For centuries, Inuit had to rely on animals and plants such as wild berries and seaweeds to survive in the Arctic. However, since the 1990's, the consumption of country foods has decreased markedly, and the rapid transition towards a Western diet has led to excessive intake of carbohydrate, salt and trans-fatty acids. In Nunavik, the prevalence of obesity is increasing, and cardiovascular diseases and associated risk factors have become major health issues (1). Global environmental changes also affect Inuit dietary patterns in many ways including the availability of local animal and plant species and/or environmental contaminant concentrations (2,3).

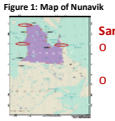
With limited access to fruits and vegetables, **wild berries, seaweeds and other plants found in Nunavik may provide plant-derived nutrients and secondary metabolites that offer unique potential for the prevention or management of metabolic disorders and associated cardiovascular complications**. They may be an important source of antioxidants, especially polyphenols (flavonoids and tannins) and carotenoids, as well as fiber and vitamins C and E. Several of these phytochemicals and nutrients have been reported to prevent or decrease lipid peroxidation, LDL oxidation, decrease glycemia, improve insulin secretion and sensitivity, and/or act as vasoprotective and anti-inflammatory agents, possibly due to their diverse actions on metabolic processes (4,5). Moreover, in addition to their antioxidant activity, certain phytochemicals chelate heavy metal ions, possibly reducing the bioavailability and subsequent toxicity of environmental contaminants (6,7).

Objectives of the project

1. **Collect selected wild berries, seaweeds and other plants** in different Nunavik villages;
2. Characterise and quantify different **phytochemicals**, **macronutrients, minerals** and **environmental contaminants** in these samples;
3. **Assess the bioactivity** (evaluate the protective potential) of the different plant extracts in *in vitro* models pertinent to the prevention and treatment of chronic diseases;
4. Conduct an **animal study** to evaluate the impact of wild berries on insulin resistance and obesity in mice;
5. **Contribute to develop community-based intervention projects in Nunavik villages** to:
   a. Improve wild berry consumption, distribution and availability throughout the year;
   b. Propose local healthy alternatives to soft drinks and snacks;
   c. Stimulate youth empowerment and employment.

Wild berry, seaweed and plant harvest

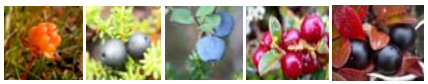
Figure 1: Map of Nunavik



Sample collection in 2012:

- Specimens of targeted species were collected from > 3 different sites in each of the 3 villages, selected according to geographic location, climatic conditions and Inuit recommendations
- In all villages, community members mentioned avoiding dump or sewage areas for picking because of possible environmental contamination; no samples were collected in these areas

Figure 2: Wild berry, seaweed and other plant species included in the study



Cloudberry — Arpiq — *Rubus chamaemorus*

Blackberry or Crowberry — Paurngaq — *Empetrum nigrum*

Alpine bilberry Or Blueberry — Kigutangirnaq — *Vaccinium uliginosum*

Mountain cranberry or Redberry — Kimminaq — *Vaccinium vitis-idaea ssp. minus*

Alpine bearberry — Kallaq — *Arctous alpina*

Brown seaweeds — Kuanniq, qirquaq & pitatsaliq — *Laminaria* spp. & *Fucus* spp.

Mountain Sorrel — Qungulig — *Oxyria digyna*

Seabeach sandwort — Malitsuagaq — *Honckenya peploides*

Northern Labrador tea — Mamaittuqutiq — *Rhododendron tomentosum*

Wild berry, seaweed and other plant analysis

- Characterisation and quantification of **phytochemicals** (flavonoids, tannins, carotenoids, etc.), **macronutrients** (carbohydrates, soluble and insoluble fibers, protein, lipids), **vitamins** and **minerals** at U of Ottawa and Institut des nutraceutiques et des aliments fonctionnels (INAF);
- Measurement of **environmental contaminants** (mercury, cadmium, lead) at the Nunavik Research Center;
- **Assessment of the bioactivity** of extracts in *in vitro* models pertinent to the prevention and treatment of chronic diseases (antioxidant, antiglycation and anti-inflammatory) at the U of Ottawa.

Preliminary results

Table 1: Total phenolic content (TPC) in wild berries at INAF

	TPC in berry extracts [1]	% yield	% water	TPC in fresh berries [1]
Cloudberry (*R. chamaemorus*)	15.2 ± 0.6	4.7	86	0.7 ± 0.3
Blackberry (*E. nigrum*)	**69.7 ± 0.6**	6.5	88	**4.5 ± 0.4**
Alpine bilberry (*V. uliginosum*)	20.3 ± 0.1	11.6	85	2.4 ± 0.1
Mountain cranberry (*V. vitis-idaea*)	**42.4 ± 0.1**	11.9	75	**5.1 ± 0.1**
Alpine bearberry (*A. alpina*)	**70.9 ± 0.3**	7.4	82	**5.3 ± 0.2**

[1] Measured by the Folin-Ciocalteu method, results expressed as gallic acid equivalents in mg/g ± SD

- **All the berries except cloudberries present a higher TPC concentration than lowbush blueberry extract (2.1 mg/g), which grows all over southern Quebec and has demonstrated significant anti-diabetic activities** (8);
- Mountain cranberry, alpine bearberry and blackberries present the highest TPC;
- All the berries present very low sugar, salt, fat and environmental contaminant concentrations and are good sources of minerals (like magnesium, manganese, chromium and iron)
- In a parallel study (8), blackberry and alpine bearberry were found to have the strongest antioxidant and antiglycation of 12 species of edible berries in Quebec;

Impacts of wild berries on adiposity and insulin sensitivity in mice

This experimental study is done by Dr André Marette research team (INAF, ULaval):

- Mice (C57Bl6, Jackson) were first fed with a high-fat, high-sucrose (HFHS) diet to induce obesity and insulin resistance (9);
- For each berry species, mice (n=12) were treated for 8 weeks with the berry extract (200 mg/kg) and compared with 2 reference groups (n=12 each): non-obese non-insulin resistant mice on chow diet and obese insulin resistant mice on HFHS diet;
- Measured outcomes: weight gain and adiposity, glycemia and insulinemia from Oral Glucose Tolerance Test (OGTT) and Insulin Tolerance Test (ITT).

Preliminary results

- All the berries had an overall tendency to prevent diet-induced body weight gain, with the exception of Alpine bilberry;
- Although berries did not improve obesity-induced glucose intolerance in oral glucose tolerance tests (OGTT), treatment with **Cloudberry reduced diet-induced hyperinsulinemia during OGTT** and **diminished glycemia values in insulin tolerance tests (ITT),** suggesting **improved insulin sensitivity**.

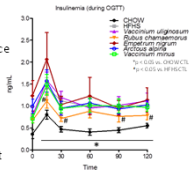


Figure 3: Blood insulin concentrations after OGTT at week 8

Community-based intervention with IPL students from Tasiujaq and Kangiqsualujjuaq:

The purple tongue project

While visiting communities in 2012, many persons mentioned that the main factors reducing their consumption of berries from the land is the **lack of space** to store them in freezers. Elders also mentioned that the youth should learn more about native plants and eat more of them. Thus, we developed an intervention pilot-project to:

- **Develop berry products that do not need to be stored in freezers** (dried berries, baby puree, fruit roll-up, granola bars, juice, yogurt popsicles) with low sugar concentration, at low cost and using locally available food items, simple cooking techniques and in accordance with Inuit taste and culture;
- **Engage Individual Path Learning (IPL) students in berry picking and harvest assessment using GPS techniques, traditional knowledge sharing activities and berry recipe design and food transformation** (and create employment) in the two communities
- **Evaluate the outcomes and impact of the intervention** on local berry consumption and youth empowerment, and **develop a pedagogical guide** for implementation of the pilot-project in other schools;

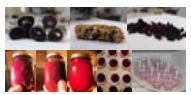


Figure 4: Berry products designed by Biopterre

Activities

- **April – July 2013:** Three workshops with Inuit colleagues to test and improve berry products
- **September 2013:** 1st workshop with IPL students in Tasiujaq (berry consumption questionnaire, berry product testing, traditional knowledge activity, GPS methods, berry picking)
- **November 2013** 2nd workshop with IPL students in Kangiqsualujjuaq (berry consumption questionnaire, food transformation techniques, hygiene and safety in a kitchen, GPS mapping)

Figure 5: 1st workshop in Tasiujaq

Coming soon…

- **Measure polyphenol metabolites in Inuit blood samples to study the properties of berries, seaweeds and other plants with respect to diabetes and cardiovascular risk factors in Nunavik adults**
- **A larger interdisciplinary research-intervention project combining the nutritional properties and traditional knowledge of these plants in relation to heart disease and diabetes, and community-based interventions to improve food security and youth empowerment , and to promote social economy.**

Understanding the benefits of country foods consumed in Nunavik will support and orient public policies aiming at improving food security, promote Inuit culture, minimize the risks from environmental contaminant exposure, and the emergence of obesity, diabetes and cardiovascular diseases in the Arctic.

We are grateful to all community members who participated in the berries, seaweeds and plants sampling and the design of the intervention project. The research project is funded by ArcticNet

For further information please contact Dr Mélanie Lemire: melanie.lemire@crchuq.ulaval.ca

References

1. Chateau-Degat et al (2011) Obesity risks: towards an emerging Inuit pattern. Int J Circumpolar Health 70(2):166-77.
2. Donaldson et al (2010) Environmental contaminants and human health in the Canadian Arctic. Sci Total Environ 15; 408(22):5165-234.
3. Arctic Monitoring Assessment Programme (AMAP) (2011) Arctic Pollution 2011. 38p.
4. Basu A et al (2010) Berries: emerging impact on cardiovascular health. Nutr Rev 68(3):168-77.
5. Crozier A et al (2009) Dietary phenolics: chemistry, bioavailability and effects on health. Nat Prod Rep 26(8):1001-43.
6. Shim SM et al (2009) Impact of phytochemical-rich foods on bioaccessibility of mercury from fish. Food Chemistry 112(1)46-50.
7. Wang T et al (2009) Total phenolic compounds, radical scavenging and metal chelation of extracts from Icelandic seaweeds. Food Chemistry 116 (1):240-248.
8. Harris et al. (Submitted to Plant Food for Human Nutrition) Investigating wild berries as a dietary approach to reducing the formation of advanced glycation endproducts.
9. White PJ et al (2010) Transgenic restoration of long-chain n-3 fatty acids in insulin target tissues improves resolution capacity and alleviates obesity-linked inflammation and insulin resistance in high-fat-fed mice. Diabetes 59:3066-73.