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Canadian Forest Service – Great Lakes Forestry Centre

Natural Products Research

INTRODUCTION

Canada's forests are often valued economically in terms of conventional products such as lumber and pulp. However, forests can be viewed more broadly as "factories" that produce rich sources of raw materials from living and dead trees, shrubs and other plants, using sunlight, CO_2 and water. The forest industry is exploring ways to make use of different sustainably produced raw materials found in forests to produce renewable, recyclable and environmentally friendly goods and products. Such materials can take the form of naturally occurring chemical (biochemical) or physical components (e.g., cellulose) in plants, and can be extracted from plant material or by-products of the pulping process.

Biochemicals are produced by plants in response to environmental stresses such as insect or microbial infestations. It is estimated that almost 2% of the carbon photosynthesized by plants is converted by the plant into biochemicals. In trees, the compounds are present in the needles, leaves, roots, bark, compression wood, and knots. The pharmaceutical industry has successfully developed many biochemical-based drugs from tree extracts, including acetylsalicylic acid (ASA or Aspirin) from willow (*Salix spp.*) and paclitaxel (Taxol) from yew (*Taxus spp.*). An estimated 70% of the drugs in the marketplace today come from either plants or plant sources.

There is an increased interest in natural products from plants for their purported health benefits, and because they are derived from renewable sources. An example comes from the discovery of large amounts of hydroxymatairesinol in the knots of Norway spruce (*Picea abies*) that resulted in a bioproduct now manufactured as HMRlignan, which has similar properties to flax lignans, a popular commodity in the natural health products marketplace.

The discovery of such compounds is a painstaking process of extraction, testing and eventual commercialization that takes many years and requires a large investment. Such research is typically multidisciplinary, bringing together expertise in plant chemistry, forest management, and medical science. The Great Lakes Forestry Centre role in this process is at the stage of isolating promising biochemical compounds from plants.

GREAT LAKES FORESTRY CENTRE (GLFC) RESEARCH

Mamdouh Abou-Zaid, a natural products chemist at GLFC, leads a team that evaluates compounds found in plants and that have potential as natural health or pest control products. With his extensive knowledge in plant chemistry, various bioassays and analytical assessments, Abou-Zaid has developed viable methods for isolating and purifying the compounds.

A key outcome of his many years of research has been the development of a database and library of biochemicals from forestry sources, serving as a useful tool in the area of natural product research. This library of forest plant extracts and purified compounds is the only one of its kind in Canada. It contains over 1,000 plant extracts and 800 purified compounds that were collected from trees, shrubs and herbs across the country. Many of these are novel natural products that possess medicinal properties. All of the active ingredients from these extracts have been cataloged along with a record of the location and date they were collected.

This task is particularly challenging due to the complex nature of plant compounds. For example, plant flavonoids, an important class of plant metabolites, consist of thousands of unique chemical structures. Each must be effectively separated to clearly identify the compound.

Drug Discovery Program

One of the team's ongoing projects is the search for biochemicals with medicinal properties that have the potential to be commercialized. In the boreal and mixed deciduous forests of Northern Ontario there are over 400 species of forest plants that produce compounds to protect themselves against insect, fungal and viral attack. There is a distinct possibility that some of these compounds could have beneficial health effects for humans. Currently, in a collaborative study with the Sudbury Regional Hospital Cancer Centre, GLFC personnel are screening plant extracts and their purified compounds from Northern Ontario flora in the search for new anti-cancer drugs.

Pharmaceuticals - Paclitaxel

Paclitaxel is a well known naturally occurring compound isolated from Canada yew or ground hemlock (*Taxus canadensis*) that is used in cancer chemotherapy. It has become a widely used drug to treat lung, ovarian and breast cancers. Canada yew has a relatively high concentration of taxanes compared with other species of yew. Dr. Abou-Zaid has worked with Ottawa's Ensyn Technologies in developing a patent for a taxol extraction method from Canada yew.

He has also worked with Tom Noland of the Ontario Ministry of Natural Resources to carry out field trials to determine whether yew plantations could be a suitable value-added crop for Northern Ontario farmers. While results show that yew can be successfully grown on a variety of Northern Ontario soil types, the significant costs for weed and deer control make it economically unfeasible at this time. The selection of the fastest growing cultivars and improvements in yew propagation will also be required before it can be a profitable endeavour.

Antioxidants – maple syrup

Antioxidants are compounds that slow or prevent oxidation in the body, which over the years lead to diseases such as cancer, strokes and neurodegenerative diseases. Worldwide awareness of the various health benefits of natural foods containing these compounds is on the rise. GLFC's natural products team examined the antioxidant compounds in four different grades of maple syrup and identified 23 compounds, which likely represents only a small fraction of those actually present. The presence of antioxidants in maple syrup will help in the promotion of this Canadian forest product.

Natural Insecticides

Some of the natural compounds studied to date have been shown to offer pest resistant properties to plants, so their extraction and identification are the first step in developing new natural pest control products. For example, scientists observed that forest tent caterpillars feed on sugar maple and not red maple leaves. By examining the compounds found in the various species of maple leaves, they were able to determine that ethyl di-gallate was the chemical protecting red maple trees from feeding by forest tent caterpillar. Armed with this information, scientists now have another tool of potential use in reducing damage to forests from this damaging insect.

Currently, the testing of different species of ash is being carried out to determine whether some are more resistant than others to the emerald ash borer, a highly destructive invasive pest that has the potential to devastate North America's ash tree population. If a compound is discovered that deters feeding by this invasive pest, it could lead to the development of new methods for pest management. It may also lead to recommendations for planting of more pest resistant species of ash.

In addition to the uses described, natural plant compounds can yield other commercially valuable products such as essential oils, turpentines, plant growth regulators, natural wax, dyestuffs, flavours, food additives, pet food additives, and adhesives and polymer materials such as rosin, tannic acids or lignin. New natural products that are beneficial to humans and animal pets are continually being discovered, helping place further value on ongoing research.

CONCLUSION

The GLFC team that researches natural products is making an important contribution to the development of a forest bioproducts industry in Canada, by finding new ways to use forest resources. It is hoped that new commercial opportunities can be created, which will lead to economic diversification in northern communities. Collaboration with academia, the forest industry and institutions such as the Sudbury Regional Hospital Cancer Centre will lead to a new multidisciplinary way of looking at our forests.

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