Non-timber Forest Products and Aboriginal Traditional Knowledge

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Abstract.—Ethnobotanical research was conducted in over 30 Aboriginal communities within Canada's boreal forest region. Specific methods for the research were developed that involved a high degree of participation by Aboriginal people in every stage of the project, with the result that well over 100 Aboriginal elders contributed information on the uses of more that 200 species of plants as foods, medicines, and materials for technology and handicrafts. The original field research was supplemented with an extensive literature review to identify potential non-timber forest products (NTFPs) based on traditional uses of plants. Important categories of NTFPs include functional foods, nutraceuticals, cosmeceuticals, herbal medicines, agrochemicals, and fine chemicals. This report details our research methods, highlights some examples of potential NTFPs from boreal plants identified in our research, and discusses concerns of Aboriginal people regarding sustainable development of NTFPs.

INTRODUCTION

The forest industry in Canada annually produces almost $70 billion in shipments of which slightly more than half are exported, mostly to the US. The major products of our forest industry have consisted of softwood lumber (28 percent), fine paper and paperboard (22 percent), wood pulp (17 percent), newsprint (17 percent), and waferboard (6 percent) (Natural Resources Canada 1999), but a significant area for future development lies in non-timber forest products (NTFPs). Diversification of the forest industry to include products other than wood and fiber can allow a greater level of sustainability by providing the same level of economic return with fewer trees harvested, and it can provide greater opportunities for employment because of the necessity for manual harvesting and value-added processing.

The sustainability aspect of NTFP development, as opposed to simply increasing the profit from a given cut-block of forest, is very important. Sustainability was generally not considered an issue in the past due to the perception that our forest was an almost endless expanse of trees. Indeed, half of Canada is covered by forests, which make up 10 percent of the entire world's forests. However, Canada harvests close to 1 million hectares (2.47 million acres, 0.4 percent of commercial forest area, 0.2 percent of total forest area) of forest per year (Natural Resources Canada 1999), which could be compared to Brazil's deforestation rate of 1.4 million hectares (0.4 percent of closed forests) per year (Brown *et al.* 1992). Most of the southern forested regions are already subject to forest tenures held by private companies for logging, and the northern half of the boreal forest region is labeled on our national forest tenure map as the "non-productive boreal forest" (Government of Canada 1991). This is rather ironic given that Aboriginal people have been living quite productively on that land for several thousand years. The federal and provincial Forest Services and forest industry are now looking for ways to diversify the forest industry, including the gathering of NTFPs.

The potential of NTFPs to help agriculture too is an area often overlooked. While we tend to think of agriculture in Canada as involving almost endless fields of wheat and canola, sustainability is a serious issue here too. Farm diversification is an essential strategy to reverse the high rate of farm bankruptcies, which have increased by over 1,000 percent since

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1979, especially on the prairies (Science Council of Canada 1992). Non-timber forest products can benefit agriculture through crop diversification, for example, the cultivation of ginseng, a forest species, under shade structures.

Canada's forests have long been important for the subsistence activities of Canada's Aboriginal peoples, including gathering fruit, vegetables, and beverage plants, medicinal plants, and materials for technology and rituals, plus hunting and snaring for meat and furs. Thus it is logical that one of the best sources of information on potentially useful native plants of our forests is the traditional knowledge of Aboriginal elders. Previous economic successes include the discovery from our eastern woodlands of the antibiotic sanguinarine from the traditional medicinal plant, bloodroot (*Sanguinaria canadensis* L., Papaveraceae), which is now available commercially in Viadent® mouthwash and toothpaste manufactured by Colgate Oral Pharmaceuticals, Inc. The prescription anticancer drugs etoposide and teniposide are semisynthetic derivatives of podophyllotoxin from the mayapple (*Podophyllum peltatum* L., Berberidaceae), another traditional medicinal forest herb (Robbers *et al.* 1996). Such precedents provide justification for the study of Aboriginal traditional plant use as a guide to potential new NTFPs.

TESTED METHODS FOR ETHNOBOTANICAL RESEARCH

Ethnobotanical research is a proven method for the discovery of potential non-timber forest products. Of the more than 120 pure drugs derived from plants in current commercial use, three-quarters were discovered through scientific investigations of traditional uses (Soejarto and Farnsworth 1989). However, it is important that this type of research be conducted with the full cooperation of Aboriginal communities. The well-tested approach in the following description will help to ensure that NTFP development becomes a truly sustainable venture for the benefit of all people.

Developing The Proposal

The proposal for ethnobotanical research was developed in consultation with a First Nations professional community worker to provide a plan that would likely be acceptable to Aboriginal councils and elders. The following steps are crucial in developing the proposal, getting it approved, and implementing it:

1. Have the proposal presented to the Band Council and elders in the languages of both the researchers and the community, e.g., in English and Cree or Dene, for informed consent, with work proceeding only after approval has been given.

2. Have the proposal reviewed and approved by the appropriate institutional Ethics Committee.

3. Create an Advisory Committee of elders to supervise the work, and set guidelines and limitations.

4. Hire, equip, and train young people from the community to assist in the research.

5. Report progress on a regular basis to the Band Council, which may terminate the project at any time.

6. Supplement the information gathered in the community with as much relevant information from the literature as possible, so that at least a foundation for the knowledge required for informed decisions on development proposals is available within a single report.

7. Ensure that copies of all research results, including reports, educational materials, and plant voucher specimens or facsimiles, will be given to the appropriate authorities within the community.

8. If economic development of a traditional knowledge-based product is a specific objective, prepare a mutually agreeable legal document regarding intellectual property rights and fair compensation.

Getting Permission to Conduct Research

Formal permission, such as a Band Council resolution, is required for any research on reservation land. An "informed consent" form prepared and presented by the Aboriginal researchers in the appropriate language is also an important tool to ensure that there will be no misunderstandings at any time regarding

permission to do the research. Most communities also want an agreement that they may preview results before publication, and if they deem it necessary, restrict the scope of what is published to protect intellectual property rights and confidentiality.

Conducting the Interviews

Bilingual interviewing, mostly by the First Nations or Métis trainees, was done in our research project to minimize misunderstandings and make the oral history recording more comfortable, since the elders could use their own language and talk to an interviewer who was already familiar with the language and customs. Since the interviewing was done by community members, the Councils were satisfied that elders would not feel duress and could easily set limits on the nature and extent of information provided.

No formal questionnaires or highly structured interviews were used in our research because previous experience showed that many elders are not comfortable with that rigid style of interaction. Traditional knowledge is not normally learned through a listing of separate facts, so interview techniques should mimic customary learning methods. For example, elders often share stories and experiences while on walks in the forest (field interviews), while examining traditional products such as foods or handicrafts and discussing the required methods and materials (artifact interviews), while re-enacting activities that used to be practiced long ago (simulation), and while getting young people to assist in traditional practices (participant observation technique). To ensure consistent and comparable documentation of the ethnobotanical information, each research team had data collection forms (fig. 1) that could gradually be completed as the information was gathered (semistructured interview technique). The work was documented in notebooks with these data entry forms and space for sketches or freestyle notes, with slides and video records. Interviews were also tape recorded to facilitate transcription. All this information has been incorporated into teaching materials as well as scientific publications.

DATE:	NUMBER:
LOCATION:	
PLANT LOCAL NAME:	
LANGUAGE/DIALECT:	
TRANSLATION:	
ENGLISH NAME:	
CONTRIBUTOR:	
USE NOTES:	
SCI. NAME:	
FAMILY:	
FLOWER/FRUIT CHAR.:	
HABITAT:	
HABIT:	HEIGHT:
SLOPE:	ASPECT:
ELEVATION:	SOIL:
COLLECTED BY:	DET. BY:

Figure 1.—*Ethnobotany field notebook data entry form.*

The Aboriginal trainees ensured that local traditions were respected, such as gifts of tobacco and cloth for elders who preferred to follow that custom rather than a strict wage scale, and ritual burying of tobacco before plant harvest to show proper respect for the Spirits. The work reinforced the trainees' own knowledge of their culture and respect for the depth of knowledge possessed by their elders. Teaming botany students with Aboriginal trainees resulted in a mutually beneficial experience. The trainees learned the basics of plant voucher specimen collection, plant identification, and proper documentation techniques. The botany students received training in the local language and through this work gained an appreciation for Aboriginal culture and practices.

Keeping a Proper Field Notebook

For each plant, notes were made on the presence and color of sap, juice, or latex; the color of flowers or fruit (that may change with drying); the height, growth form, or habit (e.g., erect, sprawling, trailing, climbing, shrubby, arborescent); branching pattern (e.g., opposite, alternate, whorled); and root system (e.g., tap

root, fibrous, bulbs, corms, tubers, rhizomes). Information was recorded on where each plant grows: region, exact location, latitude, longitude, and elevation from map and global positioning system (GPS); slope (in degrees); aspect (compass direction it faces); soil type or soil sample number (if needed for ecological studies); moisture regime of the soil; habitat and associated plants; disturbance if present; use by local inhabitants or animals if observed; date; time. "A picture is worth a thousand words," so photos or sketches were always taken to supplement the field notes. Using a small portable tape recorder helped us collect information quickly or under adverse conditions for later transcription into the field notebook.

Collecting Plant Voucher Specimens

The importance of properly collecting of specimens of the plants being studied cannot be stressed too much. A voucher specimen is a pressed, dried sample of the plant, mounted on high-quality white cardboard, and labeled with the plant's scientific and common names and a brief description of where, when, why, and by whom it was collected. Because common plant names vary from one location to another, and sometimes even from one person to another, they are unreliable as a basis for storing and collating information. Voucher specimens can be used to positively identify each plant and serve as a permanent record of the collection.

Multiple voucher specimens were collected during our research, one for each institution participating in the project to make this essential documentation readily available to other researchers. Plastic-laminated, life-size color photocopies of the voucher specimens were prepared for participating communities to use as teaching materials that would require no special storage and be durable for schools and forestry or agriculture extension offices.

Collection Materials

The bare minimum for collection materials should include a field press (as described below), knife, permanent marker, pencils, field notebook (as described above), and a plastic bag to keep things dry if it rains (garbage size and smaller). Other equipment that we found useful sometimes: GPS instrument if mapping of the resources is contemplated, pruning shears, trowel, hand lens, camera, map and/or aerial photographs to locate the sampling area, compass, whistle, insect repellent, flagging tape to mark transects or routes or plots, tape measure, high-visibility clothing (especially during hunting season!), tape recorder to make verbal notes (especially useful in bad weather when it is hard to write), folding shovel if a lot of deep roots must be collected, pole pruner for collecting tree branch samples, altimeter, clinometer, portable drier, string tags (especially useful to identify specimens by number so they do not get mixed up in the collection bag), nylon mesh bags for drying bulk specimens for later analysis, and plastic screw-capped bottles and ethanol if pickled specimens are required for chemical analysis or morphological studies of complex flower parts. Obviously, not all of these items were needed at any one time. Permits were obtained when required for collection in parks, and permission of the owner was obtained for collection on private or corporate land.

Plant Press Materials

Field press:	a corrugated cardboard box (bottom approximately 18" x 12" is best), cut so sides fold nicely over bottom, newspaper sheets cut to size, rope to close it.
Drying press:	two plywood or lattice boards (18" x 12"), two webbing belts or ropes with slip-knots, corrugated cardboard sheets, sponge (carpet underlay), blotter sheets, newspaper; plants will be sandwiched between newspaper, blotters, and then cardboard sheets.

What We Collected

For herbaceous plants we always collected at least part of the root system, stems, leaves, flowers, and/or fruit and seeds. For woody plants we collected a small stem and/or a piece of the bark (in addition to leaves, flowering and/or fruiting structures). Large fruit or succulent stems were split or cut into pieces for drying or placed in separate folded paper (e.g., cones) if too large and juicy to be pressed.

Note that some plants, such as willows, have separate sexes, both of which must be collected with flowers to identify them with certainty.

Specimens were always numbered consecutively, even if the same species was collected several times on different occasions. Each collection requires a separate number since related or otherwise similar species may be confused in the field. Only multiple specimens of the same plant collected at the same time and place shared a single collection number. Collections had different numbering schemes for different regions covered in this project because each student maintained his/her own consecutive numbering scheme, a fact that facilitated comparison of plants from different locations. The collection number was written on the pressing newspaper or on a tag firmly attached to a specimen that was to be pressed later, and the number and related information were recorded in the field notebook immediately. Using the pre-printed data form helped us keep consistent records.

Pressing Plants

All soil was cleaned from roots (mud was first rinsed off, then further brushed off when dry). Plant specimens were arranged on the newspaper carefully, so that they looked as natural as possible, without too many parts overlapping (which slows drying and looks ugly). Pruning was done if necessary. Tall plants were arranged by folding the stems like an upside-down V, or an N or M. At least one leaf was turned upside down so the under-surface could be seen after pressing. Room was left for a 3" x 5" label at the lower right-hand corner. Herbs were sandwiched between two blotters and then two cardboard sheets. For thicker specimens a sponge sheet in place of one of the blotters was used to press around the thick stem or root and still flatten the leaves. When the "sandwiches" of collected plants were ready to press, they were stacked and the stack was placed between the two plywood or lattice boards. The belts were tightened around the press by standing on the press as the ends of the belts were pulled. Further tightening was necessary later as the specimens dried and shrank.

Dry, sunny weather is best in terms of getting plants dried easily, but when that was not possible, we placed presses on racks suspended well above stoves, kerosene space heaters, or heat lamps. The faster the plants are dried, the better they will look, especially in terms of color and lack of mold, although care must be taken not to overheat the press. Plants were pressed as soon as possible after collection using a field press, which provides better specimens than if plants are collected in plastic garbage bags and pressed later.

Mounting Specimens

For permanent storage, each voucher specimen was placed on a sheet of archival quality white cardboard 12" x 18" and taped down with very thin strips of white fabric tape. Any loose parts such as conifer needles, seeds, or berries were placed in a small envelope and attached to the white cardboard in any free spot other than the lower right corner where the label was to be glued. The label (example provided in figure 2) was carefully typed and provided the plant's scientific name (*Genus specific-epithet* Author, Family), common names in English and other languages as required (e.g., Chipewyan, Cree, French), a brief summary of traditional uses, and a brief description of where, when, why, and by whom it was collected.

Storing Voucher Specimens

When the voucher specimens were submitted to each institution's herbarium, they were each assigned an accession number that serves for the indexing of the collections, e.g., on a computer database. The voucher specimens were then filed in folders with other specimens of the same species and then arranged in water and insect-proof herbarium cabinets in taxonomic order. To facilitate retrieval, the unique specimen label clearly identified it as a voucher specimen for the ethnobotany project, and it carried the collection number to connect the individual specimen to the data in the field notebook and subsequent publications.

Brandon University Herbarium
Boreal Ethnobotany Voucher

English: Fireweed
Cree: akapuskwah, athkapask
Dene: gó^{n}dhi'elé
French: bouquets rouges

Epilobium angustifolium L., Onagraceae

Food: young leaves, stems, flowers
Medicine: leaf tea for intestinal worms, poultice for wounds, boils, bruises
Tech: mat for food, stem fibre for thread

Coll: N. Spence #20, 22-Aug-95

Nelson House - Thompson highway mile 39

Figure 2.—*A sample herbarium label.*

Presenting the Results

In our reports the names of the elders contributing the information were substituted with a letter representing their cultural background (e.g., C = Cree, D = Dene: Chipewyan, or M = Métis) and a randomly assigned number for the individual. This was done to preserve confidentiality while still allowing quantitative ethnobotanical analysis of the results. For example, if identical uses are provided by several contributors from different communities or cultures, that indicates a more widely accepted use, which might take priority for followup investigations over a use reported only once. In publications detailing the results of the search, we provided a summary of the codes and anonymous biographical data (age, gender, community, and cultural affiliation).

A conscientious effort was made to produce readily accessible publications of ethnobotanical information that could be returned to the participating communities for their own use in addition to more technical peer-reviewed scientific publications that would have a much more limited audience. Examples from our research include Marles *et al.* 2000 and Spence-Tays *et al.* 1999.

RESULTS: BOREAL NON-TIMBER FOREST PRODUCTS

With the economic justification of diversification of the forestry and agricultural industries, we received funding to conduct extensive ethnobotanical field research across the central boreal forest region of the provinces of Alberta, Saskatchewan, Manitoba, Ontario, and the Labrador district of Newfoundland. A key aspect of this research is that it has involved First Nations communities in every stage, from planning to conducting field interviews, collecting and identifying plant specimens, to documenting and analyzing the results. The information to follow is based on interviews with over 100 Cree, Dene, Ojibwe, Innu, and Métis elders in more than 30 different communities across the north (see fig. 3), supplemented by an in-depth literature review. The following information is mainly summarized from Marles *et al.* (2000) except where otherwise indicated.

There has always been a rather limited demand for traditional handicrafts such as birch bark and sweet grass baskets, but we need to pay more attention to highly processed products, which provide greater employment opportunities within the community and have low bulk

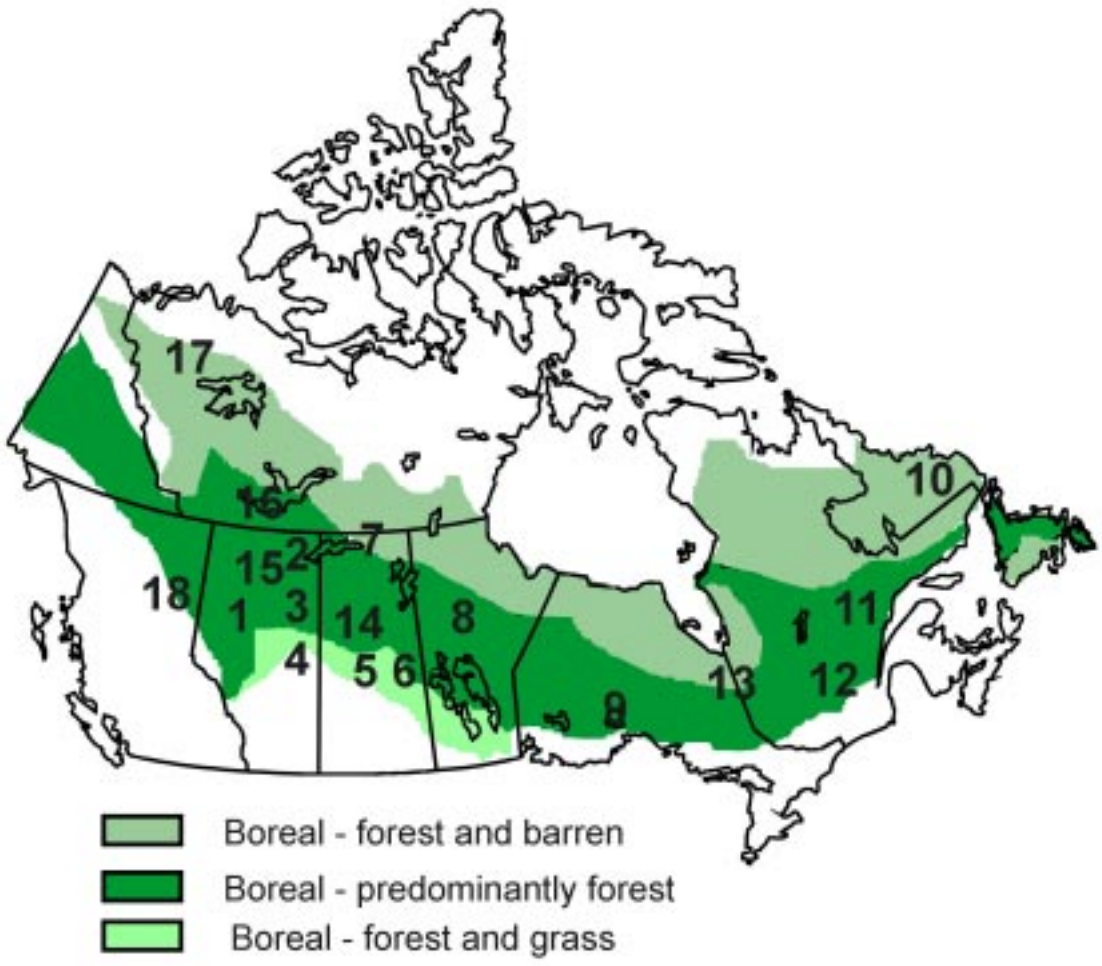

Figure 3.—*Recent ethnobotanical studies in Canada's boreal forest: #1-10: Research of Marles, colleagues and students (Abou-Zaid 1996; Clavelle 1997; Inkpen 1999; Marles et al. 2000); #11: Clément 1990; #12: Black 1980; #13: Berkes and Farkas 1978; #14: Leighton 1985; #15: Anderson 1980; Siegfried 1994; Wein* et al. *1991; Young* et al. *1989; #16: Lamont 1977; #17: Hara 1980; #18: Johnson-Gottesfeld 1988-98.*

and high value. This is important due to the isolation of many northern communities, which may depend on air and water transportation during the summer and ice roads over the frozen rivers and lakes during the winter, making the shipping of goods extremely expensive.

Some categories of plant-derived, value-added products include functional foods, nutraceuticals, cosmeceuticals, pharmaceuticals, agrochemicals, and fine chemicals. Estimates of the current North American market value for natural products vary from $5 billion to $250 billion, depending on whether natural products are defined narrowly as herbal medicines or more broadly as all functional foods, dietary supplements, medicines, and other products such as shampoos that have herbal constituents (Shambrock & Associates and Kelly Associates 1998). Even accepting the lower value, there are obviously tremendous market opportunities for boreal NTFPs that might fit into one or more of the above categories.

Functional Foods

The health benefits of fresh, unprocessed fruits and vegetables are well known. Aboriginal elders we interviewed made an explicit connection between the lack of consumption of "bush food" and the poor health of many young

members of their communities. Some northern plant products are already commercialized as healthful foods, such as wild rice (*Zizania aquatica* L., Poaceae) grains and pasta products. A "functional food," as defined by Health Canada (1997), is distinguished by the following characteristics: it is similar in appearance to conventional foods, it is consumed as part of a usual diet, it is demonstrated to have physiological benefits beyond basic nutritional functions, and/or it reduces the risk of chronic disease. One example of a "functional food" from a forest (bog) plant with a medicinal application is the cranberry (*Vaccinium macrocarpon* Ait., *V. oxycoccos* L., and *V. vitis-idaea* L., Ericaceae). Cranberry fruit and juice are known to treat or help prevent urinary tract infections due to the content of fructose, which inhibits adhesion of type 1 fimbriated *E. coli*, and particular proanthocyanidin-type condensed tannins that prevent adhesion of P-fimbriated *E. coli* bacteria to the urinary tract epithelium (Howell *et al.* 1998). These special tannins are restricted in their distribution to cranberries and blueberries (*Vaccinium myrtilloides* Michx., *V. uliginosum* L., *V. caespitosum* Michx., *V. corymbosum* L., *V. myrtillus* L., Ericaceae). Other potentially important examples from the northern forest include carotenoid-rich cloudberries (*Rubus chamaemorus* L., Rosaceae), commercialized in Newfoundland but not readily available in stores elsewhere; rhizomes and shoots of cattail (*Typha latifolia* L., Typhaceae), which have antioxidant flavonoids, low Glycemic Index carbohydrates, protein, fiber, and various vitamins and minerals; lamb's-quarter leaves (*Chenopodium album* L., Chenopodiaceae), a common weed rich in flavonoids, sesquiterpenes, and oxalic acid; and western wood lily (*Lilium philadephicum* L., Liliaceae), which has tuberous roots rich in low Glycemic Index glucomannans and health-promoting lignans and phenylpropanoids.

Nutraceuticals

A nutraceutical may be distinguished from a functional food as follows: it is produced from a food but sold in pills, powders, or other medicinal forms; it is demonstrated to have physiological benefits beyond basic nutritional functions; and/or it reduces the risk of chronic disease. Most traditional foods do not fit in this category, with the possible exception of mineral salts extracted from red samphire (*Salicornia rubra* A. Nels, Chenopodiaceae) by boiling and evaporation, and used by the Shoal Lake, Saskatchewan, Cree to season food. This crude salt provides trace minerals that act as enzyme cofactors critical for the maintenance of good health. Consumption of small amounts of chromium, manganese, and magnesium salts has been shown to be beneficial in the treatment of non-insulin dependent diabetes mellitus (Marles and Farnsworth 1995).

There are many classes of bioactive phytochemicals with known health benefits, including: mono-, di-, and triterpenoids; limonoids; phytosterols; carotenoids; flavonoids; phenylpropanoids; lignins; other polyphenols including: catechins, gallotannins, ellagitannins, and proanthocyanidins; allylic, aromatic, and isothiocyanate sulphur compounds; complex carbohydrates including fiber; lipids; and indoles. However, these nutraceutical compounds may be present in higher amounts in some wild edible plants, such as stinging nettle (*Urtica dioica* L., Urticaceae) than in cultivars such as iceberg lettuce that have been bred for mild flavor and pale color.

The inner bark (technically the inner active phloem, cambium, and outer active xylem layers) of aspen and balsam poplar (*Populus tremuloides* Michx. and *P. balsamifera* L., Salicaceae), birch (*Betula papyrifera* Marsh., *B. neoalaskana* Sarg., Betulaceae), white spruce (*Picea glauca* (Moench) Voss, Pinaceae), and pine (*Pinus banksiana* Lamb., Pinaceae), harvested in Canada's north as a starvation food or special treat in early spring, is a source of nutraceutical polyphenols already commercialized from the European maritime pine (*P. maritima* L.) as Pycnogenol®, a proanthocyanidin complex reputedly antioxidant and able to reduce blood capillary fragility.

Cosmeceuticals

Cosmeceuticals are compounds present in cosmetics that have a pharmaceutical effect, such as to improve skin texture, stimulate wound healing, control hair growth, regulate skin pigmentation, reduce inflammation, or reduce irritation, e.g., stinging, burning, and itching. Examples of plants with cosmeceutical potential include yarrow (*Achillea millefolium* L., Asteraceae), which contains anti-inflammatory sesquiterpenes, antimicrobial monoterpenes,

and hemostatic alkaloids; cow parsnip (*Heracleum maximum* Bartr., Apiaceae), which contains skin darkening furanocoumarins used commercially to treat psoriasis; and leaves of willowherb or fireweed (*Epilobium angustifolium* L., Onagraceae), the active constituent in a line of anti-inflammatory skin care products marketed by Fytochem Products, Inc. Willowherb has prostaglandin inhibitory activity due to its flavonoid glycoside (myricetin-3-*O*-β-*D*-glucuronide) content.

Traditional Herbal Medicines or Natural Health Products

More than 130 native or naturalized species of plants were identified in our study as having traditional medicinal uses. Health Canada (1995) defines, for registration purposes, a Traditional Herbal Medicine or Natural Health Product as a finished drug product intended for self-medication, for minor self-limiting ailments suitable for self-treatment, whose active ingredients are herbal only. There may be only limited scientific documentation, but these products must have a well-documented traditional use. Such registered herbal products are over-the-counter medicines with a Drug Identification Number and allowed therapeutic claims on the product label. Commercial examples include a bearberry leaf (*Arctostaphylos uva-ursi* (L.) Spreng., Ericaceae) diuretic produced by Nature's Way and the mouthwash and toothpaste with Canadian bloodroot (*Sanguinaria canadensis* L., Papaveraceae) mentioned previously. Some commercial European herbs, such as valerian (*Valeriana officinalis* L., Valerianaceae), could provide leads for similar Canadian wild herbs such as our northern valerian (*V. dioica* L.).

Medicinal plants are often used in combinations, but the elders have asked us to keep the formulas confidential to protect their intellectual property rights. We have their permission to describe and evaluate uses of certain individual plants to validate traditional knowledge. One example I can describe in some detail involves the rhizome of yellow pond lily (*Nuphar lutea* (L.) Sm., Nymphaeaceae). It is harvested from the bottom of ponds, cut into slices to be dried, then used both internally with other plants in a compound decoction and externally to treat diabetic ulcers. It is important to note that the treatment is not just herbal, but also involves smudging with burning herbs, prayers, and cleansing rituals involving the use of tobacco, charcoal, and red cloth. We cannot expect laboratory studies to perfectly describe the healing properties of the herbal medicines because the traditional healing rituals are an important psychological aspect of the healing.

North American rat root or calamus rhizome (*Acorus americanus* (Raf.) Raf., Acoraceae) decoction is widely used traditionally for colds, upset stomach, pain (rheumatism, head, etc.), and diabetes. There is scientific evidence to support its efficacy and superiority over the related species of Europe and Asia (*A. calamus* L.) (Bisset and Wichtl 1994), and thus it has a strong overseas market potential as well as demand among North American Aboriginal people.

Agrochemicals

Agrochemicals are used for the control of insects, weeds, or other pests. Naturally derived agrochemicals may be more "environmentally friendly" than current synthetic compounds due to biodegradability and novel mechanisms of action that defeat current pest resistance. A well-known example of an agrochemical from a northern plant is the insect hormone analogue juvabione from balsam fir (*Abies balsamea* (L.) Mill., Pinaceae). There is significant potential for the discovery of new insecticides from North American ethnobotanicals (Berenbaum 1989), such as yarrow, which contains insecticidal, insect repellent, and antifeedant monoterpenes and sesquiterpenes.

Fine Chemicals

Fine chemicals may be used as reagents, starting materials for synthesis, or in other industrial applications, such as terpenoids from pine (*Pinus banksiana* Lamb., Pinaceae) in turpentine. They may also include essential oils extracted for perfumery and aromatherapy, such as those from wild bergamot (*Monarda fistulosa* L., Lamiaceae) and Labrador tea (*Ledum groenlandicum* Oeder, Ericaceae).

DISCUSSION: SUSTAINABILITY OF NTFP PRODUCTION

Now that we have identified a significant number of potentially useful plants from the boreal forest, we must determine if they can be developed in a sustainable manner. There are various interpretations of "sustainable."

Ecological Sustainability

While clearcut logging is an efficient method of timber harvest, it is not likely to be ecologically sustainable if conducted on too large a scale or on unsuitable land such as steep slopes subject to erosion. Alternative strategies such as selective logging combined with the harvest of non-timber forest products could allow the same economic return per hectare with fewer trees cut, making the industry more sustainable. Conversely, some companies are sending in gatherers for the non-timber products and then clearcutting, which maximizes the dollars extracted per hectare but is less ecologically sustainable. Most native herbs, such as American ginseng (*Panax quinquefolius* L., Araliaceae), cannot be sustainably wildcrafted due to the quantities needed for commerce, and in many localities economic species have already become endangered or extirpated: American ginseng was officially up-listed to endangered status in Ontario and Quebec in 1999 (Committee on the Status of Endangered Wildlife in Canada 2000).

Biological productivity in the north tends to be low, although the long summer day compensates to some extent. Small-scale agriculture with ameliorative techniques such as raised beds or cold-frames can prove quite successful. Developing native species into new crops presents a unique set of agronomic challenges for cultivation, pest control, harvesting, and preparation for market, but for many of our economic native plants, selection of appropriate varieties and large-scale agricultural production will be the most viable option for a sustainable harvest. Our provincial Departments of Agriculture and the Crop Diversification Centres have numerous test plots of medicinal plants to evaluate cultivation, harvest, and pest control techniques under various conditions.

Economic Sustainability

Canada has a history as a major world supplier of raw materials, which we export and then buy back as finished products. This trend has carried over into medicinal plant crops, which are generally sold in bulk through brokers to American, Asian, and European markets. Much more effort must be made to develop value-added products, particularly if rural communities are to achieve the maximum benefit from new medicinal crops. Extraction and encapsulation processes are readily adapted to a cottage-industry scale. Target markets must be clearly identified and stringent quality controls established to ensure commercial viability. Health Canada (1996) has published a supplement to its Good Manufacturing Practice Guidelines specifically for herbal products.

Cultural Sustainability

Development should be consistent with local community needs and desires, not just demands of the global market. Among Aboriginal people of all ages participating in this study, there was no consensus on the desirability of economic development of plant products. Concern was expressed that pharmaceutical companies might profit from the development of medicines based on traditional remedies without any recognition or financial compensation for those providing the information, raising the issue of protection of intellectual property rights. When intellectual property rights are recognized, another question arises about the form (e.g., cash, funding for construction or scholarships, biological reserve land purchases) and quantity of fair compensation. In many cases the sacred nature of medicinal plants may be considered grounds for not developing them commercially. These issues must be dealt with fairly to ensure sustained involvement of the community in development projects. Direct involvement of community members in the research and development process empowers them to find the solutions they need. Involving Aboriginal youth in the research helps disseminate traditional knowledge, ensuring that these traditions will be sustained from one generation to the next. The preparation of educational materials from research results is another means to facilitate the transmission of traditional knowledge to new generations.

CONCLUSIONS

We believe the teamwork approach of Aboriginal researchers, community elders, scientists, foresters, agronomists, and marketers working together for the discovery and assessment of potential new plant products shows promise for sustainable boreal economic development. Many boreal plants have the potential to provide NTFPs, but issues of ecological, economic, and cultural sustainability must be adequately addressed.

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LITERATURE CITED

Abou-Zaid, M. 1996. Historical knowledge of medicinal plants used by northern Ontario First Nations People as a guide to the identification of new bioactive natural products. Northern Ontario Development Agreement Progress Report (1995-96), Project Agreement 4559. Sault Ste. Marie, ON: Natural Resources Canada, Canadian Forest Service. 32 p.

Anderson, A. 1980. Some native herbal remedies. Publ. 8A. Calgary: Friends of the Devonian Botanic Garden. revised April 1980. 76 p.

Berenbaum, May R. 1989. North American ethnobotanicals as sources of novel plant-based insecticides. In: Arnason, J.T.; Philogène, B.R.; Morand, P., eds. Insecticides of plant origin. ACS Symp. Ser. 387. Washington, DC: American Chemical Society. 213 p.

Berkes, F.; Farkas, C.S. 1978. Eastern James Bay Cree Indians: changing patterns of wild food use and nutrition. Ecology of Food and Nutrition. 7: 155-172.

Bisset, N.G.; Wichtl, M. 1994. Herbal drugs and phytopharmaceuticals: a handbook for practice on a scientific basis. Boca Raton, FL: Medpharm Scientific Publishers, Stuttgart, and CRC Press. 566 p.

Black, M.J. 1980. Algonquin ethnobotany: an interpretation of Aboriginal adaptation in southwestern Quebec. Can. Ethnology Serv. Pap. 65, National Museum of Man Mercury Series. Ottawa, Canada: National Museums of Canada. 266 p.

Brown, Lester R.; Brough, Holly; Durning, Alan; Flavin, Christopher; French, Hilary; Jacobson, Jodi; Lensenn, Nicholas; Lowe, Marcia; Postel, Sandra; Renner, Michael; Ryan, John; Starke, Linda; Young, John. 1992. State of the world 1992. A Worldwatch Institute report on progress toward a sustainable society. New York, NY: W.W. Norton. 256 p.

Clavelle, C.M. 1997. Ethnobotany of two Cree communities in the southern boreal forest of Saskatchewan. Saskatoon, SK: University of Saskatchewan. 181 p. M.A. thesis.

Clément, D. 1990. L'ethnobotanique montagnaise de Mingan. Collection Nordicana 53. Quebec City, Canada: Centre d'études nordiques, Université Laval. 108 p.

Committee on the Status of Endangered Wildlife in Canada. 2000. Canadian species at risk: May 2000. Ottawa, Canada: Canadian Wildlife Service, Environment Canada. 28 p.

Government of Canada. 1991. Forestry: seeing the forest and the trees. In: The state of Canada's environment. Ottawa, Canada: Ministry of the Environment. 10: 1-24.

Hara, H.S. 1980. The Hare Indians and their world. Can. Ethnology Serv. Pap. 63, National Museum of Man Mercury Series. Ottawa, Canada: National Museums of Canada. 301 p.

Health Canada. 1995. Drugs directorate guideline: traditional herbal medicines. Ottawa, Canada: Health Canada. 17 p.

Health Canada. 1996. Good manufacturing practices: supplementary guidelines for the manufacture of herbal medicinal products. Ottawa, Canada: Health Canada, Health Protection Branch. 6 p.

Health Canada. 1997. Functional foods and nutraceuticals. Discussion document, Food Directorate and Drugs/Medical Devices Programme. Ottawa, Canada: Health Canada. 25 p.

Howell, A.B.; Vorsa, N.; Der Marderosian, A.; Foo, L.Y. 1998. Inhibition of the adherence of p-fimbriated *Escherichia coli* to uroepithelial-cell surfaces by proanthocyanidin extracts from cranberries. New England Journal of Medicine. 339 (15): 1085-1086.

Inkpen, T. 1999. Healthy people, healthy world: preserving aspects of traditional knowledge and improving its application to environmental assessment. Winnipeg, MB: Natural Resources Institute, University of Manitoba. 149 p. Master of Natural Resources Management thesis.

Johnson-Gottesfeld, L.M. 1992a. The importance of bark products in the aboriginal economies of northwestern British Columbia, Canada. Economic Botany. 46(2): 148-157.

Johnson-Gottesfeld, L.M. 1992b. Use of cinder conk (*Inonotus obliquus*) by the Gitksan of northwestern British Columbia, Canada. Journal of Ethnobiology. 12(1): 153-156.

Johnson-Gottesfeld, L.M. 1993. Plants, land and people, a study of Wet'suwet'en ethnobotany. Edmonton, AB: University of Alberta. 252 p. M.A. thesis.

Johnson-Gottesfeld, L.M. 1994a. Conservation, territory, and traditional beliefs: an analysis of Gitksan and Wet'suwet'an subsistence, northwest British Columbia, Canada. Human Ecology. 22(4): 443-465.

Johnson-Gottesfeld, L.M. 1994b. Wet'suwet'en ethnobotany: traditional plant uses. Journal of Ethnobiology. 14(2): 185-210.

Johnson-Gottesfeld, L.M. 1995. The role of plant foods in traditional Wet'suwet'en nutrition. Ecology of Food and Nutrition. 34: 149-169.

Johnson-Gottesfeld, L.M.; Anderson, B. 1988. Gitksan traditional medicine: herbs and healing. Journal of Ethnobiology. 8(1): 13-33.

Johnson-Gottesfeld, L.M.; Hargus, S. 1998. Classification and nomenclature in Witsuwit'en ethnobotany: a preliminary examination. Journal of Ethnobiology. 18(1): 69-101.

Lamont, S.M. 1977. The Fisherman Lake Slave and their environment – a story of floral and faunal resources. Saskatoon, SK: University of Saskatchewan. 368 p. M.S. thesis.

Leighton, A.L. 1985. Wild plant use by the Woods Cree (Nihithawak) of east-central Saskatchewan. Can. Ethnology Serv. Pap. 101, National Museum of Man Mercury Series. Ottawa, Canada: National Museums of Canada. 128 p.

Marles, Robin J.; Farnsworth, Norman R. 1995. Antidiabetic plants and their active constituents. Phytomedicine. 2: 137-189.

Marles, Robin J.; Clavelle, Christina; Monteleone, Leslie; Tays, Natalie; Burns, Donna. 2000. Aboriginal plant use in Canada's northwest boreal forest. Vancouver, BC: UBC Press and Natural Resources Canada – Canadian Forest Service. 368 p.

Natural Resources Canada. 1999. The state of Canada's forests: 1998-1999. Ottawa, Canada: Natural Resources Canada – Canadian Forest Service. 112 p.

Robbers, James E.; Speedie, Marilyn K.; Tyler, Varro E. 1996. Pharmacognosy and pharmacobiotechnology. Baltimore, MD: Williams & Wilkins. 337 p.

Science Council of Canada. 1992. Sustainable agriculture: the research challenge. Rep. 43. Ottawa, Canada: Science Council of Canada. 6 p.

Shambrock, David L. & Associates (Shambrock, D.L.; Marles, R.J.; Murray, E.D.); Kelly Associates (Kelly, B.; Baldwin, R.). 1998. Manitoba phytochemical nutraceutical market study. Winnipeg, Canada: Manitoba Department of Industry, Trade and Tourism.

Siegfried, E.V. 1994. Ethnobotany of the northern Cree of Wabasca/Desmarais. Calgary, AB: University of Calgary. 336 p. M.A. thesis.

Soejarto, D.D.; Farnsworth, N.R. 1989. Tropical rain forests: potential source of new drugs? Perspectives in Biology and Medicine. 32: 244-256.

Spence-Tays, Natalie; Strutt, Kimberley D.; Marles, Robin J. 1999. Plants of the northern forest: traditional uses shared by Aboriginal elders. A set of 30 life-size color photocopies of plants and their uses. Brandon, MB: Brandon University Herbarium. 31 p.

Wein, E.E.; Sabry, J.H.; Evers, F.T. 1991. Food consumption patterns and use of country foods by native Canadians near Wood Buffalo National Park, Canada. Arctic. 44(3): 196-205.

Young, D.; Ingram, G.; Swartz, L. 1989. Cry of the eagle: encounters with a Cree healer. Toronto, Canada: University of Toronto Press. 145 p.