

CHEMISTRY OF ESSENTIAL OILS

THE CHEMISTRY OF A HEALTHY LIFE

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The Chemistry of Essential Oils

This is my wife's story of life with Multiple Sclerosis. MS affects her life and our entire family everyday due to the multifaceted exacerbations and daily issues that arise from the disease. She was diagnosed with Multiple Sclerosis in January 2002 at the age of 20. For years her friends and family watched as her health slowly deteriorated. It was a very slow process. So slow that sometime she didn't really notice. She says those were the good days.

She just never quite had the energy she had before. She could still get out and do most of what she had before; she just didn't have the desire she had previously. She also started having periods where she experienced a lot of pain and loss of sensation in her wrists and hands. The lack of being able to feel objects made it so she couldn't hold a pencil or put on makeup. As an interpreter for the deaf, she relied on her hands to do her job. Her MS made it difficult, if not at times impossible; this frustrated her because she was passionate about her chosen line of work.

Megan started having some problem with emotionally, as well. It was nothing deep; just a loss of the lightness and vitality that had characterized her mood before, but at times it was a feeling of depression. It got to the point that she lived much of her life in a fog. Over the next several years, the more severe health problems would arise almost the same time every year, if they weren't growing more frequent. It was like her life was becoming defined by her health problems. She started missing work. Most of the time she was still able to function, but she would have strings of days that she could barely get out of bed without experiencing vertigo. She did well at work (despite frequent absences) and continued to be involved in the community, despite feeling that at times she didn't quite connect fully with the outside world.

She has been on a "therapy" (Rebif, which the IUPAC name is Human Interferon Beta-1a, is a prescription medication subcutaneously or intramuscular injection by syringe; Chemical Formula, $C_9O_8H_{14}O_8N_{246}O_{252}S_7$) since her diagnosis and she doesn't see that changing in the near future. She continues to take the medication, but they have some painful and sometime debilitating side effects themselves. She often states she has flu-like symptoms after taking her shot. These effects can last days and she is required to take the shot every two to three days. She writes, "The Man Upstairs hasn't told me I can stop taking those medications and so I continue to use them. Despite my use of the medication, the disease continued to progress." (Information about Rebif found on the product's website, <http://www.rebif.com>.)

In 2009, Megan lost feeling in her left arm. In 2010, she lost feeling in both feet. Her feet were numb. The plantar fasciitis she had for a few years didn't hurt anymore because she couldn't feel the pain. She always looks for the positive things in life, and she counts that as one of them. She had some days where she seemed to have unlimited energy, but these were quickly followed by days, weeks or months where she could hardly get out of bed.

These episodes have been hard on her as well as the rest of the family. As her husband, I have wanted to be able to help and relieve her of these challenges, but have always felt powerless. Many times the only thing I can do is stand by and watch as she struggles through the difficult times. I do what I can, caring for her, helping her stand, keep her balance, or walk; at times helping her shower, or taking on the full duties of preparing the meals, take care of household chores and caring for the children.

She states, "Then, in October of 2011, I was introduced to doTERRA Essential Oils by a family member who also has MS. I am so glad she was persistent with me because I can be stubborn."

Megan continues, "One of the tips another person with MS shared on a webinar with me is to put one drop of peppermint on my feet morning and night to help with energy. I decided to try it. While my energy didn't spike or anything, after three months of doing this, I noticed something spectacular: I could feel my toes!! Then I could feel my entire foot again. I even got the pain back! Who knew that would be something I'd appreciate?? My balance improved. I could walk more. I could walk longer. It was amazing. It still is. I have been able to pair peppermint oil with physical therapy to regain all feeling and control in my left arm as well. Peppermint was the first doTERRA essential oil product that I used to help my MS."

With this story in mind, this paper will explain the history, chemistry, and use of essential oils. The reader will gain a better understanding of these topics and will be able to appreciate their use by many for the betterment of their health and lives. This is in no wise a full treatise on the subject, but is my understanding of the subject and how the chemistry of these oils makes them so useful and powerful. The description of the history of essential oils is given to illustrate the fact that many people throughout the ages effectively used essential oils for treating and preventing myriad of disease and ailments. It is also a large part of the paper because I enjoy studying history. As we progress through the paper, we will revisit the story and expand it to help us gain better insight into how the use of essential oils has affected the lives of my family.

Most people today are unfamiliar with the idea that essential oils have been used for several thousand years for healing and anointing throughout ancient civilizations. Essential oils are some of the oldest and most powerful therapeutic substances known. Perhaps those living in ancient times had a greater understanding of essential oils than we do in modern times. Fragrant oils, aromatics, and spices have played a significant role in everyday life throughout world history. Essential oils are mentioned repeatedly in the religious texts of Jews, Christians, Muslims and others. Other historical records also describe how these substances were used to treat virtually every disorder or illness known at the time.

Records dating back to 4500 BC describe the use of balsamic substances with aromatic properties for religious rituals and medicinal applications. For many centuries essential oils and other aromatics were used for religious rituals, the treatment of illnesses, and other physical and spiritual needs. Ancient writings tell of scented barks, resins, spices, and aromatic vinegars, wines, and beers that were used in rituals, temples, astrology, embalming, and medicine. Essential oils have been used medicinally to kill bacteria, fungi, and viruses for thousands of years (see Essential Oils Desk Reference).

Through the writings, and drawings from the ancient civilizations, it seems that the Egyptians were the first people to extensively make use of oils, aromatic herbs and utilized them in religion, cosmetics as well as medical purposes. At the same time, the Chinese and Indian cultures also extensively used herbs and aromatic plants for therapeutic purposes.

The Egyptians discovered the potential beneficial use of fragrance and aroma. They created a variety of ointments and aromatic mixtures, for both private use and for religious ceremonies performed in the temples and pyramids. The Egyptians were masters in the art of using many different essential oils for rituals, including cleaning their bodies and embalming

their dead. Historical records indicate they used oils, herbs and aromatic plants for medicinal purposes. By the time Joseph, the son of Jacob, was sold into slavery in Egypt (Genesis 37:25), the use of aromatic oils had been long-established and widespread, and established trade routes facilitated the movement of these substances from one place to another.

Depicted in hieroglyphics on the walls of Egyptian temples are scenes of people blending oils. These pictures even describe hundreds of oil recipes. An ancient papyrus discovered in the Temple of Edfu contained medicinal formula and perfume recipes, used by alchemists and high priests, in blending aromatic substances for rituals.

There are over 200 references to aromatics, incense, and ointments throughout the Old and New Testaments of the Bible. In the Old Testament, Moses writes a recipe of a holy anointing oil with Myrrh, Cinnamon, Calamus, Cassia and Olive Oil. Aaron uses an incense offering to stop a plague when he stood between the dead and the living and the plague was stayed. Cinnamon is known to be highly antimicrobial, anti-infectious, and antibacterial. Perhaps the most prominent references being that of wise men presenting the Christ child with frankincense and myrrh and later Mary who washes Christ's feet with her hair and anoints him with "very precious" (Mark 14:3) or "very costly" (John 12:3) oil.

Oils used in the temples were commonly used for fragancing the chambers associated with sacred rituals and religious rites by pouring them into evaporation dishes. Many centuries before the time of Christ, the ancient Egyptians collected essential oils and placed them in alabaster vessels, also known as fragrance vials or vases. These vessels were specially carved and shaped for housing scented oils.

When the tomb of the Egyptian King, King Tutankhamun, was opened in 1922, some 50 alabaster jars designed to hold 350 liters of oils were discovered. While tomb robbers had stolen nearly all of the precious oils, some of the jars still contained oil traces. Entombing the king with these oils shows how valuable fragrant essential oils were to this ancient civilization. (<http://www.younglivinghealingoil.com/OilHistory.htm>)

The Ebers Papyrus, dating back to 1500 BC, was discovered in 1917 and is a medical scroll of over 870 feet long. The scroll included over 800 different herbal and aromatic prescriptions and remedies. Other scrolls described a high success rate in treating many different diseases using various fragrances and oils. Many of these mixtures contained myrrh and honey. Myrrh is still recognized for its ability to help with infections of the skin and throat, and to regenerate skin tissue. Because of its effectiveness in preventing bacterial growth, myrrh was also used for embalming. (Essential Oils Desk Reference)

Somehow, through wars, the dark ages, the knowledge and widespread use of essential oils had become lost to most of the world or forgotten. Essential oils were reintroduced into modern medicine during the late 19th and early 20th centuries. During World War I, the use of aromatic essences in civilian and military hospitals became widespread. One physician in France, Dr. Moncière, used essential oils extensively for their antibacterial and wound-healing properties, and developed several kinds of aromatic ointments.

A French cosmetic chemist named René-Maurice Gattefossé, Ph.D., is commonly regarded as the father of aromatherapy. He and a group of scientists began studying essential oils in 1907. While studying uses of essential oils, Dr. Gattefossé caught on fire following a laboratory explosion in July, 1910. After rolling on a lawn to extinguish the flames, he wrote that "both my hands were covered with rapidly developing gas gangrene." Dr. Gattefossé said

that, "just one rinse with lavender essence stopped the gasification of the tissue. This treatment was followed by profuse sweating, and healing which began the next day." This led him to continue to study the uses and effects of essential oils. He also found that very small amounts of essential oils are absorbed by the body and interact with the body chemistry. He shared what he learned with many others including a friend by the name of Jean Valnet, a Paris medical doctor. As a physician during World War II, Dr. Valnet began using essential oils on patients when he ran out of antibiotics. To his surprise, they exerted a powerful effect in combating and counteracting infection. He was able to save the lives of many soldiers who might otherwise have died.

Two of Dr. Valnet's students, Dr. Paul Belaiche and Dr. Jean Claude Lapraz, expanded on his work, examining essential oils for their antibacterial, antiviral, antiseptic, and antifungal properties and determined that they have healing capabilities. In the 1950's, Marguerite Maury started diluting essential oils in a vegetable carrier oil and massaging it onto the skin using a Tibetan technique which is applied along the nerve endings of the spinal column. This led to a wider use of aromatics and oils being used in aromatherapy and combining essential oils with massage to meet the needs of the individuals. Because of this rediscovery by these doctors and scientists, along with others including Weber State University (my alma-mater!) and other universities, the healing power of essential oils is again gaining popularity (www.essentialoils.co.za/history-essential-oils.htm).

As described above, essential oils were well known to be natural antiseptics and were used to treat ailments of all kinds. My wife began using essential oils consistently after the Peppermint oil worked on her feet so well. She purchased Lemon, Peppermint, Lavender, and Oregano oils along with others. She wanted to begin taking care of her health problems more naturally. The oils are lipid-soluble and relatively small and so can penetrate the cell membrane and travel throughout the body. As she did so, she started applying the oils onto our son and offering them to me. At first, I was very skeptical but watched as her health improved. At the time I was having some severe headaches and my neck often stiff or it was painful to move.

I had been injured while I was on my high school swim team. The team, which was about 70 swimmers strong, practiced in a small pool that had five narrow lanes. I was swimming into the wall and another swimmer was coming off the wall at full speed after doing his flipturn. He pushed off wall incorrectly and came directly toward me as I swam into the wall. The left side of the top of my head ran directly into his shoulder. There was some popping, straining and my neck hurt for a few minutes. As I could still move, I decided to keep swimming (I was dedicated and didn't think much of the incident at the time).

Years later I remembered the incident when I began to have the pain pretty consistently. I was having these headaches and muscle pain when my wife asked if I wanted some oils and other products that were essential oils based. At first I was reluctant and then I let her apply it because it was so painful. I also took some Ibuprofen (IUPAC name, (RS)-2-(4-(2-methylpropyl)phenyl)propanoic acid) and so when the pain subsided, I was quick to point out that it was the Ibuprofen. The next time I was in pain, she again applied the Deep Blue Rub as she had done before and this time I didn't use the Ibuprofen. Again, the pain subsided fairly rapidly. Over the next few weeks she had me apply it whenever I hurt. I later added Lemongrass oil and I felt even better. After a few more weeks of doing this, the pain was less significant and so I continued to use the Deep Blue Rub and Lemongrass. In the last 3 months, I have only

needed to apply it a few times. I have begun to use various other essential oils and oil blends to help with stress, concentration and many other issues. There is much I don't know and many things that others say about essential oils I am skeptical about, but I do know that certain essential oils have helped me with some of my health and emotional wellbeing.

Essential oils contain the aromatic molecules which are extracted from different parts of plants as a concentrated liquid from its plant of origin. The term "essential oil" is often used somewhat loosely referring to all aromatic products such as essence oils, absolutes, resinoids, and concretes. "Absolutes are obtained from grain alcohol extraction of a concrete, which is the solid waxy residue that is derived from the extraction of the plant materials, usually flower petals" (Essential Oils Desk Reference). Often people think of vegetable oils when they first hear about essential oils; however, essential oils and vegetable oils are two completely different types of oils. The "essential" portion of the name refers to the oil carrying a distinctive scent, or essence, of the plant.

Essential oils are the concentrated essence of plant matter widely used in aromatherapy. They are exclusively made from botanical material. Any fragrance that contains musk (an animal product), for instance, is not pure essential oil. They are often confused with synthetic fragrance oils, which are chemical recreations of scents. While these fragrance oils may smell identical to natural plant version, they do not feature the same chemical structure and will not have the same therapeutic effects; their use is limited to perfumery (www.wisegeek.com/what-are-essential-oils.htm).

There are about 300 essential oils in use today distilled or extracted from plants from all over the world. Essential oils are highly volatile plant essences, produced primarily by steam distillation, sometimes by cold pressing or by CO₂ extraction or solvent extraction. The oldest-known and crudest method for extraction and preservation of flower essences is known as enfleurage. Most ancient Egyptian essential oils were produced by a type of enfleurage extraction method or distillation method via the dating back about 3,500 BC. This method, which involves pressing the flowers into some type of lard or oil, is used for delicate flowers whose scent cannot be preserved well using typical methods such as distillation. Raw plant material (usually stems, foliage, bark or roots) was crushed and mixed with olive oil or animal fat, although other vegetable oils were also used. The literal meaning of the French word "enfleurage" is "to saturate with the perfume of flowers" (<http://experimentalhomesteader.com>)

For example, the bark of cedar was stripped from the trunk and branches, ground into a powder, soaked with olive oil and placed in a wool cloth. The cloth was then heated. The heat pulled the essential oil out of the bark particles into the olive oil, and the wool was pressed to extract the essential oil. Sandalwood oil was also extracted in this fashion. Petals from roses or jasmine were placed in goose or goat fat. The essential oil molecules were pulled from the petals into the fat, which was then processed to separate out the essential oils. This crude, ancient technique was among the most primitive forms of essential oil extraction. (<http://www.therapeutic-grade.com/refs/history.html>)

Other extraction techniques were also used. Some of these included soaking plant parts in boiling water, cold-pressing, soaking in alcohol, steam distillation, by passing steam through the plant material and condensing the steam to separate the oil from the plant. The distillation of essential oils was developed by the Arabians, who also regularly used aromatics. The Arabs

were the first to distill ethyl alcohol from fermented sugar, thus providing a new solvent for the extraction of essential. They perfected the extraction of rose oils and rose water, which were popular in the Middle East during the Byzantine Empire.

(<http://www.britannica.com/EBchecked/topic/193135/essential-oil>)

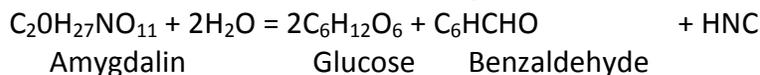
“The knowledge of distillation spread to Europe during the Middle Ages, and isolation of essential oils by distillation was described during the 11th to 13th centuries. These distilled products became a specialty of the European medieval pharmacies, and by about 1500 the following products had been introduced: oils of cedarwood, calamus, costus, rose, rosemary, spike, incense, turpentine, sage, cinnamon, benzoin, and myrrh. The alchemical theories of the Swiss physician and alchemist Paracelsus played a role in stimulating physicians and pharmacists to seek essential oils from aromatic leaves, woods, and roots.”

(<http://www.britannica.com/EBchecked/topic/193135/essential-oil>)

The distillation of essential oils was further enhanced through the process of steam distillation, using low heat and low pressure, to ensure the extraction of the finest quality essential oils. Based on the traditional methods of steam distillation from France and elsewhere, this technique is the best production methods employed in the essential oils industry today. The longer the process and lower the pressure the higher-grade essential oil is produced. For example, Lavender is produced commercially by distilling it for only 15 to 20 minutes with 155 pounds of pressure and temperatures reaching 350 degrees Fahrenheit. To produce Lavender that is therapeutic grade, the pressure should be zero pounds of pressure and steamed for an hour and 15 minutes or more.

A procedure called expression is applied only to citrus oils. Much of the essential oils from citrus fruits are by-products of the concentrated juice industry. The outer colored peel is squeezed in presses, and the oil is decanted or centrifuged to separate water and cell debris. The method is used for oil of sweet and bitter orange, lemon, lime, mandarin, tangerine, bergamot, and grapefruit. (<http://www.britannica.com/EBchecked/topic/193135/essential-oil>)

From the book *The Chemistry of Essential Oils and Artificial Perfumes* is an illustrative point about why the essential oils need to be extracted from the plant to be used as such. “One case in which the essential oil does not exist at any stage of the plant's life in the free condition, until the ferment and the glucoside have been brought into contact by artificial means, will suffice to illustrate this type of production of essential oils in the plant. The essential oil of bitter almonds does not exist as such in the kernels, which have no odour such as we ascribe to bitter almonds. The glucoside which gives rise to the essential oil is a body known as amygdalin, of the formula $C_{20}H_{27}NO_{11}$. This body crystallises in orthorhombic prisms with three molecules of water of crystallisation, which are driven off at 110° to 120° . Under the action of the ferment, emulsin (which is rarely, if ever, in contact with the amygdalin in the plant tissues) in the presence of water, amygdalin splits up into glucose, hydrocyanic acid, and benzaldehyde, the characteristic odour-bearer of essential oil of bitter almonds. The reaction (which probably occurs in two stages which need not be discussed here) is as follows :



The above illustration is typical of the method of formation of a large number of essential oils, which need not be discussed here in detail.”

(http://www.sciencemadness.org/library/books/the_chemistry_of_essential_oils_and_artificial_perfumes_ii.pdf)

Essential oils are made up of constituents including terpenes, phenols, and aldehydes, among others. These are carbon-based chains or rings. Terpenes are derived from multiples of isoprene units (a branched 5 carbon molecule), with the molecular formula C_5H_8 . Some of the most important terpene classifications in essential oils are monoterpenes ($C_{10}H_{12}$) and sesquiterpenes ($C_{15}H_{24}$). Some of the largest molecules found in essential oils are triterpenoids, which consist of 30 carbon atoms, or six isoprene units connected together. Those molecules larger than triterpenoids are not typically found in large quantities because they are too heavy to be extracted through steam distillation as described above.

Because essential oils are made up of hundreds of different chemicals, there are a great variety of effects on the body. For example, clove oil can be antiseptic and even act aphrodisiac. In some oils one or only a few components predominate: thus oil of wintergreen contains about 98 percent of methyl salicylate (IUPAC name, Methyl 2-hydroxybenzoate, also known as Salicylic acid methyl ester, molecular formula, $C_8H_8O_3$); orange oil, about 90 percent of d-limonene (IUPAC name, 1-methyl-4-(1-methylethenyl)-cyclohexene, molecular formula, $C_{10}H_{16}$); bois de rose, 90 percent of linalool (a terpene alcohol, molecular formula, $C_{10}H_{18}O$); and cassia, up to 95 percent of cinnamaldehyde (C_9H_8O). In most oils there is a mixture of anywhere from a few dozen to several hundred individual compounds. Trace components are very important, since they give the oil a characteristic and natural odor.

Terpenes, organic compounds consisting of multiples of isoprene units (containing five carbon atoms), are by far the most dominant constituents of essential oils. Individual oils, however, may contain appreciable quantities of straight chain, aromatic, or heterocyclic compounds. Thus allyl sulfides are characteristics of oil of garlic, traces of indole (C_8H_7N) and anthranilic acid esters are found in orange oil, straight chain alcohols and aldehydes (a chemical functional group, with the structure of R-CHO) are recognized in oil of violets, and phenols and other aromatic compounds are common to many oils. (All Chemical names and formulas are found at www.chemspider.com.)

Both hydrocarbons and oxygenated compounds such as alcohols, aldehydes, ketones, acids, esters, oxides, lactones, acetals, and phenols are responsible for the characteristic odours and flavours.

Essential oils are generally expensive, with prices ranging from several U.S. dollars per kilogram on the low side to several thousand dollars per kilogram. The Frankincense resin from Somalia costs \$30,000 to \$35,000 per ton, but the Frankincense essential oil (the main chemical components of frankincense oil are α -pinene, actanol, linalool, octyl acetate, bornyl acetate, incensole and incensyl acetate) sells for much more, because of the long, specific process of distilling it to be used therapeutically. The high price of the natural oils coupled with their limited availability has encouraged a search for substitutes.

Great progress has been made in the synthesis of individual components such as geraniol, citral, and linalyl acetate. These synthetic products have been combined with natural oils to extend supplies, and they have also been blended together in an attempt to duplicate the oils themselves. Such reconstituted oils usually lack certain of the "odor notes" of the natural products, because of absence of trace ingredients, which are often unidentified, that may be present in the natural oils. They also tend to have a more "chemical" odor, because of

trace impurities in the synthetics that are different from the components of natural oils. These synthetic oils are typically used in the cosmetic and fragrance industries.

Essential oils are used commercially in three primary ways: as odorants, as flavors and as pharmaceuticals. Uses as odorants include cosmetics, perfumes, soaps, detergents, and miscellaneous industrial products ranging from animal feeds to insecticides to paints. Employed as flavors they are present in bakery goods, candies, confections, meat, pickles, soft drinks, and many other food products. As pharmaceuticals they appear in dental products and a large, but decrease, number of medicines. Ninety-eight percent of all essential oils are used in the perfume and cosmetic industries, with only 2 percent created being therapeutic-grade and used in therapeutics and medicines.

The product of the methods of careful, long and sometimes expensive processes can be used for therapeutic, emotional, physical and spiritual relief. Many use this product in meditation. Others use it for its soothing affect on sore muscles, or if they are stressed out and just need to take their senses on a journey. Aromatherapy is a natural way of curing disorders of many kinds whether physical, spiritual or mental. There are numerous products of aromatherapy that can be used for relaxation such as candles, lotions, soaps, and many others. Essential oils are the ones that are most widely known.

Personal uses of essential oils include treat acne, to strengthen the immune system, to relax muscles among many other benefits. The aroma of these essential oils greatly stimulates the senses and the mood of an individual. Essential oils provide exquisite fragrances to balance mood, lift spirits, dispel negative emotions, and create a romantic atmosphere. There are masseuses that offer aromatic massages, using this product. There are masseuses that offer aromatic massages, using this product. Or, if you are a little more frugal with your money like I am, you can have your significant other give you a relaxing massage after a hard day.

There are aromatherapy oil burners and diffusers that can be used to fill entire rooms with the aroma of these essential oils. The scents can bring tranquility of mind and rejuvenates the mind and body of an individual. My children have seen the benefits of these applications. My daughter has used them often to help her with her anxiety and to calm her when she is having difficulties controlling her emotions. One of my boys uses a blend, called Breathe to augment his asthma and allergy medications.

Essential oils can play a role in your life through many applications. Aromatherapy essential oil can be bought at any natural retail outlet, but if you want the full benefit of this product, look to those companies that are involved directly with the production of the oils and oversee the quality control of the distillation process. Care of Essential Oils very necessary. Try to keep your oils in a cool, dry place, as they are sensitive to extreme temperature. Most oils come in dark, brown-tinted glass vials to protect them from the light.

After 2 days of using Life Long Vitality (a therapeutic-grade essential oil-based supplement), Frankincense and Immortelle, my was able to put the cane away she had to use after a difficult exacerbation and hasn't had to pick it up again. She states, "I feel better than I have in years. Even knowing how much better I felt, I was still surprised when a dear friend of mine stood up in a class I was teaching (about essential oils) and shared how much better I am than I was a year ago. I guess I just didn't realize how much other people had noticed my decline until she stood up and said, "She's the Megan I knew in college again."

I still tear up when I think of how much my life has improved. The quality of my life is immensely better than it was before I started using these products. My MS hasn't disappeared. There are days when it rears its ugly head and I have to slow down more than I would like. My MS has, however, stopped interfering with my life like it was before. And that is why I tell everyone I know about doTERRA essential oils. Because it has changed my life and I KNOW it can yours too. Just give it a chance.”