Medicinal Plant Intake: Improving Type 2 Diabetes Management in Canadian Aboriginal Populations**

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Summary
Aboriginal Traditional Knowledge on medicinal and food plants represents an underappreciated opportunity for the culturally relevant prevention and management of type 2 diabetes (T2D). Indeed, evidence has accumulated in recent years that many medicinal and food plants used to treat various symptoms of T2D contain active chemical constituents that exhibit significant biological activity. They notably improve the control of sugars and fats by acting on various targets of insulin, such as muscle, liver, fat, and intestine. They can also help reduce the incidence and consequences of diabetes complications such as neuropathy and kidney disease. However, many challenges remain that are related to the general lack of knowledge of health professionals and even some community members, especially youth, about Aboriginal Traditional Medicine and food. An approach combining Aboriginal Ways of Knowing and Aboriginal Traditional Knowledge with modern science and health systems holds much promise to bring down barriers and facilitate an open, mutually trusting, and respectful collaboration to improve T2D prevention and management.

Current realities
T2D is a devastating chronic disease that has both genetic and environmental components. The World Health Organization currently considers T2D as a worldwide epidemic, along with obesity, one of its major risk factors. T2D, in turn, is a major risk factor for cardiovascular diseases, renal failure, non-traumatic limb amputations, and blindness. Aboriginal populations worldwide are particularly affected. In Canada, the prevalence of T2D is three to five times higher in Aboriginal peoples than in the rest of the population. This rising prevalence has been attributed to environmental, socioeconomic, and genetic factors contributing to sedentary lifestyles, dietary transition toward highly processed market foods, and high rates of obesity. This pandemic is entrenched by an intergenerational cultural trauma that has separated the traditional knowledge of community Elders from youth experience. This is not the quality of life our First Peoples expect, nor one that Canadians should collectively tolerate.

In addition to experiencing greater risk of T2D, many Aboriginal communities in Canada and abroad not only develop the condition at a younger age, but they also suffer disproportionately from diabetic complications — the primary cause of T2D-related morbidity and mortality. Moreover, Aboriginal Peoples in rural and isolated communities struggle with food insecurity, adequate access to culturally relevant health care, public health programs, and educational opportunities as they relate to availability, access, cost, quality, and use. For many Aboriginal Peoples, T2D stems from a life out of balance and out of touch with traditional lifestyles, community, culture, and spirituality (e.g., traditional diet, traditional medicine, and time on the land). Unlike the biomedical perspective emphasizing individual healthy behavior, Aboriginal perspectives incorporate the population health determinants of T2D that extend beyond the individual to a healthy community. As a result, T2D prevention programs and treatment strategies based solely on individuals and clinical science approaches habitually fall short, whether due to poor community engagement, low individual compliance, or a lack of recognition of local ecosystems as a means to promote health and well-being.

Scientific opportunities and challenges

The rapid transition from traditional to modern lifestyle and food/medicine over recent decades in Aboriginal populations, coupled with inadequate access to culturally appropriate approaches to health care, calls for the development of complementary traditional food/medicine approaches to improve T2D management. Moreover, highly processed foods imported into Aboriginal communities are high in sugar, salt, (saturated) fats, and chemical preservatives. Due to the limited selection and cost of market foods, many Aboriginal diets are also generally low in fruit, vegetable, and plant and fish bioactive compounds (i.e., ones with biological activities to help mitigate T2D symptoms and progression). In contrast, several traditional medicinal and food products derived from terrestrial or marine plants and animals contain exceptionally high levels of the same bioactive compounds.

The choice of safe and efficacious medicinal and food plants with biological activity relevant to T2D may benefit from the "Two-Eyed Seeing" approach brought forward by Micmac Elder Albert Marshall. This approach entails combining Aboriginal Traditional Knowledge and Aboriginal Ways of Knowing with scientific knowledge and "western" health systems. To succeed, such an approach needs to be entrenched by mutual trust and respect as well as a genuine desire to discover the benefits in both knowledge systems. From the Aboriginal perspective, there is often mistrust and fear of seeing Traditional Knowledge misinterpreted, misused, or outright "stolen." Historical trauma, colonialism, and recent cases of biopiracy are, in good part, to blame. From the "western" perspective, Aboriginal Traditional Knowledge and Ways of Knowing are hard to decipher and accept on an equal footing with evidence-based scientific knowledge. However, there are ample cases in the modern therapeutic arsenal where valuable and efficacious drugs have been developed directly or indirectly from natural sources. This is notably true of therapies for T2D, such as metformin (the single most-prescribed first-line pharmaceutical) that was derived from galegin, an active component of goat's-rue (the French lilac G*alega officinalis*), and acarbose, a starch analog produced by *Actinoplanes* bacterial species. Nevertheless, in the absence of evidence-based policy, certain clinicians and public health officials are hesitant to include Aboriginal Healing Ways, notably medicinal plants, in T2D prevention or management strategies. This is related, in part, to the variability in the phytochemical composition and bioactivity of traditional medicinal plants due to geographical location, environmental conditions, and means of preparation. On the other hand, the complex chemical nature of medicinal and food plants is also advantageous since the various bioactives can act on several targets to improve glycemic control in T2D. Moreover, the fact that medicinal plants naturally combine several bioactives generally elicits fewer adverse reactions than the more powerful single molecular entities that are drugs.

Our research team has demonstrated that it is possible to develop a functional and productive multidisciplinary team of scientists that can work in a close and highly ethical manner with Aboriginal Knowledge keepers to respectfully document medicinal and food plants that have antidiabetic potential. Collectively we (i.e., scientists, clinicians, Aboriginal Knowledge keepers) have studied around 20 boreal forest plants with evidence-based anti-T2D activity, notably demonstrated through phytochemistry, pharmacology, toxicology, nutrition, and clinical science. The team also initiated observational clinical studies in an Aboriginal community, where Knowledge keepers and health professionals followed patients and used their respective tools (i.e., both pharmaceuticals and Traditional Medicine, notably the medicinal plants studied). It is thus possible to move from observation/consultation to advanced pharmacological documentation and back to the community to implement real change. Indeed, the results of our team's work are now being used to enact policies that will improve the access to Traditional medicinal and food plants for Aboriginal diabetics who desire them. We are currently carrying out a project to determine the optimal conditions to enhance the access to Aboriginal Traditional Medicine within or alongside contemporary health care. Community members, Healers, and

Elders as well as health professionals and administrators are participating through individual interviews and sharing circles to freely express their views. Workshops will then be held with all stakeholders to examine results of the consultation, to review various models of mixed care used elsewhere in Canada and the Americas, and to develop an intervention strategy for short, medium, and long term steps to improve access to Aboriginal Traditional Medicine. There is great interest from all stakeholders, and challenges raised thus far include how to reconcile a system based on an oral tradition with the established health care system based on scientific evidence and formal training.

Policy issues

To effectively curb the increasing healthcare burden of T2D among Aboriginal Peoples, intervention strategies must address not only the biological *sequelae* of glucose intolerance and insulin resistance, but also the cultural, environmental, and socioeconomic determinants of health. Most importantly, to achieve success with these populations, interventions must be community-based with local participation and engagement through all stages of design and implementation. Interdisciplinary and intersectorial efforts are urgently needed to improve culturally relevant health promotion and care. These should engage academics, community decision makers, and knowledge users. In this context, Aboriginal Traditional Knowledge and Aboriginal Ways of Knowing represent an incredibly valuable world heritage. They can help develop culturally relevant strategies to promote a healthy lifestyle that includes traditional medicinal and food plants. More specifically it is necessary to:

- Respect, promote, and protect Aboriginal Traditional Knowledge. There is an urgent need to ensure the upkeep of Aboriginal Traditional Knowledge since many Aboriginal Knowledge keepers are passing away, taking with them a wealth of knowledge and experience. Aboriginal youth should particularly be targeted through intergenerational experiential and educational activities. Aboriginal Traditional Knowledge on medicinal and food plants must be captured and transferred through culturally relevant (e.g., apprenticeship) as well as contemporary (e.g., audio-visual recordings) media. At the onset this should happen at the community and regional levels, where there is an observed uniformity and consistency in Traditional Knowledge.
- Engage Aboriginal Knowledge keepers and youth in community-based activities to develop health promotion strategies and policies that are rooted in culturally relevant practices.
    - Such activities can be organized within existing structures such as the education system (curricular and extracurricular), community public health departments, community health centres, community associations of Knowledge keepers, and those concerned with Aboriginal culture and Traditional Medicine.
    - These activities can be focused on traditional medicinal and food plants that are helpful in T2D.
- Enhance community knowledge on and dietary intake of traditional medicinal and food plants that have demonstrated benefits for T2D.
    - The increased consumption of relevant plant bioactives can help prevent and manage Type 2 diabetes.
    - Educational and health authorities need to be involved in developing tools and programs to achieve this aim.
- Organize school and community activities to encourage taking part in Traditional physical activities and spending time on the Land.
    - Such activities can be targeted to medicinal and plant food identification, collection, and preparation.