New beekeepers quickly learn that propolis is the glue bees use to bind hive parts together, making the manipulation of frames and other hive parts a growing challenge as hive equipment is increasingly coated by the bees. At warm temperatures fresh propolis is incredibly sticky, while at low temperatures it serves as a solid binding agent, making frames difficult to extract. Gathered by bees as plant resins, the complex material has been considered a form of medicine dating back thousands of years. Various studies have shown propolis to be antimicrobial in nature, with studies on herpes simplex virus, influenza virus and most recently as a potential inhibitor of HIV-1 expression (Geker et al 2005) as only a few examples of U.S. testing. The HIV study, done in vitro (a study made to occur in a controlled experimental environment rather than within a living organism or natural setting), found that propolis has powerful antiviral activity, in lab tests, against X4 and R5 variants (two categories of HIV strains, distinguished by their different approaches to infecting a cell) in the major cell types that this virus infects. The study indicated that, though the tested propolis samples were from various parts of the world, each variation of the material functioned as a viral entry inhibitor.

Dr. Nicola Bradbury of Bees for Development (2009) reports that it was long thought that bees collect the plant resins without altering their composition, but “recent work has shown that bees’ enzymes do indeed transform some components of propolis.” There is no clear and chemically standardized definition of propolis, although all experienced beekeepers know what it is. It is a beekeeper term, not based on plant botany—the precursors of propolis are the “sticky material on leaf buds” bees collect. Dr. Eva Crane, the late director of the International Bee Research Association, reported that propolis is “material that honeybees and some other bees can collect from living plants, and use alone or with beeswax in construction and adaption of their nests” (Crane, 1990). To confuse matters further, Crane adds that some authors consider the material that beekeepers scrape from their hives to be propolis, even though it may contain a large percentage of beeswax and a small amount of bee-collected pollen and honey. The propolis part of this is sometimes called balsam. Stingless bees use propolis and wax to produce a material called cerumen, which Crane suggests may be a more precise term to describe what honey bees use in their hive.

Bees use the propolis it keep their homes dry, free of drafts and hygienic. The inside walls of bee trees are remarkably smooth with a varnish of propols, sealing cracks where microorganisms may develop. The volatile components of propolis are thought to serve as an antiseptic air-fresher. The thin layer of propolis varnish inside the brood cells strengthens the comb and establishes a more hygienic space in which eggs, larvae and pupae complete their metamorphic processes. The space within the brood nest is dark, humid from honey processing and filled with the microbes associated with pollen conversion to bee bread. The thin propolis layer on much of the wood surface, as well as on the wax comb, apparently helps the bees maintain colony in healthy homeostasis (a relatively stable equilibrium among diverse elements inside the hive).

Propolis contains over 180 components (Burdock, 1998) and the exact molecules involved in this inhibitory role are unknown. Many researchers suspect that various flavonoids (organic compounds that appear as pigments in plants), moronic acid derivatives and caffeic acid (present in at least some plant resins) are contributing to the anti-HIV-1 activity.
In this article, we explore some of these chemical and medical properties, starting with the use of herbal remedy for over three thousand years, as well as recent evaluations of the substance's toxicological properties.

**History of human medical use**

As many cultures interacted with bees in earlier times, the advantages of propolis were widely accepted. While the exact sources of illnesses were as poorly understood as their cures until relatively recently in contemporary history, there is a void of solid research on the medical application of propolis since Western medicine has only been conducting research in this area for approximately 40 years. This task has proven to be highly challenging because of the variance in propolis's composition, and the lack of a standard propolis product.

But we are making headway. We are finding strong evidence of mechanisms that underlie the substance's historic reputation as a medicine. Crane collected some of the traditional uses of propolis in her book, *The World History of Beekeeping and Honey Hunting*. She cites Aristotle's *Historia animalium*, which points to propolis as a cure for bruises and suppurating sores. According to scholarly texts surviving from ancient Rome, propolis was a component in many physicians' poultices. Crane cites Arabic physician Avicenna's claims that propolis was "capable of expelling the tip of an arrow or thorns, cleans and softens the skin". Records from 12th century Europe describe medical preparations using propolis for the treatment of dental cavities and with mouth and throat infections.

Even the Incas—who had access to stingless bees (Genus *Mellipona*) before the western honey bee, genus *Apis*, was brought to the Americas by Europeans—adapted propolis as a treatment for inflammation accompanied by fever. As honey bees thrive in most habitats also occupied by humans, propolis has, historically, been an available resource. Propolis has been used in dental work, serving to both seal and clean the work site; it is readily available in health food stores as toothpaste and other personal grooming products. Inspiration for modern research of propolis as a possible agent against HIV came when researcher Genya Gekker, who received her formal training in the Ukraine, sought propolis as a traditional remedy for her own cold.

**Some recent investigations include:**

- **Antileukocytic effects**—Ethanol extracts have been tested on human liver and uterine carcinoma cells in the laboratory and shown to inhibit their growth; one of the components of propolis is cistroside diterpenoid, which shows a selective toxicity to tumor cells. Using hamster ovary cells and mouse sarcoma-type tumors, propolis killed cell growth and prevented further cell development.

- **Antioxidant effects**—Propolis flavonoids are thought to be powerful antioxidants, affecting free radicals and protecting compounds like Vitamin C from being destroyed.

- **Wound healing and tissue repair**—Propolis is thought to stimulate circulation, enzyme systems and cell metabolism in burn wounds, perhaps due to the arginine in propolis.

- **Cardiovascular effects**—Tests with mice showed that propolis reduced blood pressure and produced a sedative effect. There may be other benefits as well.

- **Dental caries effects**—When rats were given water containing a propolis extract they developed fewer dental caries when also exposed to one of the decay microbes. It has also been used as a secondary treatment to gingivitis, plaque and pulp gangrene.

- **Human tests**—A wide array of tests with humans (with different sample sizes and control conditions) suggest that propolis has some benefit in throat and lung infections, plaque and gingivitis, deep-growing fungi, ringworm, skin ulcers on the tibia, burns, external ear infections, vaginal and cervix inflammation and gastritis. We mention these with caution because they are not widely approved treatments in the United States, and require further investigation by both the medical community and potential users.

Perhaps the most remarkable part of all of the range of applications of propolis is the rate at which its purported properties are finding underlying support. Even with its inconsistent composition, it seems highly probable that the wide-range antibacterial, antiviral and antifungal properties of propolis would benefit everything from 'suppurating sores' to low-cost dentistry. Perhaps, if the traveling salesmen, who coined the phrase, had been selling 'bee oil' instead of snake oil, they'd never have sufficed their reputations!

**Uses of propolis by humans**

Though the historical properties of propolis have been widely established and the progress of science in the past 40 years of research has been promising, the reality of U.S. regulatory requirements demand rigorous testing and strict definitions before such substances can be marketed with any specific health claims. This is a challenge because the composition of propolis varies by region (which makes it particularly remarkable that all propolis samples appear to be generally effective) and the abundance of corroborating data required can be quite high.

Of particular interest, considering the range and impact of human immunodeficiency virus (HIV) on the global population, a report published in the 2005 Journal of Ethnopharmacology detailed the effects of propolis on specific cell bodies targeted by HIV type 1. To address the variance in chemical composition, the team tested substances collected from various local and global regions, specifically studying the effect of different concentrations of propolis on CD4+ and microglial cell cultures.
The bees have added a layer of propolis (red in color) to the top of the beeswax comb. There is also propolis lining the inside of the cells. This may provide antibiotic advantages to individual cells. As bees raise repeated cycles of brood, the cells have a buildup of cocoon silk and fecal material voided as larvae metamorphose to pre-pupa. While this is a generally unsanitary condition, the antibiotic propolis and inert beeswax must provide suitable protection. It still reinforces the need to replace combs as other contaminants collect in the cells.

two types of cells vital to the human immune system, when exposed to HIV type 1. Without apparent negative impact to the cells, this study suggests that a concentration of 66.6 micrograms of propolis per milliliter is sufficient to suppress the virus at over 85-98%, maximally, depending on the cell type. Even with regional variance in composition, the results reached similar levels for each type, leading the researchers to conclude that clinical trials of the substance (or one or more of its components) should be performed in the treatment of HIV-1 infections.

Stefan Bogdanov, a former researcher at the Swiss Bee Research Center, wrote a paper entitled "Propolis: Composition, Health, Medicine: A Review" in 2012 which documents dozens of uses and studies from all over the world, ranging from simple antibacterial, -viral and -fungal uses to specific applications for conditions of many varieties. Propolis has been tested in vitro and in animal experiments for properties that are anti-diabetes, anti-tumor and chemopreventive, and as an anti-inflammatory agent, all of which underscores contemporary interest in utilizing this natural product. As Dr. Crane indicates in her own writing, a standardization of propolis composition and further study on their components is required, and it seems clear that such an effort would be well rewarded.

Caution is needed

The perceived medical promises of propolis aside, there are good reasons to temper expectations about widespread propolis use in medicine. For starters, one must always consult a medical professional before consuming this (or any) substance for medicinal purposes. As amazing as propolis seems to be, there are side effects from its use, both externally and internally. To people who are already predisposed towards bee-product allergies, propolis may have a higher rate of triggering an allergic reaction. Persons with dermatitis, according to some European studies, are susceptible to outbreak from propolis contact.

In September 2010, New Zealand’s Medsafe: Information for Health Professionals, Prescriber Update Articles, issued a prescriber update that warned of hypersensitivity reactions, as well as cases of renal failure linked to propolis use. "This advice follows a review of international adverse reaction reports that identified several cases of hypersensitivity reactions in people using complementary medicines containing propolis. Patients with a history of allergies appeared to be at particular risk of these reactions. Propolis has been implicated in cases of acute renal failure." Unfortunately, this advisory referenced only a few isolated cases of caution, neglecting a statistical analysis that might suggest how much or which parts of the human population may be affected. How frequent are these events within the general public? It seems logical that individuals with known allergies should be sensitive to the use of any natural product from the beehive inasmuch as the exposure to bee-collected pollen is an ongoing concern to pollen marketers.

As of the beginning of 2012, the National Institutes of Health was only willing to rate propolis as possibly effective for cold sores, genital herpes, and improving healing and reducing pain and inflammation after mouth surgery. The MedlinePlus® entry on Propolis goes on to state that there is insufficient evidence to address claims of effectiveness on general inflammation, wounds, and any of the dozens of other claims that have come from history. Certainly, if you are a producer of propolis products, you will need to consult with FDA guidelines to ensure product compliance on medical claims and how propolis products can be marketed. A simple search of the FDA’s website on the subject returns numerous citations by the FDA against even well-established bee product companies regarding their compliance with advertising and sales.

So, is propolis worth getting excited about? Absolutely. With the availability of knowledge at every corner of the globe, the threats facing bees today and the growth of the human population, the pressures of sustaining our populations with all of our resources have never been greater. It is important that we all take an interest in advancing our understanding of these simple-yet-mysterious things that come from the most unexpected places. Research only goes as far as interest and support allows, so it falls to the global community to encourage the development of this knowledge base. The next time you find yourself grumbling as you try to pry open a hive, glued shut with propolis, consider the opportunities you may be missing!

Literature cited


For information about other work by Connor and Muir, consult the www.wicwas.com website.