

Economic Botany & its Applications



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Introduction

Economic botany can be very broadly defined as a study of relationships between plants and people. Economic botany contributes significantly to anthropology, biology, conservation, botany, and other fields of science. This link between botany and anthropology explores the ways humans use plants for food, shelter, medicines, textiles, and much more.

History of economic botany

Botany itself came about through medicine and the development of herbal remedies. Thus at its advent, botany was economic as well as systematic. As plants became useful for herbals and curatives, their economic value increased. An early set of instructions drawn up by a cosmographer of Charles the fifth instructed explorers to

"determine what are the items of sustenance of the land and which onse are generally used, whether fruits or seeds, and all manner of spices, drugs, or whatever other scents, and find out the time in which one can reproduce the trees, plants, herbs, and fruits that these parts offer, and if the natives use them for medicines, as we do."

Teosinte and rice are two examples of plants modified so that their economic values would increase.

Teosinte

The teosintes are grasses of the genus *Zea*. Native Americans bred and selected teosinte for the traits we see in corn today (large ears, multiple rows of kernels). The first ears of maize were very short, with only 8 rows of kernels. Modern corn is the result of several hundred generations of selective breeding. Modern corn is incapable of reproducing without human help; the kernels will stay firmly attached to the cob and rot. This doesn't represent a useful adaptation for the species, but is excellent for harvesting and transporting corn.

Rice

Rice was first domesticated approximately 5,000 years ago, in Southeast Asia. Rice and American wild rice are believed to have been domesticated separately. Rice variants have been adapted to the tropics where they provide a grain staple, but rice can be grown

almost anywhere. The introduction of dwarf rice variants made several rice-producing countries self-sufficient. Rice is suited to countries with high rainfall.

Economically important food plants

Plants that humans use for food are of high economic importance. Research into food plants generally involves increasing the size of the edible plant organ in question, or increasing the areas where the plant can be grown, and less frequently, finding new crop species. Results of such research are often published in the journal *Economic Botany*. The New Zealand-based Plant & Food Research publishes its own journal on cultivar development and sustainable production systems for high quality produce, and the design and development of new and novel functional foods.

Florida oranges

Citrus has been a major commercial product in Florida since the 19th century. Florida produces over 70% of the U.S. citrus supply. The color of oranges is not related to ripening, but is a serious component for sales. The orange color only develops in areas with cool nighttime temperatures. In tropical climates, growers often expose the fruit to ethylene, to promote the loss of chlorophyll and expose the beta-carotenes (the orange color).

North American apples

Apples are not native to North America, but today the North American continent boasts the greatest diversity of apples in the world. Part of this is due to "Johnny Appleseed," real name John Chapman. Chapman spent 48 years travelling all along the American northwest spreading apple seeds and planting trees. While apples come in literally thousands of varieties, the majority of the apple market is based on three: Red Delicious, Golden Delicious, and Granny Smith. The Red Delicious is the ideal apple, for marketing purposes, for the apple industry. Its large, intensely red, and instantly recognizable.

Economically valuable medicinal plants

Medical research in the U.S. alone has a budget of \$95 billion. A large portion of that money is spent on research into plants and plant extracts. Several key medical discoveries have been made by studying plants and the compounds they produce, to see the effect they have on humans.

Ephedrine

The Ephedra plant is the natural source of ephedrine, the plants principle alkaloid. Ephedrine is actually a very interesting case of economic botany in medicine. While it has been taken medicinally in the past, ephedrine can be highly toxic. Because of this fact, medical researchers studied the compound and produced pseudoephedrine. This is the medicine you can buy over the counter, in Sudafed and other decongestants.

Ephedrine imitates epinephrine in its affect on the human body. Originally developed by the plant as a herbivore deterrent, this compound, studied and refined by researchers, now helps fix allergy symptoms nationwide every year.

Echinacea

One of many herbal remedies out there, Echinacea represents a sizable industry. Many people take echinacea for cold and flu-like symptoms, but studies show that the plant has had mixed success fighting these viruses. However, those same studies show the plant possibly being useful for the treatment of upper respiratory infections. NCCAM is currently studying echinacea for the treatment of upper respiratory infections as well as its effect on the immune system.

Ornamental plants

Ornamental plants can be found in almost any store, and many people have at least one in their home. However, ornamental plants are not limited to houseplants. Landscaping agencies make heavy use of ornamental plants, usually with an accompanying high cost. Trees, shrubs, flowers, and grasses, all of these are planted by professional landscaping agencies regularly, with a large economic effect.

Chapter- 1

Ephedra

Ephedra, an extract of the plant *Ephedra sinica*, has been used as a herbal remedy in traditional Chinese medicine for the treatment of asthma and hay fever, as well as for the common cold. Known in Chinese as **ma huang** (simplified Chinese: 麻黄; traditional Chinese: 麻黃; pinyin: *má huáng*), ephedra is a stimulant that constricts blood vessels and increases blood pressure and heart rate. Several additional species belonging to the genus *Ephedra* have traditionally been used for a variety of medicinal purposes and are a possible candidate for the Soma plant of Indo-Iranian religion. Native Americans and Mormon pioneers drank a tea brewed from an *Ephedra*, called **Mormon Tea**, but North American ephedras lack the alkaloids found in species such as *E. sinica*.

Ephedra-containing dietary supplements have been linked to a high rate of serious side effects and a number of deaths, leading to concern from the U.S. Food and Drug Administration (FDA), the National Center for Complementary and Alternative Medicine, and the medical community. However, initial efforts to test and regulate ephedra were defeated by lobbying and political pressure from the dietary supplement industry. Ultimately, in response to accumulating evidence of adverse effects and deaths related to ephedra, the FDA banned the sale of ephedra-containing supplements on April 12, 2004.

Following a legal challenge by an ephedra manufacturer, the U.S. Court of Appeals for the Tenth Circuit upheld the FDA's ban of ephedra in 2006. The sale of ephedra-containing dietary supplements remains illegal in the United States due to evidence of adverse ephedra-related effects. Following the FDA's ban, the supplement industry has marketed "ephedrine-free" or "legal" ephedra products, in which the ephedra is replaced with other herbal stimulants such as bitter orange.

Biochemistry and pharmacology

The alkaloids ephedrine and pseudoephedrine are the active constituents of the plant. Pseudoephedrine is used in over-the-counter decongestants. Derivatives of ephedrine are used to treat low blood pressure, but alternatives with reduced cardiovascular risk have replaced it for treating asthma. Ephedrine is also considered a performance-enhancing

drug and is prohibited in most competitive sports. Some species in the *Ephedra* genus have no alkaloid content; however, the most commonly used species, *E. sinica*, has a total alkaloid content of 1–3% by dry weight. Ephedrine constitutes 40–90% of the alkaloid content, with the remainder consisting of pseudoephedrine and the demethylated forms of each compound.

Effects and uses

Ephedra is both a stimulant and a thermogenic; its biological effects are due to its ephedrine and pseudoephedrine content. These compounds stimulate the brain, increase heart rate, constrict blood vessels (increasing blood pressure), and expand bronchial tubes (making breathing easier). Their thermogenic properties cause an increase in metabolism, evidenced by an increase in body heat.

In traditional Chinese herbology, *E. sinica* is included in many herbal formulas used to treat cold and flu such as 麻黃湯 *ma huang tang* (ephedra decoction) or 麻杏石甘湯 *ma xing shi gan tang* (ephedra, apricot kernel, gypsum, and licorice decoction). Ephedra is used therapeutically as a diaphoretic to help expel exterior pathogens and regulate the proper functioning of the lungs.

Ephedra is widely used by athletes, despite a lack of evidence that it enhances athletic performance. Ephedra may also be used as a precursor in the illicit manufacture of methamphetamine.

Ephedra has also been used for weight loss, sometimes in combination with aspirin and caffeine (known as an ECA stack). Some studies have shown that ephedra, when taken in a regulated and supervised environment, is effective for marginal short-term weight loss (0.9 kg/month more than the placebo), although it is unclear whether such weight loss is maintained. However, several reports have documented the large number of adverse events attributable to unregulated ephedra supplements.

Side effects of ephedra may include severe skin reactions, hypertension, irritability, nervousness, dizziness, trembling, headache, insomnia, profuse perspiration, dehydration, itchy scalp and skin, vomiting, hyperthermia, irregular heartbeat, seizures, heart attack, stroke, or death.

Purity and dosage

There are no formal requirements for standardization or quality control of dietary supplements in the United States, and the dosage of effective ingredients in supplements may vary widely from brand to brand or batch to batch. Studies of ephedra supplements have found significant discrepancies between the labeled dose and the actual amount of ephedra in the product. Significant variation in ephedrine alkaloid levels, by as much as 10-fold, was seen even from lot to lot within the same brand.

Safety and regulatory actions in the United States

Escalating concerns regarding the safety of ephedra supplements led the FDA to ban the sale of ephedra-containing supplements in the United States in 2004. This ban was challenged by supplement manufacturers and initially overturned, but ultimately upheld.

Initial concerns and supplement industry response

In 1997, in response to mounting concern over serious side effects of ephedra, the FDA proposed a ban on products containing 8 mg or more of ephedrine alkaloids and stricter labeling of low-dose ephedra supplements. The FDA also proposed that ephedra labels be required to disclose known health risks of ephedra, such as heart attack, stroke, or death.

In response, the supplement industry created a public relations group, the Ephedra Education Council, to lobby against the labeling requirements, and commissioned a scientific review by a private consulting firm, which reported that ephedra was safe. The Ephedra Education Council also attempted to block publication of a study confirming wide discrepancies between the labeled potency of supplements and the actual amount of ephedra in the product.

During this time, Metabolife, makers of the best-selling brand of ephedra supplement, had received over 14,000 complaints of adverse events associated with its product; these reports were not provided to the FDA. Senators Orrin Hatch and Tom Harkin, authors of the Dietary Supplements Health and Education Act, questioned the scientific basis for the FDA's proposed labeling changes, arguing that the reported problems were insufficient to warrant regulatory action. At the time, Hatch's son was working for a firm hired to lobby Congress and the FDA on behalf of ephedra manufacturers.

In addition to the activities of the Ephedra Education Council, Metabolife spent more than \$4 million between 1998 and 2000 lobbying against state regulation of ephedra in Texas. *Business Week* reported that efforts to regulate ephedra and other potentially harmful supplements had been "beaten down by deep-pocketed industry lobbying." Ultimately, in 2000, the FDA withdrew the proposed labeling changes and restrictions.

Additional evidence

A review of ephedra-related adverse reactions, published in the *New England Journal of Medicine* in 2000, found a number of cases of sudden cardiac death or severe disability resulting from ephedra use, many of which occurred in young adults using ephedra in the labeled dosages. Subsequently, in response to pressure from the consumer advocacy group Public Citizen, Metabolife was compelled by the Department of Justice in 2002 to turn over reports of over 15,000 ephedra-related adverse events, ranging from insomnia to death, which the company had previously withheld from the FDA. Use of ephedra was considered to have possibly contributed to the death of Minnesota Vikings offensive lineman Korey Stringer from heatstroke in 2001.

Death of Steve Bechler

Steve Bechler, a pitcher for the Baltimore Orioles, died of complications from heatstroke following a spring training workout on February 17, 2003. The medical examiner found that ephedra toxicity played a "significant role" in Bechler's sudden death. Following Bechler's death, the FDA re-opened its efforts to regulate ephedra use. According to Bruce Silverglade, legal director for the Center for Science in the Public Interest, "All of a sudden [after Bechler's death] Congress dropped objections to an ephedra ban and started demanding the FDA act."

Senator Orrin Hatch, who in 1999 had helped block the FDA's attempts to regulate ephedra, said in March 2003 that "it has been obvious to even the most casual observer that problems exist", and called FDA regulation of ephedra "long overdue." Given Hatch's prior defense of ephedra, *Time* described his statement as "a dazzling display of hypocrisy."

Ephedra banned

In response to renewed calls for the regulation of ephedra, the FDA commissioned a large meta-analysis of ephedra's safety and efficacy by the RAND Corporation. This study found that while ephedra promoted modest short-term weight loss, there was no evidence that it was effective for long-term weight loss or performance enhancement. The use of ephedra in this study was associated with significant gastrointestinal, psychiatric, and autonomic side effects. Almost simultaneously, a study in *Annals of Internal Medicine* found that ephedra was 100 to 700 times more likely to cause a significant adverse reaction than other commonly used supplements such as kava or Ginkgo biloba.

On December 30, 2003, the FDA issued a press release recommending that consumers stop buying and using ephedra, and indicating its intention to ban the sale of ephedra-containing supplements. Subsequently, on 12 April 2004, the FDA issued a final rule banning the sale of ephedra-containing dietary supplements. Tommy Thompson, the Secretary of Health and Human Services, stated that "...These products pose unacceptable health risks, and any consumers who are still using them should stop immediately."

Legal challenges

Nutraceutical Corporation, a supplement manufacturer based in Park City, Utah, challenged the legality of the FDA's ban of ephedra as exceeding the authority given the agency by the Dietary Health Supplements and Education Act. Nutraceutical Corporation stated that they did not intend to start marketing ephedra, but were concerned about the scope of the FDA's regulatory action. Judge Tena Campbell of the Utah Federal District Court ruled that the FDA had not proven that low doses of ephedra were unsafe, although she also noted that studies to address the safety of low-dose ephedra would be unethical. Nevertheless, her ruling overturned the ban on the sale of ephedra in the state of Utah, and called into question whether the ban could be enforced anywhere in the United States.

The ruling was appealed to the U.S. Court of Appeals for the Tenth Circuit in Denver, Colorado. On August 17, 2006, the Appeals Court upheld the FDA's ban of ephedra, finding that the 133,000-page administrative record compiled by the FDA supported the agency's finding that ephedra posed an unreasonable risk to consumers. Nutraceutical Corp. filed a petition for a writ of certiorari seeking a rehearing on the ban of ephedra; however, on May 14, 2007 the United States Supreme Court declined to hear this petition. The sale of ephedra-containing dietary supplements remains illegal in the United States.

"Legal" ephedra

Following the FDA ban, the dietary supplement industry in the U.S. has marketed various formulations of "legal" or "ephedrine-free" ephedra. These formulations replace ephedra with other herbal stimulants, most commonly bitter orange. While bitter orange is not subject to FDA regulation, "legal" or "ephedrine-free" supplements have been associated with adverse effects similar to those of ephedra, such as strokes. The National Center for Complementary and Alternative Medicine has found that "there is currently little evidence that bitter orange is safer to use than ephedra."

Use in sports

Ephedrine is listed as a banned substance by both the International Olympic Committee and the World Anti-Doping Agency. The U.S. National Football League banned players from using ephedra as a dietary supplement in 2001 after the death of Minnesota Vikings offensive tackle Korey Stringer; ephedra was found in Stringer's locker and the team contended that it contributed to his death. The substance is also banned by the National Basketball Association. Nonetheless, ephedra remains widely used by athletes; a 2006 survey of collegiate hockey players found that nearly half had used ephedra in the belief it would enhance athletic performance.

Prominent cases of ephedra use

In the 1994 FIFA World Cup, the Argentine footballer Diego Armando Maradona tested positive for ephedrine. The Japanese motorcycle racer Noriyuki Haga tested positive for it in 2000, being disqualified from two races and banned from two more as a result. NFL punter Todd Sauerbrun of the Denver Broncos was suspended for the first month of the 2006 season after testing positive for ephedra.

Chapter- 2

Echinacea (Economically valuable medicinal plant)



Echinacea purpurea 'Maxima'



The spiny center of the head showing the paleae, from which the name derives

Echinacea is a genus of herbaceous flowering plants in the daisy family, Asteraceae. The nine species it contains are commonly called **purple coneflowers**. They are endemic to eastern and central North America, where they are found growing in moist to dry prairies and open wooded areas. They have large, showy heads of composite flowers, blooming from early to late summer. The generic name is derived from the Greek word ἔχινος (*echino*), meaning "spiny," due to the spiny central disk. Some species are used in herbal medicines and some are cultivated in gardens for their showy flowers. A few species are of conservation concern.

Description

Echinacea species are herbaceous, drought-tolerant perennial plants growing up to 140 cm in height. They grow from taproots, except *E. purpurea*, which grows from a short caudice with fibrous roots. They have erect stems that in most species are unbranched. Both the basal and cauline leaves are arranged alternately. The leaves are normally hairy with a rough texture, having uniseriate trichomes (1-4 rings of cells) but sometimes they lack hairs. The basal leaves and the lower stem leaves have petioles, and as the leaves progress up the stem the petioles often decrease in length. The leaf blades in different species may have one, three or five nerves. Some species have linear to lanceolate shaped leaves, and others have elliptic- to ovate-shaped leaves; often the leaves decrease in size as they progress up the stems. Leaf bases gradually increase in width away from the petioles or the bases are rounded to heart shaped. Most species have leaf margins that are entire, but sometimes they are dentate or serrate. The flowers are

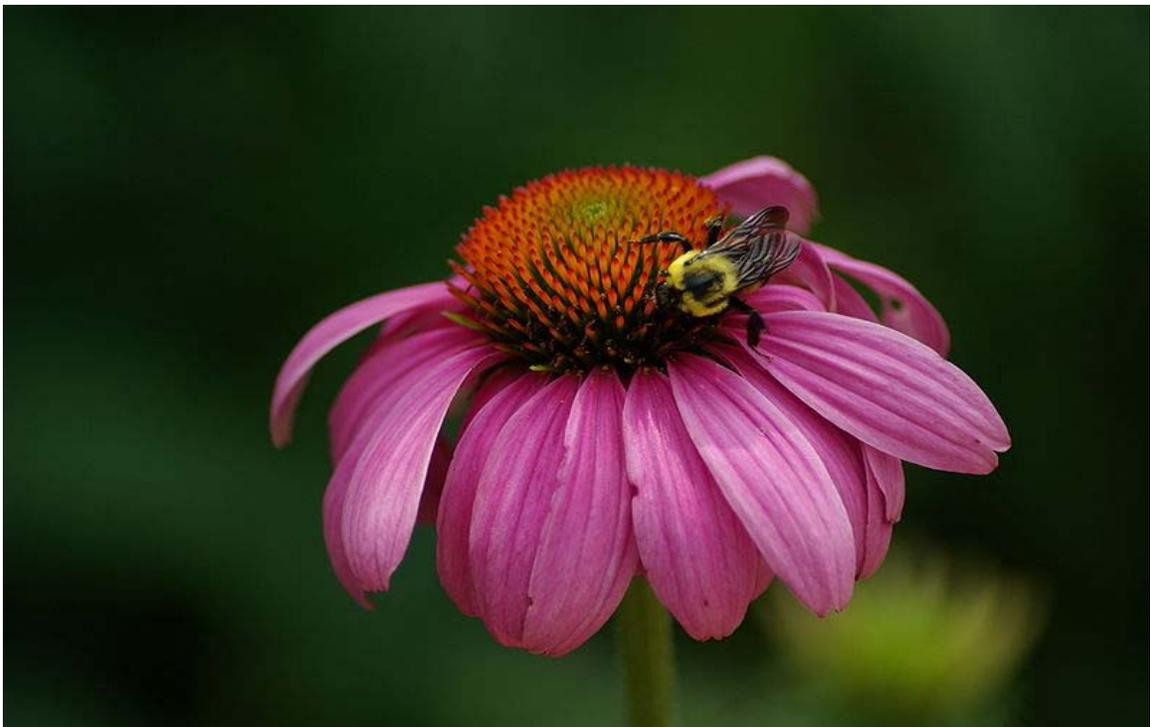
collected together into single rounded heads that terminate long peduncles. The inflorescences have crateriform to hemispheric shaped involucre which are 12–40 mm wide. The phyllaries, or bracts below the flower head, are persistent and number 15–50. The phyllaries are produced in a 2–4 series. The receptacles are hemispheric to conic in shape. The paleae have orange to reddish purple ends, and are longer than the disc corollas. The paleae bases partially surrounding the cypselae, and are keeled with the apices abruptly constricted to awn-like tips. The ray florets number 8–21 and the corollas are dark purple to pale pink, white, or yellow. The tubes of the corolla are hairless or sparsely hairy, and the laminae are spreading, reflexed, or drooping in habit and linear to elliptic or obovate in shape. The abaxial faces of the laminae are glabrous or moderately hairy. The flower heads have typically 200-300 fertile, bisexual disc florets but some have more. The corollas are pinkish, greenish, reddish-purple or yellow and have tubes shorter than the throats. The pollen is normally yellow in most species, but usually white in *E. pallida*. The three or four-angled fruits, called cypselae, are tan or bicolored with a dark brown band distally. The pappi is persistent and variously crown-shaped with 0 to 4 or more prominent teeth. $x = 11$.

Like all Asteraceae, the flowering structure is a composite inflorescence, with purple (rarely yellow or white) florets arranged in a prominent, somewhat cone-shaped head — "cone-shaped" because the petals of the outer ray florets tend to point downward (are reflexed) once the flower head opens, thus forming a cone. Plants are generally long lived, with distinctive flowers. The common name "cone flower" comes from the characteristic center "cone" at the center of the flower. The generic name Echinacea is rooted in the Greek word ἔχινος (*echinos*), meaning hedgehog, it references the spiky appearance and feel of the flower heads. *Echinacea* plants also reseed in the fall. New flowers will grow where seeds have fallen from the prior year.

Species



A bee on an *Echinacea paradoxa* head (inflorescence)



A bee on an *Echinacea purpurea* head

The species of *Echinacea* are

- *Echinacea angustifolia* – Narrow-leaf Coneflower
- *Echinacea atrorubens* – Topeka Purple Coneflower
- *Echinacea laevigata* – Smooth Coneflower, Smooth Purple Coneflower
- *Echinacea pallida* – Pale Purple Coneflower
- *Echinacea paradoxa* – Yellow Coneflower, Bush's Purple Coneflower
- *Echinacea purpurea* – Purple Coneflower, Eastern Purple Coneflower
- *Echinacea sanguinea* – Sanguine purple Coneflower
- *Echinacea simulata* – Wavyleaf Purple Coneflower
- *Echinacea tennesseensis* – Tennessee Coneflower

Researchers at the Agricultural Research Service are using DNA analysis to help determine the number of *Echinacea* species. The DNA analysis allows researchers to reveal clear distinctions among species based on chemical differences in root metabolites. The research concluded that of the 40 genetically diverse populations of *Echinacea* studied, there were nine distinct species.

Medicinal effects

One (in vitro) study suggested that some echinacea supplements could have some antitumor properties. Marketed and studied medicinal products contain different species (*E. purpurea*, *E. angustifolia*, *E. pallida*), different organs (roots and herbs) and different preparations (extracts and expressed juice). Their chemical composition is very different. Despite this, most reviews about medicinal effects of *Echinacea* do not discriminate between different products. A 2007 study by the University of Connecticut combined findings from 14 previously-reported trials examining *Echinacea* and concluded that *Echinacea* can cut the chances of catching a cold by more than half, and shorten the duration of a cold by an average of 1.4 days. However, Dr. Wallace Sampson, an editor of *Scientific Review of Alternative Medicine* and a Stanford University emeritus clinical professor of medicine, says that the referenced trials lack the similarities necessary to provide definitive results when combined into one report. "If you have studies that measure different things, there is no way to correct for that. These researchers tried, but you just can't do it."

A 2003 controlled double-blind study from the University of Virginia School of Medicine and documented in the *New England Journal of Medicine* stated that echinacea extracts had "no clinically significant effects" on rates of infection or duration or intensity of symptoms. The effects held when the herb was taken immediately following infectious viral exposure and when taken as a prophylaxis starting a week prior to exposure. In a press release, Dr. Michael Murray, the Director of Education for Factors Group of Nutritional Companies, a manufacturer of *Echinacea*-related products, calls the study "faulty and inaccurate." According to Dr. Murray, none of the three extracts used on the 399 study participants contained all three of the components of *Echinacea* responsible for its immune-enhancing effects: polysaccharides, alkylamides and cichoric acid. In

addition, Dr. Murray said "the standard dosage for dried *Echinacea angustifolia* root is normally three grams per day or more and this study used less than one gram."

An earlier University of Maryland review based on 13 European studies concluded that echinacea, when taken at first sign of a cold, reduced cold symptoms or shortened their duration. The review also found that three of four published studies concluded that taking echinacea to prevent a cold was ineffective.

The European Medicines Agency (EMA) assessed the body of evidence and approved the use of expressed juice and dried expressed juice from fresh flowering aerial parts of *Echinacea purpurea* for the short-term prevention and treatment of the common cold. According to their recommendations:

It should not be used for more than 10 days. The use in children below 1 year of age is contraindicated, because of theoretically possible undesirable effect on immature immune system. The use in children between 1 and 12 years of age is not recommended, because efficacy has not been sufficiently documented although specific risks are not documented. In the absence of sufficient data, the use in pregnancy and lactation is not recommended.

Popular belief and traditional use

Echinacea is popularly believed to be an immunostimulator, stimulating the body's non-specific immune system and warding off infections. A study commonly used to support that belief is a 2007 meta-analysis in *The Lancet Infectious Diseases*. The studies pooled in the meta-analysis used different types of echinacea, different parts of the plant, and various dosages. This review cannot inform recommendations on the efficacy of any particular type of echinacea, dosage, or treatment regimen. The safety of echinacea under long-term use is also unknown.

History

Echinacea angustifolia was widely used by the North American Plains Indians for its general medicinal qualities. Echinacea was one of the basic antimicrobial herbs of eclectic medicine from the mid 19th century through the early 20th century, and its use was documented for snakebite, anthrax, and for relief of pain. In the 1930s echinacea became popular in both Europe and America as a herbal medicine. According to Wallace Sampson, MD, its modern day use as a treatment for the common cold began when a Swiss herbal supplement maker was "erroneously told" that echinacea was used for cold prevention by Native American tribes who lived in the area of South Dakota. Although Native American tribes didn't use echinacea to prevent the common cold, some Plains tribes did use echinacea to treat some of the symptoms that could be caused by the common cold: The Kiowa used it for coughs and sore throats, the Cheyenne for sore throats, the Pawnee for headaches, and many tribes including the Lakotah used it as an analgesic.

Native Americans learned of *E. angustifolia* by observing elk seeking out the plants and consuming them when sick or wounded, and identified those plants as elk root.

Active substances

Like most crude drugs from plant or animal origin, the constituent base for echinacea is complex, consisting of a wide variety of chemicals of variable effect and potency. Some chemicals may be directly antimicrobial, while others may work at stimulating or modulating different parts of the immune system. All species have chemical compounds called phenols, which are common to many other plants. Both the phenol compounds cichoric acid and caftaric acid are present in *E. purpurea*, other phenols include echinacoside, which is found in greater levels within *E. angustifolia* and *E. pallida* roots than in other species. When making herbal remedies, these phenols can serve as markers for the quantity of raw echinacea in the product. Other chemical constituents that may be important in echinacea health effects include alkylamides and polysaccharides.

The immunomodulatory effects of echinacea preparations could be caused by fat-soluble alkylamides (alkamides), which occur mostly in *E. angustifolia* and *E. purpurea* but not in *E. pallida*. Alkylamides bind to human CB2 and CB1 cannabinoid receptors and thus inhibit tumor necrosis factor α TNF-alpha.

As with any herbal preparation, individual doses may vary significantly in active chemical composition. In addition to poor process control which may affect inter- and intra-batch homogeneity, species, plant part, extraction method, and contamination or adulteration with other products all lead to variability between products.

Root or whole plant

As with any plant, the chemical makeup of echinacea is not consistent throughout the organism. In particular, the root has been promoted as containing a more efficacious mixture of active chemicals. A 2003 study in the Journal of the American Medical Association (Taylor *et al.* 2003) found that when echinacea products made from the entire plant were taken after the second cold symptom appeared they provided no measurable beneficial effect for children in treating the severity or duration of symptoms caused by the common cold virus. The study has been criticized for using whole-plant extracts instead of root extracts, and the dosages studied were lower than those recommended by herbalists. A 2005 study in the New England Journal of Medicine (Turner, 2005) focused on several root extracts, but still found no statistically significant effects on duration, intensity, or prevention of symptoms.

Frequency of administration

Proponents of echinacea assert that it is not a "one-dose" treatment, and that in order to work effectively, a dose should be taken at the very first sign of a cold symptom. Subsequent doses are called for every two to four hours after the first dose, including during the overnight sleeping period, until the cold symptoms have disappeared.

The several species of echinacea differ in their precise chemical constitution, and may provide variable dosages of any active ingredients.

Side effects and contraindications

Reported adverse effects of echinacea are primarily allergic in nature and also include anaphylaxis, asthma attacks, thrombocytopenic purpura, leucopenia, abdominal pain, nausea, dysuria, arthralgia, myalgia, and dizziness. These tend to be infrequent, mild, and transient. Echinacea should not be taken by persons with progressive systemic and autoimmune disorders, connective tissue disorders, or related diseases. It should not be used with immunosuppressants or hepatotoxic drugs, and has the potential to interfere with anesthesia.

In one investigation by an independent consumer testing laboratory, five of eleven selected retail echinacea products failed quality testing. Four of the failing products contained measured levels of phenols believed to be related to potency below the levels stated on the labels. One failing product was contaminated with lead.

Other uses

Some species of echinacea, notably *E. purpurea*, *E. angustifolia*, and *E. pallida*, are grown as ornamental plants in gardens. They tolerate a wide variety of conditions, maintain attractive foliage throughout the season, and multiply rapidly. Appropriate species are used in prairie restorations.

Chapter- 3

Herbalism

Herbalism is a traditional medicinal or folk medicine practice based on the use of plants and plant extracts. Herbalism is also known as **botanical medicine, medical herbalism, herbal medicine, herbology, and phytotherapy**. The scope of herbal medicine is sometimes extended to include fungal and bee products, as well as minerals, shells and certain animal parts. Pharmacognosy is the study of medicines derived from natural sources.

Traditional use of medicines is recognized as a way to learn about potential future medicines. In 2001, researchers identified 122 compounds used in mainstream medicine which were derived from "ethnomedical" plant sources; 80% of these compounds were used in the same or related manner as the traditional ethnomedical use.

Many plants synthesize substances that are useful to the maintenance of health in humans and other animals. These include aromatic substances, most of which are phenols or their oxygen-substituted derivatives such as tannins. Many are secondary metabolites, of which at least 12,000 have been isolated — a number estimated to be less than 10% of the total. In many cases, substances such as alkaloids serve as plant defense mechanisms against predation by microorganisms, insects, and herbivores. Many of the herbs and spices used by humans to season food yield useful medicinal compounds.

Similarly to prescription drugs, a number of herbs are thought to be likely to cause adverse effects. Furthermore, "adulteration, inappropriate formulation, or lack of understanding of plant and drug interactions have led to adverse reactions that are sometimes life threatening or lethal.. Although such Adverse Drug Events are minuscule compared with the 20% of GP visitations said to be due to ADRs of conventional drugs. or the 6-7% of hospital admissions due to ADRs Well manufactured herbal products have far fewer ADRs and/or side effects generally than many drugs.

Anthropology of herbalism

People on all continents have used hundreds to thousands of indigenous plants for treatment of ailments since prehistoric times. Medicinal herbs were found in the personal

effects of *Ötzi the Iceman*, whose body was frozen in the Ötztal Alps for more than 5,300 years. These herbs appear to have been used to treat the parasites found in his intestines. Anthropologists theorize that animals evolved a tendency to seek out bitter plant parts in response to illness.

Indigenous healers often claim to have learned by observing that sick animals change their food preferences to nibble at bitter herbs they would normally reject. Field biologists have provided corroborating evidence based on observation of diverse species, such as chimpanzees, chickens, sheep and butterflies. Lowland gorillas take 90% of their diet from the fruits of *Aframomum melegueta*, a relative of the ginger plant, that is a potent antimicrobial and apparently keeps shigellosis and similar infections at bay.

Researchers from Ohio Wesleyan University found that some birds select nesting material rich in antimicrobial agents which protect their young from harmful bacteria.

Sick animals tend to forage plants rich in secondary metabolites, such as tannins and alkaloids. Since these phytochemicals often have antiviral, antibacterial, antifungal and antihelminthic properties, a plausible case can be made for self-medication by animals in the wild.

Some animals have digestive systems especially adapted to cope with certain plant toxins. For example, the koala can live on the leaves and shoots of the eucalyptus, a plant that is dangerous to most animals. A plant that is harmless to a particular animal may not be safe for humans to ingest. A reasonable conjecture is that these discoveries were traditionally collected by the medicine people of indigenous tribes, who then passed on safety information and cautions.

The use of herbs and spices in cuisine developed in part as a response to the threat of food-borne pathogens. Studies show that in tropical climates where pathogens are the most abundant, recipes are the most highly spiced. Further, the spices with the most potent antimicrobial activity tend to be selected. In all cultures vegetables are spiced less than meat, presumably because they are more resistant to spoilage.

History



The use of plants as medicines predates written human history. A 60 000-year-old Neanderthal burial site, "SHANIDAR-4", in northern Iraq has yielded large amounts of pollen from 8 plant species, 7 of which are used now as herbal remedies

In the written record, the study of herbs dates back over 5,000 years to the Sumerians, who described well-established medicinal uses for such plants as laurel, caraway, and thyme. Ancient Egyptian medicine of 1000 B.C. are known to have used garlic, opium, castor oil, coriander, mint, indigo, and other herbs for medicine and the Old Testament also mentions herb use and cultivation, including mandrake, vetch, caraway, wheat, barley, and rye.

In Indian Ayurveda medicine has used many herbs such as turmeric possibly as early as 1900 B.C. Many other herbs and minerals used in Ayurveda were later described by ancient Indian herbalists such as Charaka and Sushruta during the 1st millennium BC. The *Sushruta Samhita* attributed to Sushruta in the 6th century BC describes 700 medicinal plants, 64 preparations from mineral sources, and 57 preparations based on animal sources.

The first Chinese herbal book, the *Shennong Bencao Jing*, compiled during the Han Dynasty but dating back to a much earlier date, possibly 2700 B.C., lists 365 medicinal

plants and their uses - including ma-Huang, the shrub that introduced the drug ephedrine to modern medicine. Succeeding generations augmented on the *Shennong Bencao Jing*, as in the *Yaoxing Lun (Treatise on the Nature of Medicinal Herbs)*, a 7th century Tang Dynasty treatise on herbal medicine.

The ancient Greeks and Romans made medicinal use of plants. Greek and Roman medicinal practices, as preserved in the writings of Hippocrates and - especially - Galen, provided the pattern for later western medicine. Hippocrates advocated the use of a few simple herbal drugs - along with fresh air, rest, and proper diet. Galen, on the other hand, recommended large doses of drug mixtures - including plant, animal, and mineral ingredients. The Greek physician compiled the first European treatise on the properties and uses of medicinal plants, *De Materia Medica*. In the first century AD, Dioscorides wrote a compendium of more than 500 plants that remained an authoritative reference into the 17th century. Similarly important for herbalists and botanists of later centuries was the Greek book that founded the science of botany, Theophrastus' *Historia Plantarum*, written in the fourth century B.C.



Middle Ages

The uses of plants for medicine and other purposes changed little in early medieval Europe. Many Greek and Roman writings on medicine, as on other subjects, were preserved by hand copying of manuscripts in monasteries. The monasteries thus tended to become local centers of medical knowledge, and their herb gardens provided the raw materials for simple treatment of common disorders. At the same time, folk medicine in the home and village continued uninterrupted, supporting numerous wandering and settled herbalists. Among these were the “wise-women,” who prescribed herbal remedies often along with spells and enchantments. It was not until the late Middle Ages that women who were knowledgeable in herb lore became the targets of the witch hysteria. One of the most famous women in the herbal tradition was Hildegard of Bingen. A twelfth century Benedictine nun, she wrote a medical text called *Causes and Cures*.

Medical schools known as Bimaristan began to appear from the 9th century in the medieval Islamic world among Persians and Arabs, which was generally more advanced than medieval Europe at the time. The Arabs venerated Greco-Roman culture and learning, and translated tens of thousands of texts into Arabic for further study. As a trading culture, the Arab travellers had access to plant material from distant places such as China and India. Herbals, medical texts and translations of the classics of antiquity filtered in from east and west. Muslim botanists and Muslim physicians significantly expanded on the earlier knowledge of materia medica. For example, al-Dinawari described more than 637 plant drugs in the 9th century, and Ibn al-Baitar described more than 1,400 different plants, foods and drugs, over 300 of which were his own original discoveries, in the 13th century. The experimental scientific method was introduced into the field of materia medica in the 13th century by the Andalusian-Arab botanist Abu al-Abbas al-Nabati, the teacher of Ibn al-Baitar. Al-Nabati introduced empirical techniques in the testing, description and identification of numerous materia medica, and he separated unverified reports from those supported by actual tests and observations. This allowed the study of materia medica to evolve into the science of pharmacology.

Avicenna's *The Canon of Medicine* (1025) lists 800 tested drugs, plants and minerals. Book Two is devoted to a discussion of the healing properties of herbs, including nutmeg, senna, sandalwood, rhubarb, myrrh, cinammon, and rosewater. Baghdad was an important center for Arab herbalism, as was Al-Andalus between 800 and 1400. Abulcasis (936-1013) of Cordoba authored *The Book of Simples*, an important source for later European herbals, while Ibn al-Baitar (1197–1248) of Malaga authored the *Corpus of Simples*, the most complete Arab herbal which introduced 200 new healing herbs, including tamarind, aconite, and nux vomica. Other pharmacopoeia books include that written by Abu-Rayhan Biruni in the 11th century and Ibn Zuhr (Avenzoar) in the 12th century (and printed in 1491). The origins of clinical pharmacology also date back to the Middle Ages in Avicenna's *The Canon of Medicine*, Peter of Spain's *Commentary on Isaac*, and John of St Amand's *Commentary on the Antedotary of Nicholas*. In particular, the *Canon* introduced clinical trials, randomized controlled trials, and efficacy tests.

Alongside the university system, folk medicine continued to thrive. The continuing importance of herbs for the centuries following the Middle Ages is indicated by the hundreds of herbals published after the invention of printing in the fifteenth century. Theophrastus' *Historia Plantarum* was one of the first books to be printed, but Dioscorides' *De Materia Medica*, Avicenna's *Canon of Medicine* and Avenzoar's pharmacopoeia were not far behind.



Modern era

The fifteenth, sixteenth, and seventeenth centuries were the great age of herbals, many of them available for the first time in English and other languages rather than Latin or Greek. The first herbal to be published in English was the anonymous *Grete Herball* of 1526. The two best-known herbals in English were *The Herball or General History of Plants* (1597) by John Gerard and *The English Physician Enlarged* (1653) by Nicholas Culpeper. Gerard's text was basically a pirated translation of a book by the Belgian herbalist Dodoens and his illustrations came from a German botanical work. The original edition contained many errors due to faulty matching of the two parts. Culpeper's blend of traditional medicine with astrology, magic, and folklore was ridiculed by the physicians of his day yet his book - like Gerard's and other herbals - enjoyed phenomenal popularity. The Age of Exploration and the Columbian Exchange introduced new medicinal plants to Europe. The *Badianus Manuscript* was an illustrated Aztec herbal translated into Latin in the 16th century.

The second millennium, however, also saw the beginning of a slow erosion of the pre-eminent position held by plants as sources of therapeutic effects. This began with the Black Death, which the then dominant Four Element medical system proved powerless to stop. A century later, Paracelsus introduced the use of active chemical drugs (like arsenic, copper sulfate, iron, mercury, and sulfur). These were accepted even though they had toxic effects because of the urgent need to treat Syphilis. The rapid development of chemistry and the other physical sciences, led increasingly to the dominance of chemotherapy - chemical medicine - as the orthodox system of the twentieth century.

Role in modern human society



Botánicas, such as this one in Jamaica Plain, Massachusetts, cater to the Latino community and sell herbal cures and folk medicine alongside statues of saints, candles decorated with prayers, lucky bamboo, and other items.

The use of herbs to treat disease is almost universal among non-industrialized societies. A number of traditions came to dominate the practice of herbal medicine at the end of the twentieth century:

- The "classical" herbal medicine system, based on Greek and Roman sources
- The Siddha and Ayurvedic medicine systems from various South Asian Countries
- Chinese herbal medicine (Chinese herbology) 中药 (zhōngyào)

- Traditional African medicine
- Unani-Tibb medicine
- Shamanic herbalism: a catch-all phrase for information mostly supplied from South America and the Himalayas
- Native American medicine.

Many of the pharmaceuticals currently available to physicians have a long history of use as herbal remedies, including opium, aspirin, digitalis, and quinine. The World Health Organization (WHO) estimates that 80 percent of the world's population presently uses herbal medicine for some aspect of primary health care. Pharmaceuticals are prohibitively expensive for most of the world's population, half of which lives on less than \$2 U.S. per day. In comparison, herbal medicines can be grown from seed or gathered from nature for little or no cost.

In addition to the use in the developing world, herbal medicine is used in industrialized nations by alternative medicine practitioners such as naturopaths. A 1998 survey of herbalists in the UK found that many of the herbs recommended by them were used traditionally but had not been evaluated in clinical trials. In Australia, a 2007 survey found that these Western herbalists tend to prescribe liquid herbal combinations of herbs rather than tablets of single herbs.

The use of, and search for, drugs and dietary supplements derived from plants have accelerated in recent years. Pharmacologists, microbiologists, botanists, and natural-products chemists are combing the Earth for phytochemicals and leads that could be developed for treatment of various diseases. In fact, according to the World Health Organisation, approximately 25% of modern drugs used in the United States have been derived from plants.

- Among the 120 active compounds currently isolated from the higher plants and widely used in modern medicine today, 80 percent show a positive correlation between their modern therapeutic use and the traditional use of the plants from which they are derived.
- More than two thirds of the world's plant species - at least 35,000 of which are estimated to have medicinal value - come from the developing countries.
- At least 7,000 medical compounds in the modern pharmacopoeia are derived from plants

Biological background



The anthocyanins in sweet violets produce deep red, violet and blue shades



The carotenoids in primrose produce bright red, yellow and orange shades

All plants produce chemical compounds as part of their normal metabolic activities. These are divided into primary metabolites, such as sugars and fats, found in all plants, and secondary metabolites, compounds not essential for basic function found in a smaller range of plants, some useful ones found only in a particular genus or species. Pigments harvest light, protect the organism from radiation and display colors to attract pollinators. Many common weeds, such as nettle, dandelion and chickweed, have medicinal properties.

The functions of secondary metabolites are varied. For example, some secondary metabolites are toxins used to deter predation, and others are pheromones used to attract insects for pollination. Phytoalexins protect against bacterial and fungal attacks. Allelochemicals inhibit rival plants that are competing for soil and light.

Plants upregulate and downregulate their biochemical paths in response to the local mix of herbivores, pollinators and microorganisms. The chemical profile of a single plant may vary over time as it reacts to changing conditions. It is the secondary metabolites and pigments that can have therapeutic actions in humans and which can be refined to produce drugs.

Plants synthesize a bewildering variety of phytochemicals but most are derivatives of a few biochemical motifs.

- Alkaloids contain a ring with nitrogen. Many alkaloids have dramatic effects on the central nervous system. Caffeine is an alkaloid that provides a mild lift but the alkaloids in datura cause severe intoxication and even death.
- polyphenol, also known as phenolics, contain phenol rings. The anthocyanins that give grapes their purple color, the isoflavones, the phytoestrogens from soy and the tannins that give tea its astringency are phenolics.
- Terpenoids are built up from terpene building blocks. Each terpene consists of two paired isoprenes. The names monoterpenes, sesquiterpenes, diterpenes and triterpenes are based on the number of isoprene units. The fragrance of rose and lavender is due to monoterpenes. The carotenoids produce the reds, yellows and oranges of pumpkin, corn and tomatoes.
- Glycosides consist of a glucose moiety attached to an aglycone. The aglycone is a molecule that is bioactive in its free form but inert until the glycoside bond is broken by water or enzymes. This mechanism allows the plant to defer the availability of the molecule to an appropriate time, similar to a safety lock on a gun. An example is the cyanoglycosides in cherry pits that release toxins only when bitten by a herbivore.

The word drug itself comes from the Dutch word "droog" (via the French word Drogue), which means 'dried plant'. Some examples are inulin from the roots of dahlias, quinine from the cinchona, morphine and codeine from the poppy, and digoxin from the foxglove.

The active ingredient in willow bark, once prescribed by Hippocrates, is salicin, which is converted in the body into salicylic acid. The discovery of salicylic acid would eventually lead to the development of the acetylated form acetylsalicylic acid, also known as "aspirin", when it was isolated from a plant known as meadowsweet. The word *aspirin* comes from an abbreviation of meadowsweet's Latin genus *Spiraea*, with an additional "A" at the beginning to acknowledge acetylation, and "in" was added at the end for easier pronunciation. "Aspirin" was originally a brand name, and is still a protected trademark in some countries. This medication was patented by Bayer AG.

Herbal philosophy



Rosemary

Four approaches to the use of plants as medicine include:

1. The magical/shamanic

Almost all non-modern societies recognise this kind of use. The practitioner is regarded as endowed with gifts or powers that allow him/her to use herbs in a way that is hidden from the average person, and the herbs are said to affect the spirit or soul of the person.

2. The energetic

This approach includes the major systems of TCM, Ayurveda, and Unani. Herbs are regarded as having actions in terms of their energies and affecting the energies of the body. The practitioner may have extensive training, and ideally be sensitive to energy, but need not have supernatural powers.

3. The functional dynamic

This approach was used by early physiomedical practitioners, whose doctrine forms the basis of contemporary practice in the UK. Herbs have a functional action, which is not necessarily linked to a physical compound, although often to a physiological function, but there is no explicit recourse to concepts involving energy.

4. The chemical

Modern practitioners - called Phytotherapists - attempt to explain herb actions in terms of their chemical constituents. It is generally assumed that the specific combination of secondary metabolites in the plant are responsible for the activity claimed or demonstrated, a concept called synergy.

Most modern herbalists concede that pharmaceuticals are more effective in emergency situations where time is of the essence. An example would be where a patient had an acute heart attack that posed imminent danger. However they claim that over the long term herbs can help the patient resist disease, and that in addition, they provide nutritional and immunological support that pharmaceuticals lack. They view their goal as prevention as well as cure.

Herbalists tend to use extracts from parts of plants, such as the roots or leaves but not isolate particular phytochemicals. Pharmaceutical medicine prefers single ingredients on the grounds that dosage can be more easily quantified. It is also possible to patent single compounds, and therefore generate income. Herbalists often reject the notion of a single active ingredient, arguing that the different phytochemicals present in many herbs will interact to enhance the therapeutic effects of the herb and dilute toxicity. Furthermore, they argue that a single ingredient may contribute to multiple effects. Herbalists deny that herbal synergism can be duplicated with synthetic chemicals. They argue that phytochemical interactions and trace components may alter the drug response in ways that cannot currently be replicated with a combination of a few putative active ingredients. Pharmaceutical researchers recognize the concept of drug synergism but note that clinical trials may be used to investigate the efficacy of a particular herbal preparation, provided the formulation of that herb is consistent.



Thai chili peppers contain capsaicin

In specific cases the claims of synergy and multifunctionality have been supported by science. The open question is how widely both can be generalized. Herbalists would argue that cases of synergy can be widely generalized, on the basis of their interpretation of evolutionary history, not necessarily shared by the pharmaceutical community. Plants are subject to similar selection pressures as humans and therefore they must develop resistance to threats such as radiation, reactive oxygen species and microbial attack in order to survive. Optimal chemical defenses have been selected for and have thus developed over millions of years. Human diseases are multifactorial and may be treated by consuming the chemical defences that they believe to be present in herbs. Bacteria, inflammation, nutrition and ROS (reactive oxygen species) may all play a role in arterial disease. Herbalists claim a single herb may simultaneously address several of these

factors. Likewise a factor such as ROS may underlie more than one condition. In short herbalists view their field as the study of a web of relationships rather than a quest for single cause and a single cure for a single condition.

In selecting herbal treatments herbalists may use forms of information that are not applicable to pharmacists. Because herbs can moonlight as vegetables, teas or spices they have a huge consumer base and large-scale epidemiological studies become feasible. Ethnobotanical studies are another source of information. For example, when indigenous peoples from geographically dispersed areas use closely related herbs for the same purpose that is taken as supporting evidence for its efficacy. Herbalists contend that historical medical records and herbals are underutilized resources. They favor the use of convergent information in assessing the medical value of plants. An example would be when in-vitro activity is consistent with traditional use.

Popularity

A survey released in May 2004 by the National Center for Complementary and Alternative Medicine focused on who used complementary and alternative medicines (CAM), what was used, and why it was used. The survey was limited to adults, aged 18 years and over during 2002, living in the United States.

According to this survey, herbal therapy, or use of natural products other than vitamins and minerals, was the most commonly used CAM therapy (18.9%) when all use of prayer was excluded.

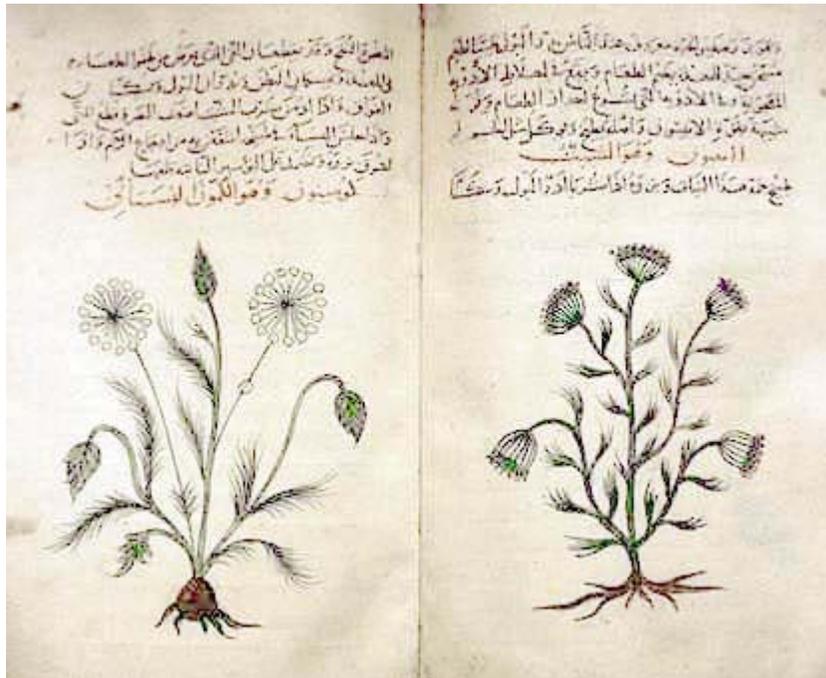
Herbal remedies are very common in Europe. In Germany, herbal medications are dispensed by apothecaries (e.g., Apotheke). Prescription drugs are sold alongside essential oils, herbal extracts, or herbal teas. Herbal remedies are seen by some as a treatment to be preferred to pure medical compounds which have been industrially produced.

In the United Kingdom, the training of medical herbalists is done by state funded Universities. For example, Bachelor of Science degrees in herbal medicine are offered at Universities such as University of East London, Middlesex University, University of Central Lancashire, University of Westminster, University of Lincoln and Napier University in Edinburgh at the present.

In the United States, a Bachelor of Science degree in herbal sciences is offered at Bastyr University, and a Master of Science in herbal medicine is offered at Tai Sophia Institute. There are also many smaller organizations and teachers offering certifications.

A 2004 Cochrane Collaboration review found that herbal therapies are supported by strong evidence but are not widely used in all clinical settings.

Types of herbal medicine systems



Dioscorides' Materia Medica, c. 1334 copy in Arabic, describes medicinal features of cumin and dill.

Use of medicinal plants can be as informal as, for example, culinary use or consumption of an herbal tea or supplement, although the sale of some herbs considered dangerous is often restricted to the public. Sometimes such herbs are provided to professional herbalists by specialist companies. Many herbalists, both professional and amateur, often grow or "wildcraft" their own herbs.

Some researchers trained in both western and traditional Chinese medicine have attempted to deconstruct ancient medical texts in the light of modern science. One idea is that the yin-yang balance, at least with regard to herbs, corresponds to the pro-oxidant and anti-oxidant balance. This interpretation is supported by several investigations of the ORAC ratings of various yin and yang herbs.

In America, early settlers relied on plants imported from Europe, and also from local Indian knowledge. One particularly successful practitioner, Samuel Thomson developed a hugely popular system of medicine. This approach was subsequently broadened to include concepts introduced from modern physiology, a discipline called Physiomedicalism. Another group, the Eclectics, were a later offshoot from the orthodox medical profession, who were looking to avoid the then current medical treatments of mercury and bleeding, and introduced herbal medicine into their practices. Both groups were eventually overcome by the actions of the American Medical Association, which was formed for this purpose. Cherokee medicine tends to divide herbs into foods, medicines and toxins and to use seven plants in the treatment of disease, which is defined

with both spiritual and physiological aspects, according to Cherokee herbalist David Winston.

In India, Ayurvedic medicine has quite complex formulas with 30 or more ingredients, including a sizable number of ingredients that have undergone "alchemical processing", chosen to balance "Vata", "Pitta" or "Kapha."

In Tamil Nadu, Tamils have their own medicinal system now popularly called the Siddha medicinal system. The Siddha system is entirely in the Tamil language. It contains roughly 300,000 verses covering diverse aspects of medicine such as anatomy, sex ("kokokam" is the sexual treatise of par excellence), herbal, mineral and metallic compositions to cure many diseases that are relevant even to-day. Ayurveda is in Sanskrit, but Sanskrit was not generally used as a mother tongue and hence its medicines are mostly taken from Siddha and other local traditions.

In addition there are more modern theories of herbal combination like William LeSassier's triune formula which combined Pythagorean imagery with Chinese medicine ideas and resulted in 9 herb formulas which supplemented, drained or neutrally nourished the main organ systems affected and three associated systems. His system has been taught to thousands of influential American herbalists through his own apprenticeship programs during his lifetime, the William LeSassier Archive and the David Winston Center for Herbal Studies. Different chemicals in herbs are more abundant than in a single drug. Some chemicals in herbs may work as growth hormones or antibiotics, nutrients, and toxin neutralizers.

Many traditional African remedies have performed well in initial laboratory tests to ensure they are not toxic and in tests on animals. Gawo, a herb used in traditional treatments, has been tested in rats by researchers from Nigeria's University of Jos and the National Institute for Pharmaceutical Research and Development. According to research in the African Journal of Biotechnology, Gawo passed tests for toxicity and reduced induced fevers, diarrhoea and inflammation

Routes of administration

The exact composition of a herbal product is influenced by the method of extraction. A tisane will be rich in polar components because water is a polar solvent. Oil on the other hand is a non-polar solvent and it will absorb non-polar compounds. Alcohol lies somewhere in between. There are many forms in which herbs can be administered, these include:

- Tinctures - Alcoholic extracts of herbs such as Echinacea extract. Usually obtained by combining 100% pure ethanol (or a mixture of 100% ethanol with water) with the herb. A completed tincture has a ethanol percentage of at least 25% (sometimes up to 90%). The term tincture is sometimes applied to preparations using other solvents than ethanol.

- Herbal wine and elixirs - These are alcoholic extract of herbs; usually with an ethanol percentage of 12-38% Herbal wine is a maceration of herbs in wine, while an elixir is a maceration of herbs in spirits (e.g., vodka, grappa, etc.)
- Tisanes - Hot water extracts of herb, such as chamomile.
- Decoctions - Long-term boiled extract of usually roots or bark.
- Macerates - Cold infusion of plants with high mucilage-content as sage, thyme, etc. Plants are chopped and added to cold water. They are then left to stand for 7 to 12 hours (depending on herb used). For most macerates 10 hours is used.
- Vinegars - Prepared at the same way as tinctures, except using a solution of acetic acid as the solvent.
- Topicals:
 - Essential oils - Application of essential oil extracts, usually diluted in a carrier oil (many essential oils can burn the skin or are simply too high dose used straight – diluting in olive oil or another food grade oil such as almond oil can allow these to be used safely as a topical).
 - Salves, oils, balms, creams and lotions - Most topical applications are oil extractions of herbs. Taking a food grade oil and soaking herbs in it for anywhere from weeks to months allows certain phytochemicals to be extracted into the oil. This oil can then be made into salves, creams, lotions, or simply used as an oil for topical application. Any massage oils, antibacterial salves and wound healing compounds are made this way.
 - Poultices and compresses - One can also make a poultice or compress using whole herb (or the appropriate part of the plant) usually crushed or dried and re-hydrated with a small amount of water and then applied directly in a bandage, cloth or just as is.
- Whole herb consumption - This can occur in either dried form (herbal powder), or fresh juice, (fresh leaves and other plant parts).
- Syrups - Extracts of herbs made with syrup or honey. Sixty five parts of sugar are mixed with 35 parts of water and herb. The whole is then boiled and macerated for three weeks.
- Extracts - Include liquid extracts, dry extracts and nebulisates. Liquid extracts are liquids with a lower ethanol percentage than tinctures. They can (and are usually) made by vacuum distilling tinctures. Dry extracts are extracts of plant material which are evaporated into a dry mass. They can then be further refined to a capsule or tablet. A nebulisate is a dry extract created by freeze-drying.
- Inhalation as in aromatherapy can be used as a mood changing treatment to fight a sinus infection or cough, or to cleanse the skin on a deeper level (steam rather than direct inhalation here)
- Apply fresh herb paste on skin.
- Ground herb and boil in water such as herbal tea.

Examples of plants used as medicine

Few herbal remedies have conclusively demonstrated any positive effect on humans, possibly due to inadequate testing. Many of the studies cited refer to animal model

investigations or in-vitro assays and therefore cannot provide more than weak supportive evidence.

- *Aloe vera* has traditionally been used for the healing of burns and wounds. A systematic review (from 1999) states that the efficacy of aloe vera in promoting wound healing is unclear, while a later review (from 2007) concludes that the cumulative evidence supports the use of aloe vera for the healing of first to second degree burns.
- Artichoke (*Cynara cardunculus*) may reduce production cholesterol levels according to *in vitro* studies and a small clinical study.
- Blackberry (*Rubus fruticosus*) leaf has drawn the attention of the cosmetology community because it interferes with the metalloproteinases that contribute to skin wrinkling.
- Black raspberry (*Rubus occidentalis*) may have a role in preventing oral cancer.
- Boophone (*Boophone disticha*) This highly toxic plant has been used in South African traditional medicine for treatment of mental illness. Research demonstrate *in vitro* and *in vivo* effect against depression.
- Butterbur (*Petasites hybridus*)
- Calendula (*Calendula officinalis*) has been used traditionally for abdominal cramps and constipation. In animal research an aqueous-ethanol extract of *Calendula officinalis* flowers was shown to have both spasmolytic and spasmogenic effects, thus providing a scientific rationale for this traditional use. There is "limited evidence" that calendula cream or ointment is effective in treating radiation dermatitis.
- Cannabis.
- Cranberry (*Vaccinium oxycoccos*) may be effective in treating urinary tract infections in women with recurrent symptoms.
- Echinacea (*Echinacea angustifolia*, *Echinacea pallida*, *Echinacea purpurea*) extracts may limit the length and severity of rhinovirus colds; however, the appropriate dosage levels, which might be higher than is available over-the-counter, require further research.
- Elderberry (*Sambucus nigra*) may speed the recovery from type A and B influenza. However it is possibly risky in the case of avian influenza because the immunostimulatory effects may aggravate the cytokine cascade.
- Feverfew (*Chrysanthemum parthenium*) is sometimes used to treat migraine headaches. Although many reviews of Feverfew studies show no or unclear efficacy, a more recent RTC showed favorable results Feverfew is not recommended for pregnant women as it may be dangerous to the fetus.
- Gawo (*Faidherbia albida*), a traditional herbal medicine in West Africa, has shown promise in animal tests
- Garlic (*Allium sativum*) may lower total cholesterol levels
- German Chamomile (*Matricaria chamomilla*) has demonstrated antispasmodic, anxiolytic, antiinflammatory and some antimutagenic and cholesterol-lowering effects in animal research. *In vitro* chamomile has demonstrated moderate antimicrobial and antioxidant properties and significant antiplatelet activity, as

well as preliminary results against cancer. Essential oil of chamomile was shown to be a promising antiviral agent against herpes simplex virus type 2 (HSV-2) *in vitro*.

- Ginger (*Zingiber officinale*), administered in 250 mg capsules for four days, effectively decreased nausea and vomiting of pregnancy in a human clinical trial.
- Grapefruit (Naringenin) components may prevent obesity.
- Green tea (*Camelia sinensis*) components may inhibit growth of breast cancer cells and may heal scars faster.
- Purified extracts of the seeds of *Hibiscus sabdariffa* may have some antihypertensive, antifungal and antibacterial effect. Toxicity tested low except for an isolated case of damage to the testes of a rat after prolonged and excessive consumption.
- Honey may reduce cholesterol. May be useful in wound healing.
- Lemon grass (*Cymbopogon citratus*), administered daily as an aqueous extract of the fresh leaf, has lowered total cholesterol and fasting plasma glucose levels in rats, as well as increasing HDL cholesterol levels. Lemon grass administration had no effect on triglyceride levels.
- Magnolia
- Meadowsweet (*Filipendula ulmaria*, *Spiraea ulmaria*) can be used for a variety of anti-inflammatory and antimicrobial purposes due to presence of salicylic acid. Effective for fevers and inflammations, pain relief, ulcers and bacteriostatic. Listed as therapeutical in 1652 by Nicholas Culpeper. In 1838, salicylic acid was isolated from the plant. The word Aspirin is derived from spirin, based on Meadowsweet's synonym name *Spiraea ulmaria*.
- Milk thistle (*Silybum marianum*) extracts have been recognized for many centuries as "liver tonics.". Research suggests that milk thistle extracts both prevent and repair damage to the liver from toxic chemicals and medications.
- Morinda citrifolia (noni) is used in the Pacific and Caribbean islands for the treatment of inflammation and pain. Human studies indicate potential cancer preventive effects.
- Nigella sativa (Black cumin) has demonstrated analgesic properties in mice. The mechanism for this effect, however, is unclear. In vitro studies support antibacterial, antifungal, anticancer, anti-inflammatory and immune modulating effects. However few randomized double blind studies have been published.
- Ocimum gratissimum and tea tree oil can be used to treat acne.
- Oregano (*Origanum vulgare*) may be effective against multi-drug resistant bacteria.
- Pawpaw can be used as insecticide (killing lice, worms),.
- Peppermint oil may have benefits for individuals with irritable bowel syndrome.
- Phytolacca or Pokeweed can be applied topically or taken internally. Topical treatments have been used for acne and other ailments. It is used as a treatment for tonsillitis, swollen glands and weight loss.
- Pomegranate contains the highest percentage of ellagitannins of any commonly consumed juice. Punicalagin, an ellagitannin unique to pomegranate, is the highest molecular weight polyphenol known. Ellagitannins are metabolized into urolithins by gut flora, and have been shown to inhibit cancer cell growth in mice.

- Rauvolfia Serpentina, high risk of toxicity if improperly used, used extensively in India for sleeplessness, anxiety, and high blood pressure.
- Rooibos (*Aspalathus linearis*) contains a number of phenolic compounds, including flavanols, flavones, flavanones, flavonols, and dihydrochalcones. Rooibos has traditionally been used for skin ailments, allergies, asthma and colic in infants. In an animal study with diabetic mice, aspalathin, a rooibos constituent improved glucose homeostasis by stimulating insulin secretion in pancreatic beta cells and glucose uptake in muscle tissue.
- Rose hips – Small scale studies indicate that hips from *Rosa canina* may provide benefits in the treatment of osteoarthritis. Rose hips show anti COX activity.
- Salvia lavandulaefolia may improve memory
- Saw Palmetto can be used for BPH. Supported in some studies, failed to confirm in others.
- Shiitake mushrooms (*Lentinus edodes*) are edible mushrooms that have been reported to have health benefits, including cancer-preventing properties. In laboratory research a shiitake extract has inhibited the growth of tumor cells through induction of apoptosis. Both a water extract and fresh juice of shiitake have demonstrated antimicrobial activity against pathogenic bacteria and fungi in vitro.
- Soy and other plants that contain phytoestrogens (plant molecules with estrogen activity) (black cohosh probably has serotonin activity) have some benefits for treatment of symptoms resulting from menopause.
- St. John's wort, has yielded positive results, proving more effective than a placebo for the treatment of mild to moderate depression in some clinical trials. A subsequent, large, controlled trial, however, found St. John's wort to be no better than a placebo in treating depression. However, more recent trials have shown positive results or positive trends that failed significance. A 2004 meta-analysis concluded that the positive results can be explained by publication bias but later analyses have been more favorable. The Cochrane Database cautions that the data on St. John's wort for depression are conflicting and ambiguous.
- Stinging nettle In some clinical studies effective for benign prostatic hyperplasia and the pain associated with osteoarthritis. In-vitro tests show antiinflammatory action. In a rodent model, stinging nettle reduced LDL cholesterol and total cholesterol. In another rodent study it reduced platelet aggregation.
- Valerian root can be used to treat insomnia. Clinical studies show mixed results and researchers note that many trials are of poor quality.
- Vanilla
- Willow bark (*Salix alba*) can be used for a variety of anti-inflammatory and antimicrobial purposes due to presence of salicylic acid and tannins. Has been in use for approx. 6000yrs and was described in the 1st century AD by Dioscorides.

Safety

A number of herbs are thought to be likely to cause adverse effects. Furthermore, "adulteration, inappropriate formulation, or lack of understanding of plant and drug interactions have led to adverse reactions that are sometimes life threatening or lethal."

Proper double-blind clinical trials are needed to determine the safety and efficacy of each plant before they can be recommended for medical use. Although many consumers believe that herbal medicines are safe because they are "natural", herbal medicines and synthetic drugs may interact, causing toxicity to the patient. Herbal remedies can also be dangerously contaminated, and herbal medicines without established efficacy, may unknowingly be used to replace medicines that do have corroborated efficacy.

Standardization of purity and dosage is not mandated in the United States, but even products made to the same specification may differ as a result of biochemical variations within a species of plant. Plants have chemical defense mechanisms against predators that can have adverse or lethal effects on humans. Examples of highly toxic herbs include poison hemlock and nightshade. They are not marketed to the public as herbs, because the risks are well known, partly due to a long and colorful history in Europe, associated with "sorcery", "magic" and intrigue. Although not frequent, adverse reactions have been reported for herbs in widespread use. On occasion serious untoward outcomes have been linked to herb consumption. A case of major potassium depletion has been attributed to chronic licorice ingestion, and consequently professional herbalists avoid the use of licorice where they recognise that this may be a risk. Black cohosh has been implicated in a case of liver failure. Few studies are available on the safety of herbs for pregnant women, and one study found that use of complementary and alternative medicines are associated with a 30% lower ongoing pregnancy and live birth rate during fertility treatment. Examples of herbal treatments with likely cause-effect relationships with adverse events include aconite, which is often a legally restricted herb, ayurvedic remedies, broom, chaparral, Chinese herb mixtures, comfrey, herbs containing certain flavonoids, germander, guar gum, liquorice root, and pennyroyal. Examples of herbs where a high degree of confidence of a risk long term adverse effects can be asserted include ginseng, which is unpopular among herbalists for this reason, the endangered herb goldenseal, milk thistle, senna, against which herbalists generally advise and rarely use, aloe vera juice, buckthorn bark and berry, cascara sagrada bark, saw palmetto, valerian, kava, which is banned in the European Union, St. John's wort, Khat, Betel nut, the restricted herb Ephedra, and Guarana.

There is also concern with respect to the numerous well-established interactions of herbs and drugs. In consultation with a physician, usage of herbal remedies should be clarified, as some herbal remedies have the potential to cause adverse drug interactions when used in combination with various prescription and over-the-counter pharmaceuticals, just as a patient should inform a herbalist of their consumption of orthodox prescription and other medication.

For example, dangerously low blood pressure may result from the combination of an herbal remedy that lowers blood pressure together with prescription medicine that has the same effect. Some herbs may amplify the effects of anticoagulants. Certain herbs as well as common fruit interfere with cytochrome P450, an enzyme critical to much drug metabolism.

Name confusion

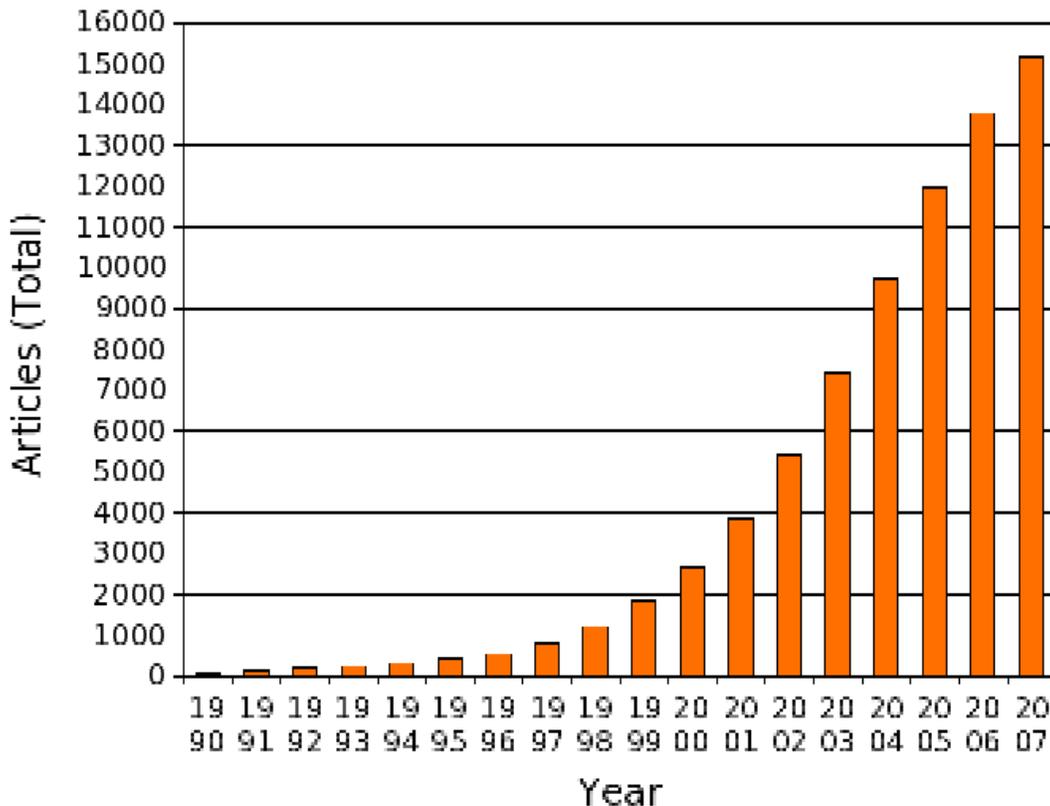
The common names of herbs (folk taxonomy) may not reflect differences in scientific taxonomy, and the same (or a very similar) common name might group together different plant species with different effects.

For example, in 1993 in Belgium, medical doctors created a formula including some Traditional Chinese medicine (TCM) herbs for weight loss. One herb (*Stephania tetrandra*) was swapped for another (*Aristolochia fangchi*) whose name in Chinese was extremely similar but which contained higher levels of a renal toxin, aristolochic acid; this mistake resulted in 105 cases of kidney damage.

Note that neither herb used in a TCM context would be used for weight loss or given for long periods of time. In Chinese medicine these herbs are used for certain forms of acute arthritis and edema.

For this reason, Western herbalists use binomial nomenclature in their terminology within the profession.

Effectiveness



Running total of the number of research papers listed on PubMed from 1990-2007 containing the word "phytotherapy."

The highest standard for pharmaceutical testing is repeated, small-scale, randomized, double-blind tests. In 2002 the U.S. National Center for Complementary and Alternative Medicine of the National Institutes of Health began funding clinical trials into the effectiveness of herbal medicine. In a 2010 survey of 1000 plants, 356 had clinical trials published evaluating their "pharmacological activities and therapeutic applications" while 12% of the plants, although available in the Western market, had "no substantial studies" of their properties.

Many herbs have shown positive results in-vitro, animal model or small-scale clinical tests but many studies on herbal treatments have also found negative results. The quality of the trials on herbal remedies is highly variable and many trials of herbal treatments have been found to be of poor quality, with many trials lacking an intention to treat analysis or a comment on whether blinding was successful. The few randomized, double-blind tests that receive attention in medical publications are often questioned on methodological grounds or interpretation. Likewise, studies published in peer-reviewed medical journals such as Journal of the American Medical Association receive more consideration than those published in specialized herbal journals.

One study found that non-impact factor alternative medicine journals published more studies with positive results than negative results and that trials finding positive results were of lower quality than trials finding negative results. High impact factor mainstream medical journals, on the other hand, published equal numbers of trials with positive and negative results. In high impact journals, trials finding positive results were also found to have lower quality scores than trials finding negative results. Another study reported that some clinical studies of herbal medicines were not inferior to similar medical studies. However, this study used a matched pair design and excluded all herbal trials that were not controlled, did not use a placebo or did not use random or quasi random assignment.

Herbalists criticize mainstream studies on the grounds that they make insufficient use of historical usage, which has been shown useful in drug discovery and development in the past and present. They maintain that tradition can guide the selection of factors such as optimal dose, species, time of harvesting and target population.

Dosage is in general an outstanding issue for herbal treatments: while most medicines are heavily tested to determine the most effective and safest dosages (especially in relation to things like body weight, drug interactions, etc.), there are fewer varieties of dosages for various herbal treatments on the market. Furthermore, from a conventional pharmacological perspective, herbal medicines taken in whole form cannot generally guarantee a consistent dosage or drug quality, since certain samples may contain more or less of a given active ingredient.

Several methods of standardization may be applied to herbs. One is the ratio of raw materials to solvent. However different specimens of even the same plant species may vary in chemical content. For this reason, thin layer chromatography is sometimes used by growers to assess the content of their products before use. Another method is standardization on a signal chemical.

Standards and quality control

The issue of regulation is an area of continuing controversy in the EU and USA. At one end of the spectrum, some herbalists maintain that traditional remedies have a long history of use, and do not require the level of safety testing as xenobiotics or single ingredients in an artificially concentrated form. On the other hand, others are in favor of legally enforced quality standards, safety testing and prescription by a qualified practitioner. Some professional herbalist organizations have made statements calling for a category of regulation for herbal products. Yet others agree with the need for more quality testing but believe it can be managed through reputation without government intervention. The legal status of herbal ingredients varies by country.

In the EU, herbal medicines are now regulated under the European Directive on Traditional Herbal Medicinal Products.

In the United States, most herbal remedies are regulated as dietary supplements by the Food and Drug Administration. Manufacturers of products falling into this category are not required to prove the safety or efficacy of their product, though the FDA may withdraw a product from sale should it prove harmful.

The National Nutritional Foods Association, the industry's largest trade association, has run a program since 2002, examining the products and factory conditions of member companies, giving them the right to display the GMP (Good Manufacturing Practices) seal of approval on their products.

In the UK, herbal remedies that are bought over the counter are regulated as supplements, as in the US. However, herbal remedies prescribed and dispensed by a qualified "Medical Herbalist", after a personal consultation, are regulated as medicines.

A Medical Herbalist can prescribe some herbs which are not available over the counter, covered by Schedule III of the Medicines Act. Forthcoming changes to laws regulating herbal products in the UK, are intended to ensure the quality of herbal products used.

Some herbs, such as Cannabis, are outright banned in most countries. Since 2004, the sales of ephedra as a dietary supplement is prohibited in the United States by the Food and Drug Administration., and subject to Schedule III restrictions in the United Kingdom.

Danger of extinction

On January 18, 2008, the Botanic Gardens Conservation International (representing botanic gardens in 120 countries) stated that "400 medicinal plants are at risk of extinction, from over-collection and deforestation, threatening the discovery of future cures for disease." These included Yew trees (the bark is used for cancer drugs, paclitaxel); Hoodia (from Namibia, source of weight loss drugs); half of Magnolias (used as Chinese medicine for 5,000 years to fight cancer, dementia and heart disease); and Autumn crocus (for gout). The group also found that 5 billion people benefit from

traditional plant-based medicine for health care. Some herbalists are aware of this problem and substitute least concern species as a result.

Chapter- 4

Orange (Economically important food plant)

Orange



Orange blossoms and oranges on tree

Scientific classification

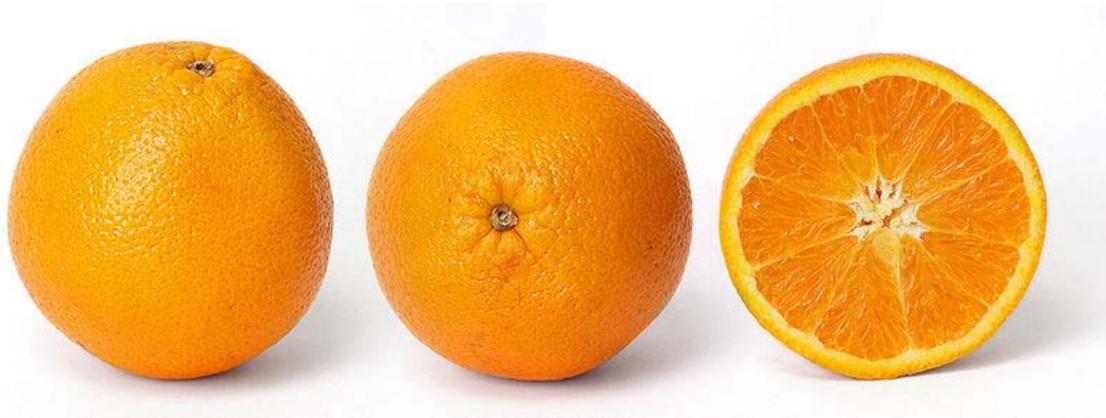
Kingdom:	Plantae
(unranked):	Angiosperms
(unranked):	Eudicots
(unranked):	Rosids
Order:	Sapindales
Family:	Rutaceae
Genus:	<i>Citrus</i>
Species:	<i>C. ×sinensis</i>

An **orange**—specifically, the **sweet orange**—is the citrus *Citrus × sinensis* (syn. *Citrus aurantium* L. var. *dulcis* L., or *Citrus aurantium* Risso) and its fruit. The orange is a hybrid of ancient cultivated origin, possibly between pomelo (*Citrus maxima*) and mandarin (*Citrus reticulata*). It is a small flowering tree growing to about 3 m tall with evergreen leaves, which are arranged alternately, of ovate shape with crenulate margins and 4–10 cm long. The orange fruit is a hesperidium, a type of berry.

Oranges originated in Southeast Asia and were cultivated in China by 2500 BC. The fruit of *Citrus sinensis* is called *sweet orange* to distinguish it from *Citrus aurantium*, the bitter orange. The name is thought to ultimately derive from the Sanskrit for the orange tree, with its final form developing after passing through numerous intermediate languages.

In a number of languages, it is known as a "Chinese apple" (e.g. Dutch *Sinaasappel*, "China's apple", or northern German *Apfelsine*).

Terminology

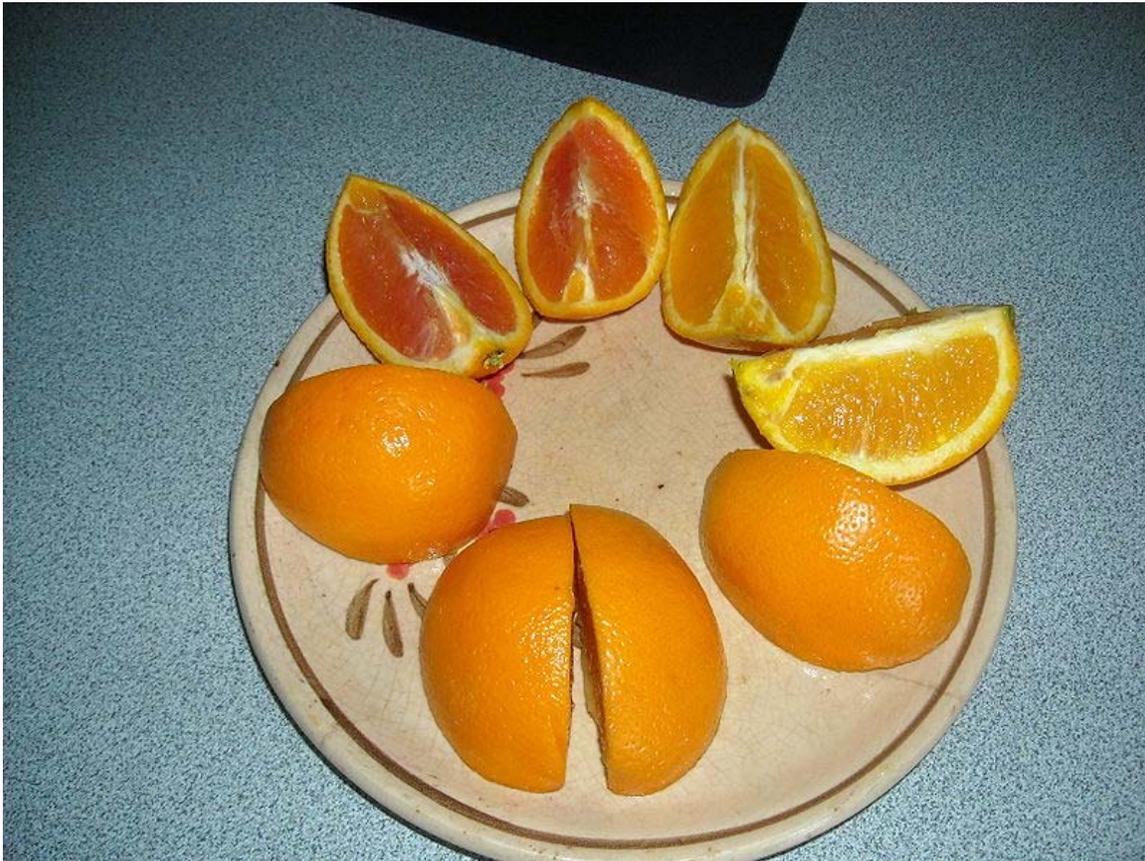


Orange fruit and cross section

All citrus trees are of the single genus, *Citrus*, and remain largely interbreedable; that is, there is only one "superspecies" which includes grapefruits, lemons, limes, and oranges. Nevertheless, names have been given to the various members of the genus, oranges often being referred to as *Citrus sinensis* and *Citrus aurantium*. Fruits of all members of the genus *Citrus* are considered berries because they have many seeds, are fleshy, soft, and derive from a single ovary. An orange seed is called a pip. The white thread-like material attached to the inside of the peel is called pith.

Varieties

Blood orange



Comparison between the inside and the outside of both the regular and blood orange

Blood oranges are a natural variety of *C. sinensis* derived from abnormal pigmentation of the fruit, that gives its pulp a streaking red colour. The juice produced from such oranges is often dark burgundy, hence reminiscent of blood. Original blood oranges were first discovered and cultivated in the 15th century in Sicily, however since then their cultivation became worldwide, and most blood oranges today are hybrids.

The fruit has found a niche as an interesting ingredient variation on traditional Seville marmalade, with its striking red streaks and distinct flavour. The **scarlet navel** is a variety with the same dual-fruit mutation as the navel orange.

Navel orange



A peeled sectioned navel orange. The underdeveloped twin is located on the bottom right.

According to Dorsett, Shamel, and Popenoe (1917) of the U.S. Department of Agriculture who conducted a study at first hand, a single mutation in 1810 to 1820 in a Selecta orange tree planted at a monastery near Bahia in Brazil, probably yielded the **navel orange**, also known as the Washington, Riverside, or Bahia navel. However, a researcher at the University of California, Riverside, believes that the parent variety was more likely the Portuguese navel (Umbigo) orange described by Risso and Poiteau (1818-22). The mutation causes the orange to develop a second orange at the base of the original fruit, opposite the stem, as a conjoined twin in a set of smaller segments embedded within the peel of the larger orange. From the outside, it looks similar to the human navel, hence its name.

Because the mutation left the fruit seedless, and therefore sterile, the only means available to cultivate more of this new variety is to graft cuttings onto other varieties of citrus tree. It was introduced into Australia in 1824 and Florida in 1835. Twelve such cuttings of the original tree were transplanted to Riverside, California in 1870, which eventually led to worldwide popularity. The California Citrus State Historic Park preserves this history in Riverside, California, as does the Orcutt Ranch Horticulture Center in Los Angeles County, California.

Today, navel oranges continue to be produced through cutting and grafting. This does not allow for the usual selective breeding methodologies, and so not only do the navel oranges of today have exactly the same genetic makeup as the original tree, and are therefore clones, all navel oranges can be considered to be the fruit of that single nearly two-hundred-year-old tree. This is similar to the common yellow seedless banana, the Cavendish. On rare occasions, however, further mutations can lead to new varieties.



orange seeds (pips)

Persian orange

The Persian orange, grown widely in southern Europe after its introduction to Italy in the 11th century, was bitter. Sweet oranges brought to Europe in the 15th century from India by Portuguese traders quickly displaced the bitter, and are now the most common variety of orange cultivated. The sweet orange will grow to different sizes and colours according to local conditions, most commonly with ten *carpels*, or segments, inside.

Some South East Indo-European tongues name the orange after Portugal, which was formerly the main source of imports of sweet oranges. Examples are Bulgarian *portokal* [портокал], Greek *portokali* [πορτοκάλι], Persian *portaghal* [لڤاڤترڤ], Albanian "portokall", Macedonian *portokal* [портокал], and Romanian *portocală*. Also in South Italian dialects (Neapolitan), orange is named *portogallo* or *purtualle*, literally "the

Portuguese one". Related names can also be found in other languages: Turkish *Portakal*, Arabic *al-burtuqal* [لبقربل], Amharic *birtukan*, and Georgian *phortokhali*.

Portuguese, Spanish, Arab, and Dutch sailors planted citrus trees along trade routes to prevent scurvy. On his second voyage in 1493, Christopher Columbus brought the seeds of oranges, lemons and citrons to Haiti and the Caribbean. They were introduced in Florida (along with lemons) in 1513 by Spanish explorer Juan Ponce de León, to California by the Franciscans in the 18th century, and were introduced to Hawaii in 1792.

Valencia orange

The Valencia or Murcia orange is one of the sweet oranges used for juice extraction. It is a late-season fruit, and therefore a popular variety when the navel oranges are out of season. For this reason, the orange was chosen to be the official mascot of the 1982 FIFA World Cup, which was held in Spain. The mascot was called "Naranjito" ("little orange"), and wore the colours of the Spanish football team uniform.

Attributes

Nutritional Value

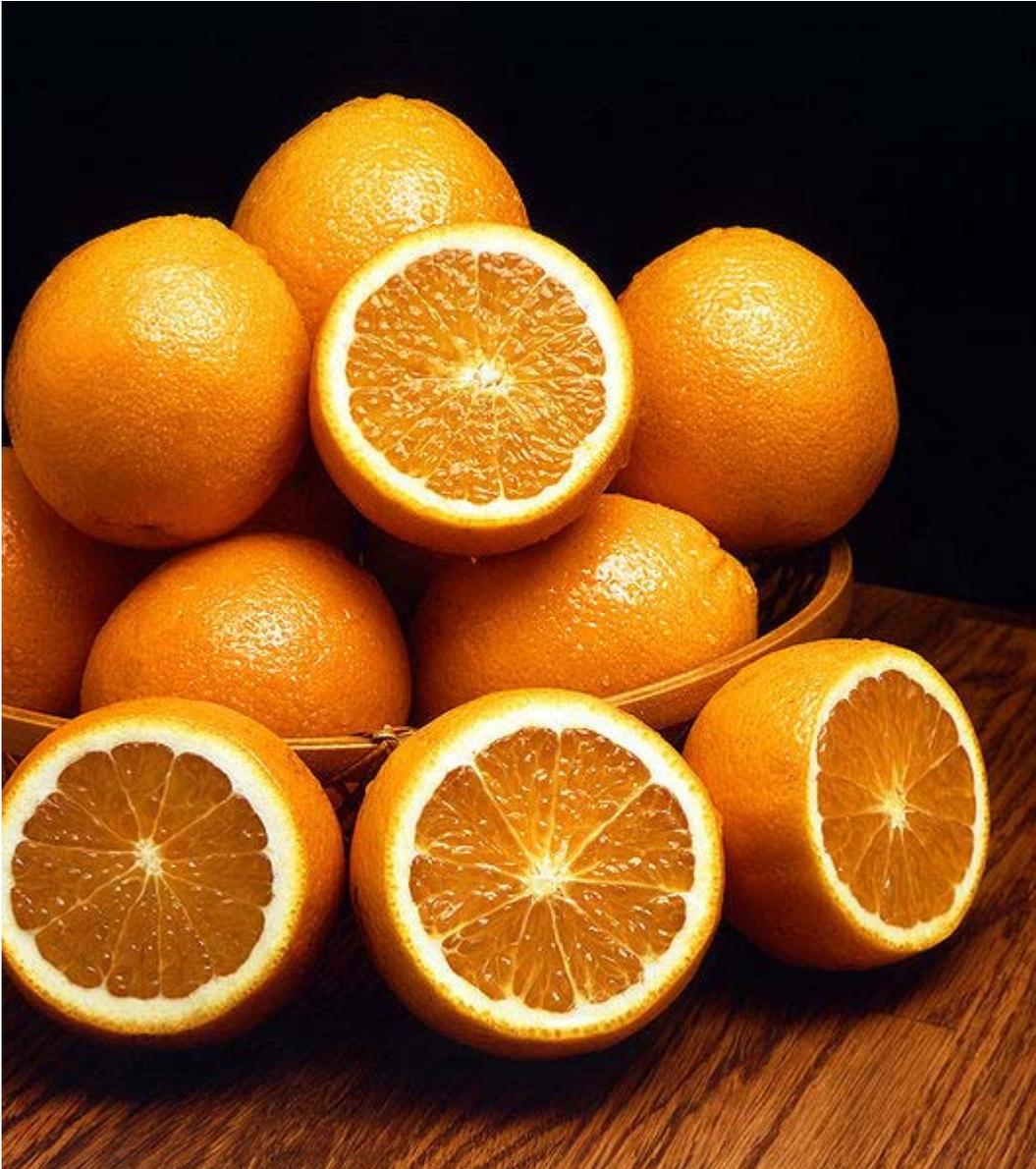
Orange, raw, Florida

Nutritional value per 100 g (3.5 oz)

Energy	192 kJ (46 kcal)
Carbohydrates	11.54 g
Sugars	9.14 g
Dietary fiber	2.4 g
Fat	0.21 g
Protein	0.70 g
Thiamine (Vit. B ₁)	0.100 mg (8%)
Riboflavin (Vit. B ₂)	0.040 mg (3%)
Niacin (Vit. B ₃)	0.400 mg (3%)
Pantothenic acid (B ₅)	0.250 mg (5%)
Vitamin B ₆	0.051 mg (4%)
Folate (Vit. B ₉)	17 µg (4%)
Vitamin C	45 mg (75%)
Calcium	43 mg (4%)
Iron	0.09 mg (1%)

Magnesium	10 mg (3%)
Phosphorus	12 mg (2%)
Potassium	169 mg (4%)
Zinc	0.08 mg (1%)

Percentages are relative to US recommendations for adults.

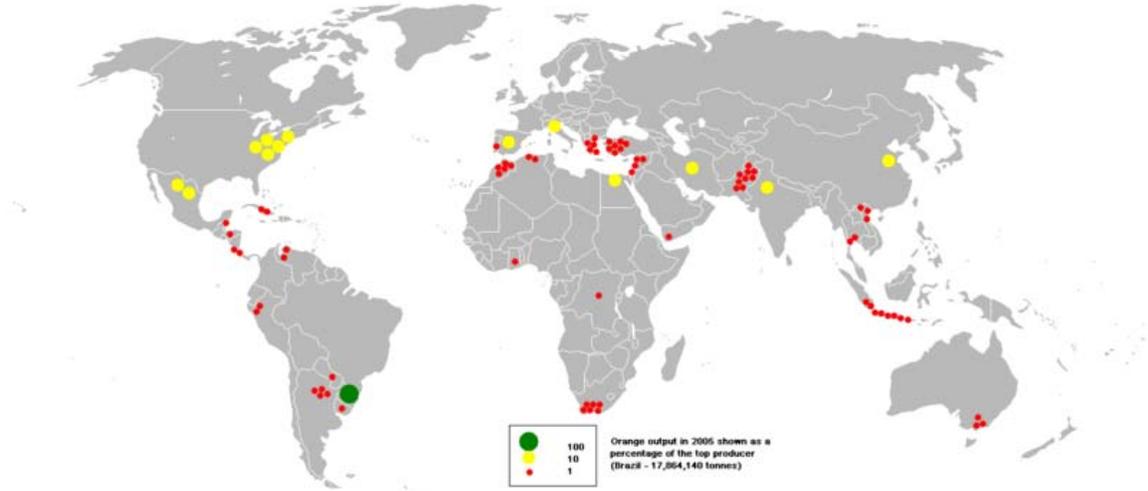


These varieties are called 'Ambersweet' oranges

Acidity

Like all citrus fruits, the *orange* is acidic, with a pH level of around 2.5-3; depending on the age, size and variety of the fruit. Although this is not, on average, as strong as the lemon, it is still quite acidic on the pH scale – as acidic as household vinegar.

Production



Orange output in 2005

Top Orange Producers — 2005 (million tonnes)	
Brazil	17.8
United States	8.4
Mexico	4.1
India	3.1
China	2.4
Spain	2.3
Italy	2.2
Iran	1.9
Egypt	1.8
Pakistan	1.6
World Total	61.7

Oranges grown for commercial production are generally grown in groves and are produced throughout the world. The top three orange-producing countries are Brazil, the United States, and Mexico. Oranges are sensitive to frost, and a common treatment to

prevent frost damage when sub-freezing temperatures are expected, is to spray the trees with water, since as long as unfrozen water is turning to ice on the trees' branches, the ice that has formed stays just *at* the freezing point, giving protection even if air temperatures have dropped far lower.

Growing

Oranges can be grown outdoors in warmer climates, and indoors in cooler climates. Like most citrus plants, oranges will not do well unless kept between 15.5°C - 29°C (60°F - 85°F). Orange trees grown from the seeds of a store-bought fruit may not produce fruit, and any fruit that is produced may be different than the parent fruit, due to modern techniques of hybridization. To grow the seed of a store-bought orange, one must not let the seed dry out (an approach used for many citrus plants). One method is to put the seeds between the halves of a damp paper towel until they germinate, and then plant them. Many just plant them straight into the soil, making sure to water them regularly. Oranges require a huge amount of water and the citrus industry in the Middle East is a contributing factor to the desiccation of the region.

Storage

After harvesting, oranges have a shelf life of about one week at room temperature and one month refrigerated. In either case, they are optimally stored loosely in an open or perforated plastic bag. Oranges produce odours that are absorbed by meat, eggs and dairy products.

Etymology

The word *orange* is derived from Sanskrit *nāraṅgaḥ* "orange tree." The Sanskrit word is in turn borrowed from the Dravidian root for 'fragrant'. In Tamil, a bitter orange is known as 'Narandam', a sweet orange is called 'nagarugam' and 'naari' means fragrance. In Telugu the orange is called 'naringa'. The Sanskrit word was borrowed into European languages through Persian گنران *nārang*, Armenian նարինջ *nārinj*, Arabic جنران *nāranj*, (Spanish *naranja* and Portuguese *laranja*), Late Latin *arangia*, Italian *arancia* or *arancio*, and Old French *orenge*, in chronological order. The first appearance in English dates from the 14th century. The forms starting with n- are older, and this initial n- may have been mistaken as part of the indefinite article, in languages with articles ending with an -n sound (e.g., in French *une norenge* may have been taken as *une orenge*), a process called juncture loss. The name of the colour is derived from the fruit, first appearing in this sense in 1542.

Some languages have different words for the bitter and the sweet orange, such as Modern Greek *nerantzi* and *portokali*, respectively. Or in Persian, the words are *narang* and *porteghal* (Portugal), in the same order. The reason is that the sweet orange was brought from China or India to Europe during the 15th century by the Portuguese. For the same reason, some languages refer to it as *Applesin* (or variants), which means "Apple from

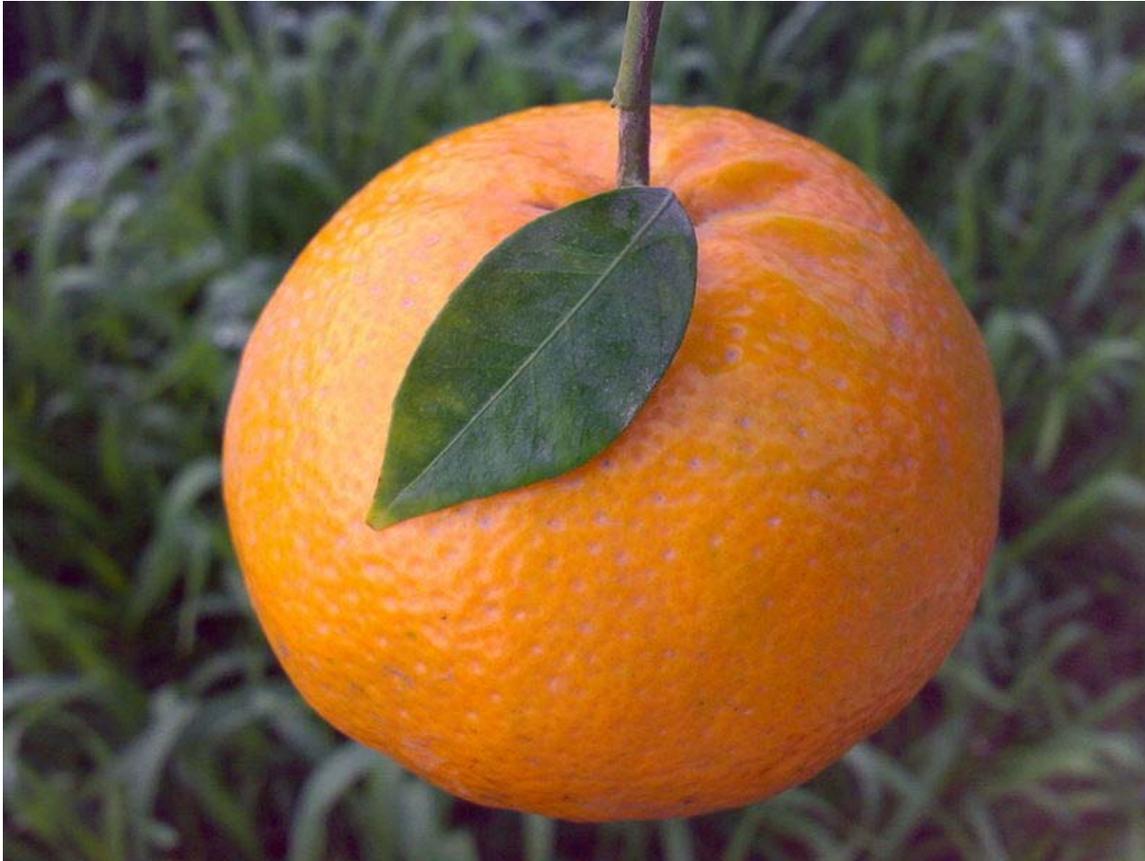
China,"as does Puerto Ricans, calling it "una China" for the fruit or "jugo de china" for orange juice, while the bitter orange was introduced through Persia.

Several slavic languages use the variants *pomaranč* (Slovak), *pomeranč* (Czech), *pomaranča* (Slovene), *pomarańcza* (Polish) from old French *pomme d'orange*.

Juice and other products



Oranges and orange juice



Kinnow, a variety of Mandarin orange widely cultivated in Pakistan

Oranges are widely grown in warm climates worldwide, and the flavours of oranges vary from sweet to sour. The fruit is commonly peeled and eaten fresh, or squeezed for its juice. It has a thick bitter rind that is usually discarded, but can be processed into animal feed by removing water, using pressure and heat. It is also used in certain recipes as flavouring or a garnish. The outer-most layer of the rind can be grated or thinly veneered with a tool called a zester, to produce orange zest. Zest is popular in cooking because it contains the oil glands and has a strong flavour similar to the fleshy inner part of the orange. The white part of the rind, called the *pericarp* or *albedo* and including the pith, is a source of pectin and has nearly the same amount of vitamin C as the flesh.

Products made from oranges

- Orange juice is one of the commodities traded on the New York Board of Trade. Brazil is the largest producer of orange juice in the world, followed by the USA. It is made by squeezing the fruit on a special instrument called a "*juicer*" or a "*squeezer*." The juice is collected in a small tray underneath. This is mainly done in the home, and in industry is done on a much larger scale.
- Frozen orange juice concentrate is made from freshly squeezed and filtered orange juice.

- Sweet orange oil is a by-product of the juice industry produced by pressing the peel. It is used as a flavouring of food and drink and for its fragrance in perfume and aromatherapy. Sweet orange oil consists of about 90% d-Limonene, a solvent used in various household chemicals, such as to condition wooden furniture, and along with other citrus oils in grease removal and as a hand-cleansing agent. It is an efficient cleaning agent which is promoted as being environmentally friendly and preferable to petroleum distillates. However, d-Limonene is classified from slightly toxic to humans to very toxic to marine life in different countries. Its smell is considered more pleasant by some than those of other cleaning agents. Although once thought to cause renal cancer in rats, limonene now is known as a significant chemopreventive agent with potential value as a dietary anti-cancer tool in humans. There is no evidence for carcinogenicity or genotoxicity in humans. The IARC classifies *d*-limonene under Class 3: *not classifiable as to its carcinogenicity to humans*.
- The orange blossom, which is the state flower of Florida, is highly fragrant and traditionally associated with good fortune. It has long been popular in bridal bouquets and head wreaths for weddings.
- Orange blossom essence is an important component in the making of perfume.
- The petals of orange blossom can also be made into a delicately citrus-scented version of rosewater; orange blossom water (aka orange flower water) is a common part of both French and Middle Eastern cuisines, most often as an ingredient in desserts and baked goods.
- In the United States, orange flower water is used to make orange blossom scones and marshmallows.
- The orange blossom gives its touristic nickname to the *Costa del Azahar* ("Orange-blossom coast"), the Castellon seaboard.
- In Spain, fallen blossoms are dried and then used to make tea.
- Orange blossom honey, or actually citrus honey, is produced by putting beehives in the citrus groves during bloom, which also pollinates seeded citrus varieties. Orange blossom honey is highly prized, and tastes much like orange.
- Marmalade, a conserve usually made with Seville oranges. All parts of the orange are used to make marmalade: the pith and pips are separated, and typically placed in a muslin bag where they are boiled in the juice (and sliced peel) to extract their pectin, aiding the setting process.
- Orange peel is used by gardeners as a slug repellent.
- Orange leaves can be boiled to make tea.
- Orange wood sticks (also spelt orangewood) are used as cuticle pushers in manicures and pedicures, and as spudgers for manipulating slender electronic wires
- Orange wood is a flavoring wood in meat grilling much as mesquite, oak, pecan and hickory are used.

Chapter- 5

Apple (Economically important food plant)

Apple



A typical apple

Scientific classification

Kingdom:	Plantae
Division:	Magnoliophyta
Class:	Magnoliopsida
Order:	Rosales
Family:	Rosaceae
Subfamily:	Maloideae or Spiraeoideae
Tribe:	Maleae
Genus:	<i>Malus</i>
Species:	<i>M. domestica</i>

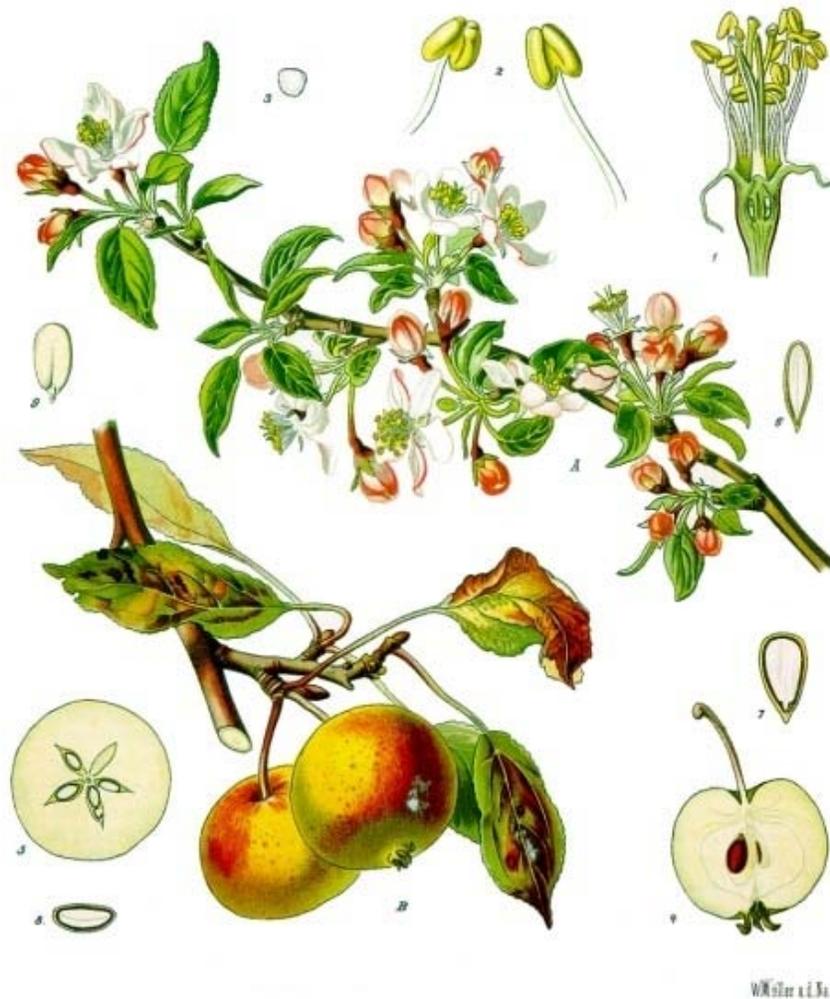
The **apple** is the pomaceous fruit of the apple tree, species *Malus domestica* in the rose family (Rosaceae), and is a perennial. It is one of the most widely cultivated tree fruits,

and the most widely known of the many members of genus *Malus* that are used by humans.

The tree originated in Western Asia, where its wild ancestor is still found today. There are more than 7,500 known cultivars of apples, resulting in a range of desired characteristics. Cultivars vary in their yield and the ultimate size of the tree, even when grown on the same rootstock.

At least 55 million tonnes of apples were grown worldwide in 2005, with a value of about \$10 billion. China produced about 35% of this total. The United States is the second-leading producer, with more than 7.5% of world production. Iran is third, followed by Turkey, Russia, Italy and India.

Botanical information



Blossoms, fruits, and leaves of the apple tree (*Malus domestica*)



Wild *Malus sieversii* apple in Kazakhstan

The apple forms a tree that is small and deciduous, reaching 3 to 12 metres (9.8 to 39 ft) tall, with a broad, often densely twiggy crown. The leaves are alternately arranged simple ovals 5 to 12 cm long and 3–6 centimetres (1.2–2.4 in) broad on a 2 to 5 centimetres (0.79 to 2.0 in) petiole with an acute tip, serrated margin and a slightly downy underside. Blossoms are produced in spring simultaneously with the budding of the leaves. The flowers are white with a pink tinge that gradually fades, five petaled, and 2.5 to 3.5 centimetres (0.98 to 1.4 in) in diameter. The fruit matures in autumn, and is typically 5 to 9 centimetres (2.0 to 3.5 in) in diameter. The center of the fruit contains five carpels arranged in a five-point star, each carpel containing one to three seeds.

Wild ancestors

The wild ancestors of *Malus domestica* are *Malus sieversii*, found growing wild in the mountains of Central Asia in southern Kazakhstan, Kyrgyzstan, Tajikistan, and Xinjiang, China, and possibly also *Malus sylvestris*.

Genome

In 2010, an Italian-led consortium announced they had decoded the complete genome of the apple (Golden delicious variety). It had about 57,000 genes, the highest number of any plant genome studied to date and more genes than the human genome (about 30,000).

History

The center of diversity of the genus *Malus* is in eastern Turkey. The apple tree was perhaps the earliest tree to be cultivated, and its fruits have been improved through selection over thousands of years. Alexander the Great is credited with finding dwarfed apples in Asia Minor in 300 BCE; those he brought back to Macedonia might have been the progenitors of dwarfing root stocks. Winter apples, picked in late autumn and stored just above freezing, have been an important food in Asia and Europe for millennia, as well as in Argentina and in the United States since the arrival of Europeans. Apples were

brought to North America with colonists in the 17th century, and the first apple orchard on the North American continent was said to be near Boston in 1625. In the 20th century, irrigation projects in Washington state began and allowed the development of the multibillion dollar fruit industry, of which the apple is the leading species.

Until the 20th century, farmers stored apples in frostproof cellars during the winter for their own use or for sale. Improved transportation of fresh apples by train and road replaced the necessity for storage.

Cultural aspects



"Brita as Iduna" (1901) by Carl Larsson

Germanic paganism

In Norse mythology, the goddess Iðunn is portrayed in the *Prose Edda* (written in the 13th century by Snorri Sturluson) as providing apples to the gods that give them eternal youthfulness. English scholar H. R. Ellis Davidson links apples to religious practices in Germanic paganism, from which Norse paganism developed. She points out that buckets of apples were found in the Oseberg ship burial site in Norway, and that fruit and nuts (Iðunn having been described as being transformed into a nut in *Skáldskaparmál*) have been found in the early graves of the Germanic peoples in England and elsewhere on the continent of Europe, which may have had a symbolic meaning, and that nuts are still a recognized symbol of fertility in southwest England.

Davidson notes a connection between apples and the Vanir, a tribe of gods associated with fertility in Norse mythology, citing an instance of eleven "golden apples" being given to woo the beautiful Gerðr by Skírnir, who was acting as messenger for the major Vanir god Freyr in stanzas 19 and 20 of *Skírnismál*. Davidson also notes a further connection between fertility and apples in Norse mythology in chapter 2 of the *Völsunga saga* when the major goddess Frigg sends King Rerir an apple after he prays to Odin for a child, Frigg's messenger (in the guise of a crow) drops the apple in his lap as he sits atop a mound. Rerir's wife's consumption of the apple results in a six-year pregnancy and the Caesarean section birth of their son - the hero Völsung.

Further, Davidson points out the "strange" phrase "Apples of Hel" used in an 11th-century poem by the skald Thorbiorn Brúnarson. She states this may imply that the apple was thought of by the skald as the food of the dead. Further, Davidson notes that the potentially Germanic goddess Nehalennia is sometimes depicted with apples and that parallels exist in early Irish stories. Davidson asserts that while cultivation of the apple in Northern Europe extends back to at least the time of the Roman Empire and came to Europe from the Near East, the native varieties of apple trees growing in Northern Europe are small and bitter. Davidson concludes that in the figure of Iðunn "we must have a dim reflection of an old symbol: that of the guardian goddess of the life-giving fruit of the other world."

Greek mythology



Heracles with the apple of Hesperides

Apples appear in many religious traditions, often as a mystical or forbidden fruit. One of the problems identifying apples in religion, mythology and folktales is that the word "apple" was used as a generic term for all (foreign) fruit, other than berries, but including nuts, as late as the 17th century. For instance, in Greek mythology, the Greek hero Heracles, as a part of his Twelve Labours, was required to travel to the Garden of the Hesperides and pick the golden apples off the Tree of Life growing at its center.

The Greek goddess of discord, Eris, became disgruntled after she was excluded from the wedding of Peleus and Thetis. In retaliation, she tossed a golden apple inscribed *Καλλίστη* (*Kalliste*, sometimes transliterated *Kallisti*, 'For the most beautiful one'), into

the wedding party. Three goddesses claimed the apple: Hera, Athena, and Aphrodite. Paris of Troy was appointed to select the recipient. After being bribed by both Hera and Athena, Aphrodite tempted him with the most beautiful woman in the world, Helen of Sparta. He awarded the apple to Aphrodite, thus indirectly causing the Trojan War.

The apple was thus considered, in ancient Greece, to be sacred to Aphrodite, and to throw an apple at someone was to symbolically declare one's love; and similarly, to catch it was to symbolically show one's acceptance of that love. An epigram claiming authorship by Plato states:

I throw the apple at you, and if you are willing to love me, take it and share your girlhood with me; but if your thoughts are what I pray they are not, even then take it, and consider how short-lived is beauty.

—Plato, *Epigram VII*



Adam and Eve

Showcasing the apple as a symbol of sin.
Albrecht Dürer, 1507

Atalanta, also of Greek mythology, raced all her suitors in an attempt to avoid marriage. She outran all but Hippomenes (a.k.a. Melanion, a name possibly derived from *melon* the Greek word for both "apple" and fruit in general), who defeated her by cunning, not speed. Hippomenes knew that he could not win in a fair race, so he used three golden apples (gifts of Aphrodite, the goddess of love) to distract Atalanta. It took all three apples and all of his speed, but Hippomenes was finally successful, winning the race and Atalanta's hand.

The Apple in the Garden of Eden

Though the forbidden fruit in the Book of Genesis is not identified, popular Christian tradition has held that it was an apple that Eve coaxed Adam to share with her. This may have been the result of Renaissance painters adding elements of Greek mythology into biblical scenes (alternative interpretations also based on Greek mythology occasionally replace the apple with a pomegranate). In this case the unnamed fruit of Eden became an apple under the influence of story of the golden apples in the Garden of Hesperides. As a result, in the story of Adam and Eve, the apple became a symbol for knowledge, immortality, temptation, the fall of man into sin, and sin itself. In Latin, the words for "apple" and for "evil" are similar (*mālum* "an apple", *mālum* "an evil, a misfortune"). This may also have influenced the apple becoming interpreted as the biblical "forbidden fruit". The larynx in the human throat has been called Adam's apple because of a notion that it was caused by the forbidden fruit sticking in the throat of Adam. The apple as symbol of sexual seduction has been used to imply sexuality between men, possibly in an ironic vein.

Apple cultivars



'Sundown' apple cultivar and its cross section



Different kinds of apple cultivars in a supermarket

There are more than 7,500 known cultivars of apples. Different cultivars are available for temperate and subtropical climates. One large collection of over 2,100 apple cultivars is housed at the National Fruit Collection in England. Most of these cultivars are bred for eating fresh (dessert apples), though some are cultivated specifically for cooking (cooking apples) or producing cider. Cider apples are typically too tart and astringent to eat fresh, but they give the beverage a rich flavour that dessert apples cannot.

Commercially popular apple cultivars are soft but crisp. Other desired qualities in modern commercial apple breeding are a colourful skin, absence of russeting, ease of shipping, lengthy storage ability, high yields, disease resistance, typical 'Red Delicious' apple shape, and popular flavour. Modern apples are generally sweeter than older cultivars, as popular tastes in apples have varied over time. Most North Americans and Europeans favour sweet, subacid apples, but tart apples have a strong minority following. Extremely sweet apples with barely any acid flavour are popular in Asia and especially India.

Old cultivars are often oddly shaped, russeted, and have a variety of textures and colours. Some find them to have a better flavour than modern cultivators, but may have other problems which make them commercially unviable, such as low yield, liability to disease, or poor tolerance for storage or transport. A few old cultivars are still produced on a large scale, but many have been kept alive by home gardeners and farmers that sell directly to

local markets. Many unusual and locally important cultivars with their own unique taste and appearance exist; apple conservation campaigns have sprung up around the world to preserve such local cultivars from extinction. In the United Kingdom, old cultivars such as 'Cox's Orange Pippin' and 'Egremont Russet' are still commercially important even though by modern standards they are low yielding and disease prone.

Apple production

Apple breeding



Apple blossom from an old Ayrshire variety

In the wild, apples grow quite readily from seeds. However, like most perennial fruits, apples are ordinarily propagated asexually by grafting. This is because seedling apples are an example of "extreme heterozygotes", in that rather than inheriting DNA from their parents to create a new apple with those characteristics, they are instead different from their parents, sometimes radically. Triploids have an additional reproductive barrier in that the 3 sets of chromosomes cannot be divided evenly during meiosis, yielding unequal segregation of the chromosomes (aneuploids). Even in the very unusual case when a triploid plant can produce a seed (apples are an example), it happens infrequently, and seedlings rarely survive. Most new apple cultivars originate as seedlings, which either arise by chance or are bred by deliberately crossing cultivars with promising characteristics. The words 'seedling', 'pippin', and 'kernel' in the name of an apple cultivar

suggest that it originated as a seedling. Apples can also form bud sports (mutations on a single branch). Some bud sports turn out to be improved strains of the parent cultivar. Some differ sufficiently from the parent tree to be considered new cultivars.

Breeders can produce more rigid apples through crossing. For example, the Excelsior Experiment Station of the University of Minnesota has, since the 1930s, introduced a steady progression of important hardy apples that are widely grown, both commercially and by backyard orchardists, throughout Minnesota and Wisconsin. Its most important introductions have included 'Haralson' (which is the most widely cultivated apple in Minnesota), 'Wealthy', 'Honeygold', and 'Honeycrisp'.

Apples have been acclimatized in Ecuador at very high altitudes, where they provide crops twice per year because of constant temperate conditions in a whole year.

Apple rootstocks

Rootstocks used to control tree size have been used in apple cultivation for over 2,000 years. Dwarfing rootstocks were probably discovered by chance in Asia. Alexander the Great sent samples of dwarf apple trees back to his teacher, Aristotle, in Greece. They were maintained at the Lyceum, a center of learning in Greece.

Most modern apple rootstocks were bred in the 20th century. Much research into the existing rootstocks was begun at the East Malling Research Station in Kent, England. Following that research, Malling worked with the John Innes Institute and Long Ashton to produce a series of different rootstocks with disease resistance and a range of different sizes, which have been used all over the world.

Pollination



Apple tree in flower



Orchard mason bee on apple bloom, British Columbia, Canada

Apples are self-incompatible; they must cross-pollinate to develop fruit. During the flowering each season, apple growers usually provide pollinators to carry the pollen. Honey bees are most commonly used. Orchard mason bees are also used as supplemental pollinators in commercial orchards. Bumblebee queens are sometimes present in orchards, but not usually in enough quantity to be significant pollinators.

There are four to seven pollination groups in apples, depending on climate:

- Group A – Early flowering, May 1 to 3 in England (Gravenstein, Red Astrachan)
- Group B – May 4 to 7 (Idared, McIntosh)
- Group C – Mid-season flowering, May 8 to 11 (Granny Smith, Cox's Orange Pippin)
- Group D – Mid/late season flowering, May 12 to 15 (Golden Delicious, Calville blanc d'hiver)
- Group E – Late flowering, May 16 to 18 (Braeburn, Reinette d'Orléans)
- Group F – May 19 to 23 (Suntan)
- Group H – May 24 to 28 (Court-Pendu Gris) (also called Court-Pendu plat)

One cultivar can be pollinated by a compatible cultivar from the same group or close (A with A, or A with B, but not A with C or D).

Varieties are sometimes classed as to the day of peak bloom in the average 30 day blossom period, with pollinizers selected from varieties within a 6 day overlap period.

Maturation and harvest

Cultivars vary in their yield and the ultimate size of the tree, even when grown on the same rootstock. Some cultivars, if left unpruned, will grow very large, which allows them to bear much more fruit, but makes harvesting very difficult. Mature trees typically bear 40–200 kilograms (88–440 lb) of apples each year, though productivity can be close to zero in poor years. Apples are harvested using three-point ladders that are designed to fit amongst the branches. Dwarf trees will bear about 10–80 kilograms (22–180 lb) of fruit per year.

Storage

Commercially, apples can be stored for some months in controlled-atmosphere chambers to delay ethylene-induced onset of ripening. The apples are commonly stored in chambers with higher concentrations of carbon dioxide with high air filtration. This prevents ethylene concentrations from rising to higher amounts and preventing ripening from moving too quickly. Ripening continues when the fruit is removed. For home storage, most varieties of apple can be held for approximately two weeks when kept at the coolest part of the refrigerator (i.e. below 5°C). Some types, including the Granny Smith and Fuji, have a longer shelf life.

Pests and diseases



Leaves with significant insect damage

The trees are susceptible to a number of fungal and bacterial diseases and insect pests. Many commercial orchards pursue an aggressive program of chemical sprays to maintain high fruit quality, tree health, and high yields. A trend in orchard management is the use of organic methods. These use a less aggressive and direct methods of conventional farming. Instead of spraying potent chemicals, often shown to be potentially dangerous and maleficent to the tree in the long run, organic methods include encouraging or discouraging certain cycles and pests. To control a specific pest, organic growers might encourage the prosperity of its natural predator instead of outright killing it, and with it the natural biochemistry around the tree. Organic apples generally have the same or greater taste than conventionally grown apples, with reduced cosmetic appearances.

A wide range of pests and diseases can affect the plant; three of the more common diseases/pests are mildew, aphids and apple scab.

- Mildew: which is characterized by light grey powdery patches appearing on the leaves, shoots and flowers, normally in spring. The flowers will turn a creamy yellow colour and will not develop correctly. This can be treated in a manner not dissimilar from treating Botrytis; eliminating the conditions which caused the

disease in the first place and burning the infected plants are among the recommended actions to take.



Feeding aphids

- Aphids: There are five species of aphids commonly found on apples: apple grain aphid, rosy apple aphid, apple aphid, spirea aphid and the woolly apple aphid. The aphid species can be identified by their colour, the time of year when they are present and by differences in the cornicles, which are small paired projections from the rear of aphids. Aphids feed on foliage using needle-like mouth parts to suck out plant juices. When present in high numbers, certain species reduce tree growth and vigor.

- Apple scab: Symptoms of scab are olive-green or brown blotches on the leaves. The blotches turn more brown as time progresses, then brown scabs form on the fruit. The diseased leaves will fall early and the fruit will become increasingly covered in scabs - eventually the fruit skin will crack. Although there are chemicals to treat scab, their use might not be encouraged as they are quite often systematic, which means they are absorbed by the tree, and spread throughout the fruit.

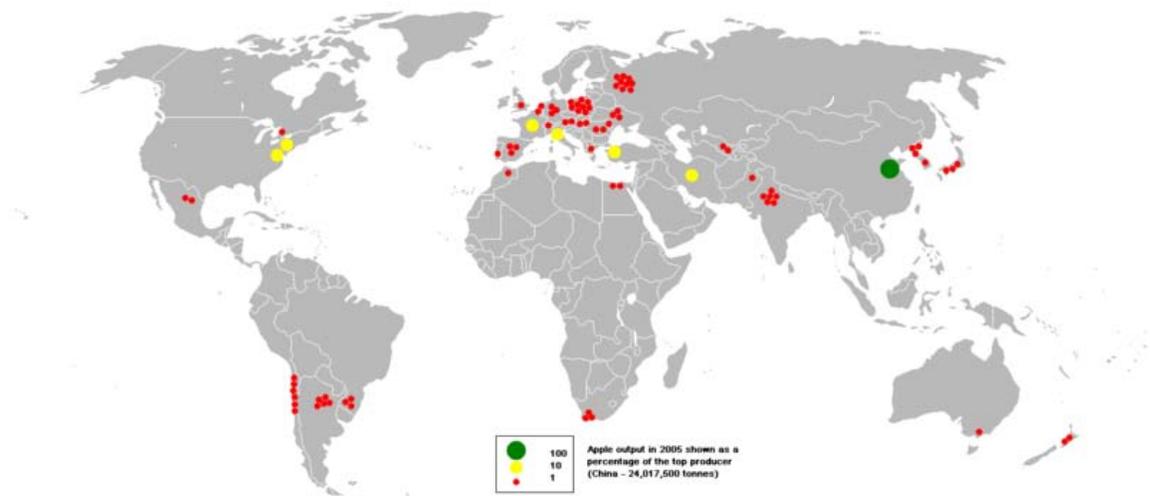
Among the most serious disease problems are fireblight, a bacterial disease; and *Gymnosporangium* rust, and black spot, two fungal diseases.

Young apple trees are also prone to mammal pests like mice and deer, which feed on the soft bark of the trees, especially in winter.

Records

Guinness World Records reports that the heaviest apple known weighed 1.849 kg (4 lb 1 oz) and was grown in Hirosaki city, Japan in 2005.

Commerce



Apple output in 2005

At least 55 million tonnes of apples were grown worldwide in 2005, with a value of about \$10 billion. China produced about two-fifths of this total. United States is the second leading producer, with more than 7.5% of the world production.

In the United States, more than 60% of all the apples sold commercially are grown in Washington state. Imported apples from New Zealand and other more temperate areas are competing with US production and increasing each year.

Most of Australia's apple production is for domestic consumption. Imports from New Zealand have been disallowed under quarantine regulations for fireblight since 1921.

The largest exporters of apples in 2006 were China, Chile, Italy, France and the U.S., while the biggest importers in the same year were Russia, Germany, the UK and the Netherlands.

Top Ten Apple Producers — 11 June 2008

Country	Production (Tonnes)	Footnote
 People's Republic of China	27 507 000	F
 United States	4 237 730	
 Iran	2 660 000	F
 Turkey	2 266 437	
 Russia	2 211 000	F
 Italy	2 072 500	
 India	2 001 400	
 France	1 800 000	F
 Chile	1 390 000	F
 Argentina	1 300 000	F
World	64 255 520	A

No symbol = official figure, F = FAO estimate, A = Aggregate (may include official, semi-official, or estimates);

Human consumption

Apples can be canned or juiced. They are milled to produce apple cider (non-alcoholic, sweet cider) and filtered for apple juice. The juice can be fermented to make cider (alcoholic, hard cider), ciderkin, and vinegar. Through distillation, various alcoholic beverages can be produced, such as applejack, Calvados, and apple wine. Pectin and apple seed oil may also be produced.

Apples are an important ingredient in many desserts, such as apple pie, apple crumble, apple crisp and apple cake. They are often eaten baked or stewed, and they can also be dried and eaten or reconstituted (soaked in water, alcohol or some other liquid) for later use. Puréed apples are generally known as apple sauce. Apples are also made into apple butter and apple jelly. They are also used (cooked) in meat dishes.

- In the UK, a toffee apple is a traditional confection made by coating an apple in hot toffee and allowing it to cool. Similar treats in the US are candy apples (coated in a hard shell of crystallised sugar syrup), and caramel apples, coated with cooled caramel.
- Apples are eaten with honey at the Jewish New Year of Rosh Hashanah to symbolize a sweet new year.

- Farms with apple orchards may open them to the public, so consumers may themselves pick the apples they will buy.

Sliced apples turn brown with exposure to air due to the conversion of natural phenolic substances into melanin upon exposure to oxygen. Different cultivars vary in their propensity to brown after slicing. Sliced fruit can be treated with acidulated water to prevent this effect.

Organic apples are commonly produced in the United States. Organic production is difficult in Europe, though a few orchards have done so with commercial success, using disease-resistant cultivars and the very best cultural controls. The latest tool in the organic repertoire is a spray of a light coating of kaolin clay, which forms a physical barrier to some pests, and also helps prevent apple sun scald.

Fallen apples

Eating fallen apples (known in the UK as 'windfalls'), rather than picking directly from the tree, is generally safe. There may be a risk of food poisoning if the orchard is also the area of keeping cattle or other animals, which may contaminate the apples with feces. Still, the risk may be significantly higher if the apples are used to make home-made (unpasteurized) cider or juice, thus letting *E. coli* multiply.

On the other hand, if the apples are eaten unprocessed, and kept free from risk of contamination with animal feces, then eating fallen apples is generally safe, even if there is some general decay or worms in them. Still, they may be submerged in water with salt added, which kills the worms. Apparent molds may be largely removed by putting in water with some vinegar added, but if they are of a large quantity, then there might be mold or mold products left to evoke mold health issues such as allergic reactions and respiratory problems.

Apple allergy

Oral allergy syndrome is an allergic reaction some people will experience due to the birch pollen left on the apples. Because the pollen is the main irritant, only the raw apples, especially their skin, cause the allergic reaction. Cooked apples do not cause these symptoms as the heat denatures the proteins in the pollen, rendering them harmless to those sensitive. If one is allergic to apples, he or she may also experience an allergic reaction with other fruits in the Rosaceae family which include peaches and hazelnuts.

Symptoms

Symptoms vary from person to person but are generally mild. This typically includes the sensation of itching and swelling around the mouth and lips. Other symptoms include watery eyes, runny nose and sneezing. Hives may develop in those who have a high sensitivity to the pollen. Abdominal pain and diarrhea may also occur.

Health benefits

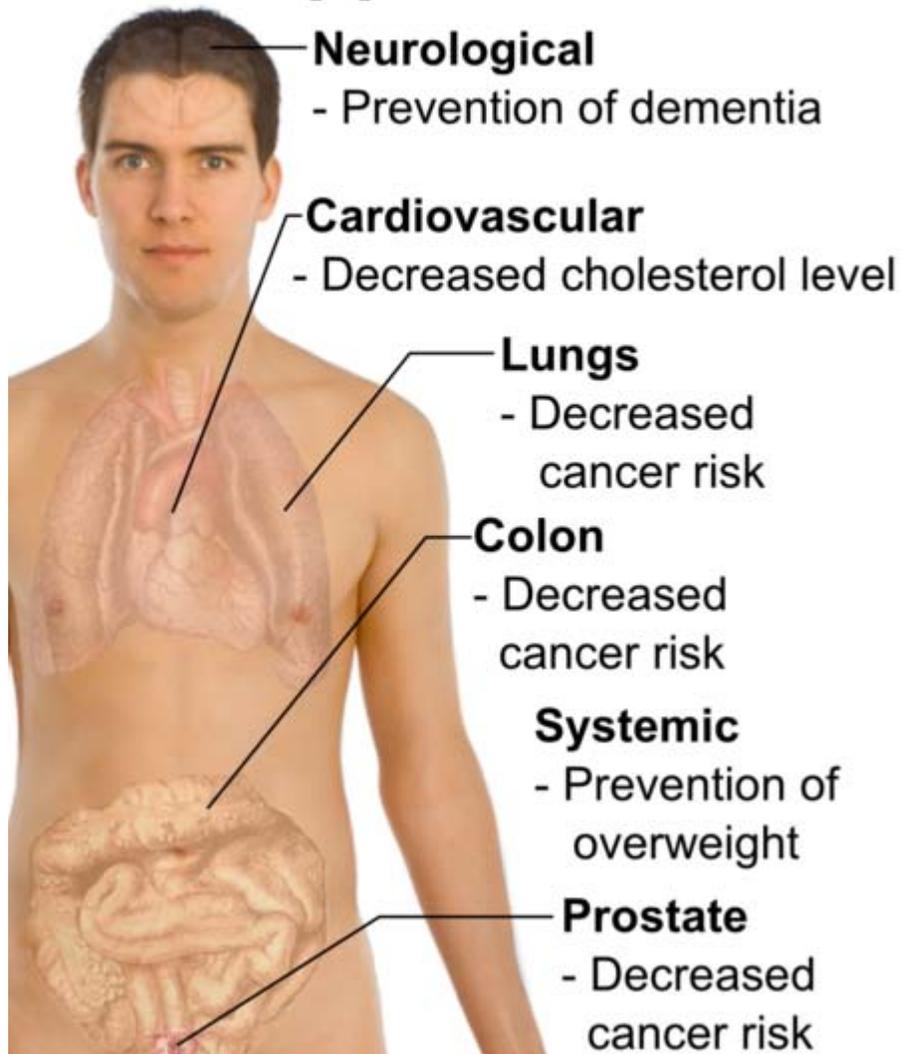
Apples, with skin (edible parts)

Nutritional value per 100 g (3.5 oz)

Energy	218 kJ (52 kcal)
Carbohydrates	13.81 g
Sugars	10.39 g
Dietary fiber	2.4 g
Fat	0.17 g
Protein	0.26 g
Water	85.56 g
Vitamin A equiv.	3 µg (0%)
Thiamine (Vit. B ₁)	0.017 mg (1%)
Riboflavin (Vit. B ₂)	0.026 mg (2%)
Niacin (Vit. B ₃)	0.091 mg (1%)
Pantothenic acid (B ₅)	0.061 mg (1%)
Vitamin B ₆	0.041 mg (3%)
Folate (Vit. B ₉)	3 µg (1%)
Vitamin C	4.6 mg (8%)
Calcium	6 mg (1%)
Iron	0.12 mg (1%)
Magnesium	5 mg (1%)
Phosphorus	11 mg (2%)
Potassium	107 mg (2%)
Zinc	0.04 mg (0%)

Percentages are relative to US recommendations for adults.

Health benefits of **Apples**



Health benefits of apple consumption

The proverb "*An apple a day keeps the doctor away.*", addressing the health effects of the fruit, dates from the 19th century Wales. Research suggests that apples may reduce the risk of colon cancer, prostate cancer and lung cancer. Compared to many other fruits and vegetables, apples contain relatively low amounts of vitamin C, but are a rich source of other antioxidant compounds. The fiber content, while less than in most other fruits, helps regulate bowel movements and may thus reduce the risk of colon cancer. They may also help with heart disease, weight loss, and controlling cholesterol, as they do not have any cholesterol, have fiber, which reduces cholesterol by preventing reabsorption, and (like most fruits and vegetables) are bulky for their caloric content.

There is evidence that in vitro apples possess phenolic compounds which may be cancer-protective and demonstrate antioxidant activity. The predominant phenolic phytochemicals in apples are quercetin, epicatechin, and procyanidin B2.

Apple juice concentrate has been found to increase the production of the neurotransmitter acetylcholine in mice, providing a potential mechanism for the "prevention of the decline in cognitive performance that accompanies dietary and genetic deficiencies and aging." Other studies have shown an "alleviat[ion of] oxidative damage and cognitive decline" in mice after the administration of apple juice.

However, apple seeds are mildly poisonous, containing a small amount of amygdalin, a cyanogenic glycoside; it usually is not enough to be dangerous to humans, but can deter birds.

Chapter- 6

Medicinal Plant and Habitat Conservation

Medicinal Plant Conservation

Medicinal Plant Conservation strategies need to be understood and planned for based on an understanding of indigenous knowledge and practices. Many of the things we consume when we are ill contain medicinal plants that are found all over the world. The teas we drink to help us sleep or alleviate stress have herbal elements in them that produce positive effects. A lot of medicine we consume contains herbal ingredients and it has been said that 70-80% of the world's population relies on some form of non-conventional medicine and around 25-40% of all prescription drugs contain active ingredients derived from plants in the United States alone. Many countries rely on these medicinal plants for the health and well being of it's population, but the market demand has led to an increased pressure on the natural resources that lend to the production of some of these plants. The most serious proximate threats when extracting medicinal plants generally are habitat loss, habitat degradation, and over harvesting. Developing markets for natural products, particularly those that are harvested from the wild, can trigger a demand that cannot be met by available or legal supplies and demands a conservation initiative so the local populations are not exploited, causing more damage to their resources. Many times populations are taken advantage of for their resources and knowledge, which can often be for financial gain. Conservation of medicinal plants in its biocultural perspective not only implies conservation of biodiversity but also places an equal emphasis on conservation of cultural diversity.

Around the Globe

Asia represents one of the most important centers of knowledge with regard to the use of plant species for treatment of various diseases. Kunwar states, it has been estimated that the Himalayan region harbors over 10,000 species of medicinal and aromatic plants, supporting the livelihoods of about 600 million people living in the area. In Nepal they use a traditional healing system that is called Ayurveda, which is influenced by Buddhism and Hinduism's central ideas of balance in life. High altitude medicinal plants provide quality products, and this is the reason why they are often the first choice of local users as immediate therapy and by pharmaceutical companies as precious ingredients.

When it comes to profits made in the communities up to 50% of the Nepal's rural household's income is derived from commercial collection of medicinal and aromatic plants.

KwaZulu-Natal, South Africa community of Mnoqobokazi has high unemployment rates in the area and reliance on subsistence agriculture and wild produce is still high. Socioeconomic factors such as low education levels and lack of access to western health care have been cited as important reasons for reliance on indigenous medicine in South Africa. Both villagers and healers in the area would cultivate one or more species because they could only be found far away, or were frequently used, or had to be fresh when used, or they were planted as protection against witchcraft. Also there were ten people from Mnoqobokazi, mainly women, who harvested plants on a commercial basis to conserve. An interview with a conservation officer at the Wetland Park claimed that harvesting of medicinal plants was not a problem in this part as it was further north. In other parts of South Africa the most frequently used medicinal plants are slow-growing forest trees, in which the bark and underground parts are mainly the parts utilized. Because there is a high demand for such resources, the trees are becoming endangered and a lot of the collection is unrestricted. Regulations are now being placed on some of the resources that originally had been exploited and many schools and research facilities are working together to come up with new ways to foster their beloved trees and still manage to get what is needed from the trees as well by proposing the idea of substituting the bark or underground parts with leaves of the same plant.

Samoa has had a great influence on western medicine when it comes to finding a cure for HIV/AIDS. New research has shown that the isolation of prostratin, found in the bark of the Samoan mamala tree, from *Homalanthus nutans* has led to the extreme potency against HIV-1. Both the National Cancer Institute and Brigham Young University have guaranteed to return to the Samoan people a significant portion of any royalties. Dr Paul Cox, an American ethnobotanist, raised money based on awareness of environmental degradation due to logging, in order to protect the 30,000-acre (120 km²) lowland forest of Falealupo village on the island of Savai'i. The Swedish Society for the Conservation of Nature established three new indigenously controlled preserves. Controlled preserves cause controversy because in traditional Polynesian societies, land, including the natural plant and animal populations, which occupied it, were viewed as sacred and an ancestral inheritance. Western approaches to conservation on indigenous land and within an indigenous community must collaborate and understand indigenous knowledge systems in order to conserve cultural identity. Paul Cox stated that, "the loss of these indigenous knowledge systems may yet prove to be one of the greatest tragedies of our age". The U.S National Park Service officials, the American Samoan Government, and the traditional chiefs (*matai*) and orators of the villages of Tafua had agreed to lease their lands for 50 years to the U.S National Park Service in order to protect American Samoa's rain forests. The Tafua rain forest received funding from the Swedish International Development Authority, which was used to secure water supply, improve roads, and used for assistance in the development of village-based environmental tourism in Tafua. Cox explains, "all parties to these agreements agree that any development of tourism must be

village initiatives, rather than foreign initiatives, and must be carefully planned and controlled so that the Samoan culture in these areas is not jeopardized”.

Habitat Conservation



The remaining fragmented habitats of the African Elephant

Habitat conservation is a land management practice that seeks to conserve, protect and restore, habitat areas for wild plants and animals, especially conservation reliant species, and prevent their extinction, fragmentation or reduction in range. It is a priority of many groups that cannot be easily characterized in terms of any one ideology.

Natural Causes and Human Impact

The conservation of natural resources is the fundamental problem. Unless we solve that problem, it will avail us little to solve all others.

Theodore Roosevelt

Habitat destruction can occur naturally due or by human activity. For example, Climate change devastated tropical rainforests during the Carboniferous Period, 300 million years ago. At this time, Europe and North America lay on the equator and were covered by steamy tropical rainforests. Rainforest collapse had dramatic consequences on the direction of evolution, putting amphibians at a great disadvantage compared to reptiles.

Most of the species extinctions from 1000 AD to 2000 AD are due to human activities, in particular destruction of plant and animal habitats. Raised rates of extinction are being driven by human consumption of organic resources, especially related to tropical forest destruction. While most of the species that are becoming extinct are not food species, their biomass is converted into human food when their habitat is transformed into pasture, cropland, and orchards. It is estimated that more than a third of the Earth's biomass is tied up in only the few species that represent humans, livestock and crops. Because an ecosystem decreases in stability as its species are made extinct, these studies warn that the global ecosystem is destined for collapse if it is further reduced in complexity. Factors contributing to loss of biodiversity are: overpopulation, deforestation, pollution (air pollution, water pollution, soil contamination) and global warming or climate change, driven by human activity. These factors, while all stemming from overpopulation, produce a cumulative impact upon biodiversity.

Conservation movement

Some of the conservation movement's goals are to protect habitats and promote continued recreational opportunities for people such as hiking, birdwatching, fishing and hunting.

Ecology movement

The global ecology movement is based upon environmental protection, and is one of several new social movements that emerged at the end of the 1960s. As a values-driven social movement, it should be distinguished from the pre-existing science of ecology. Aspects of the ecology movement view wild species as possessing natural life-rights to exist based upon the importance of maintaining and preserving biodiversity. Another argument for the preservation of species is based upon species competition: species tend to compete most intensely with their own kind, so therefore any cessation of competition between humans must be presaged by cessation of competition between humans and other species.

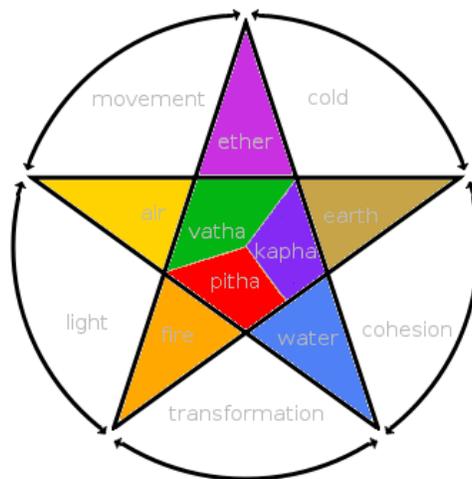
Chapter- 7

Ayurveda

Ayurveda (Sanskrit: आयुर्वेद; *Āyurveda*, the "science of life") or **ayurvedic medicine** is a system of traditional medicine native to India and practiced in other parts of the world as a form of alternative medicine. In Sanskrit, the word *ayurveda* consists of the words *āyus*, meaning "longevity", and *veda*, meaning "related to knowledge" or "science". Evolving throughout its history, ayurveda remains an influential system of medicine in South Asia. The earliest literature on Indian medical practice appeared during the Vedic period in India. The *Suśruta Saṃhitā* and the *Charaka Saṃhitā* were influential works on traditional medicine during this era. Over the following centuries, ayurvedic practitioners developed a number of medicinal preparations and surgical procedures for the treatment of various ailments and diseases.

In Western medicine, ayurveda is classified as a system of complementary and alternative medicine (CAM) that is used to complement, rather than replace, the treatment regimen and relationship that exists between a patient and their existing physician.

Overview



The three doshas and the 5 great elements from which they are composed



Traditional Indian ayurvedic spa

Ayurveda is grounded in a metaphysics of the "five great elements"—all of which compose the Universe, including the human body. Chyle or plasma (called *rasa dhatu*), blood (*rakta dhatu*), flesh (*mamsa dhatu*), fat (*medha dhatu*), bone (*asthi dhatu*), marrow (*majja dhatu*), and semen or female reproductive tissue (*shukra dhatu*) are held to be the seven primary constituent elements -- saptadhatu of the body. Ayurveda deals elaborately with measures of healthful living during the entire span of life and its various phases. Ayurveda stresses a balance of three elemental energies or humors: *vata* (air & space – "wind"), *pitta* (fire & water – "bile") and *kapha* (water & earth – "phlegm"). According to ayurveda, these three regulatory principles—*doshas*—are important for health, because when they are in a more balanced state, the body will function to its fullest, and when imbalanced, the body will be affected negatively in certain ways. Ayurveda holds that each human possesses a unique combination of *doshas*. In ayurveda, the human body perceives attributes of experiences as 20 *Guna*. Surgery and surgical instruments are employed. It is believed that building a healthy metabolic system, attaining good digestion, and proper excretion leads to vitality. Ayurveda also focuses on exercise, yoga, meditation, and massage. Thus, body, mind, and spirit/consciousness need to be addressed both individually and in unison for health to ensue.

The practice of *Panchakarma* is believed to eliminate toxic elements from the body.

Eight disciplines of ayurveda treatment, called *ashtangas* are given below:

- Internal medicine (*Kaaya-chikitsa*)
- Paediatrics (*Kaumarabhrtyam*)
- Surgery (*Shalya-chikitsa*)
- Eye and ENT (Shalakya tantra)
- Demonic possession (*Bhuta vidya*): *Bhuta vidya* has been called psychiatry.
- Toxicology (*Agadatantram*)
- Prevention diseases and improving immunity and rejuvenation (*rasayana*)
- Aphrodisiacs and improving health of progeny (*Vajikaranam*)

In Hindu mythology, the origin of ayurvedic medicine is attributed to the physician of the gods, Dhanvantari.

Practices



Several philosophers in India combined religion and traditional medicine—notable examples being that of Hinduism and ayurveda. Shown in the image is the philosopher Nagarjuna—known chiefly for his doctrine of the *Mādhyamaka* (middle path)—who wrote medical works *The Hundred Prescriptions* and *The Precious Collection*, among others.

Balance

Hinduism and Buddhism have been an influence on the development of many of ayurveda's central ideas — particularly its fascination with balance, known in Buddhism

as *Mādhyamaka*. Balance is emphasized; suppressing natural urges is seen to be unhealthy, and doing so may almost certainly lead to illness. However, people are cautioned to stay within the limits of reasonable balance and measure. For example, emphasis is placed on moderation of food intake, sleep, sexual intercourse, and the intake of medicine.

Diagnosis

The *Charaka Samhita* recommends a tenfold examination of the patient. The qualities to be judged are:

- constitution
- abnormality
- essence
- stability
- body measurements
- diet suitability
- psychic strength
- digestive capacity
- physical fitness
- age

In addition, Chopra (2003) identifies five influential criteria for diagnosis:

- origin of the disease
- prodrominal (precursory) symptoms
- typical symptoms of the fully developed disease
- observing the effect of therapeutic procedures
- the pathological process'

Ayurvedic practitioners approach diagnosis by using all five senses. Hearing is used to observe the condition of breathing and speech. The study of the vital pressure points or *marma* is of special importance.

Hygiene



Sesame and sunflower oil are used in ayurvedic medicine. Both contain linoleate in triglyceride form and may have antineoplastic properties



Hundreds of plant-based medicines are used in ayurvedic medicine—including cardamom and cinnamon.

Hygiene is an Indian cultural value and a central practice of ayurvedic medicine. Hygienic living involves regular bathing, cleansing of teeth, skin care, and eye washing. Occasional anointing of the body with oil is also prescribed.

Treatments

Ayurveda stresses the use of plant-based medicines and treatments. Hundreds of plant-based medicines are employed, including cardamom and cinnamon. Some animal products may also be used, for example milk, bones, and gallstones. In addition, fats are used both for consumption and for external use. Minerals, including sulfur, arsenic, lead, copper sulfate and gold are also consumed as prescribed. This practice of adding minerals to herbal medicine is known as *rasa shastra*.

In some cases, alcohol is used as a narcotic for the patient undergoing an operation. The advent of Islam introduced opium as a narcotic. Both oil and tar are used to stop bleeding. Traumatic bleeding is said to be stopped by four different methods ligation of the blood vessel; cauterisation by heat; using different herbal or animal preparations locally which facilitate clotting; and different medical preparations which constrict the bleeding or oozing vessels. Different oils may be used in a number of ways including regular

consumption as a part of food, anointing, smearing, *head massage*, and prescribed application to infected areas.



Facemask

Shrotas

Ensuring the proper functions of channels (shrotas) that transport fluids from one point to another is a vital goal of ayurvedic medicine, because the lack of healthy shrotas is thought to cause rheumatism, epilepsy, paralysis, convulsions, and insanity. Practitioners induce sweating and prescribe steam-based treatments as a means to open up the channels and dilute the doshas that cause the blockages and lead to disease.

History

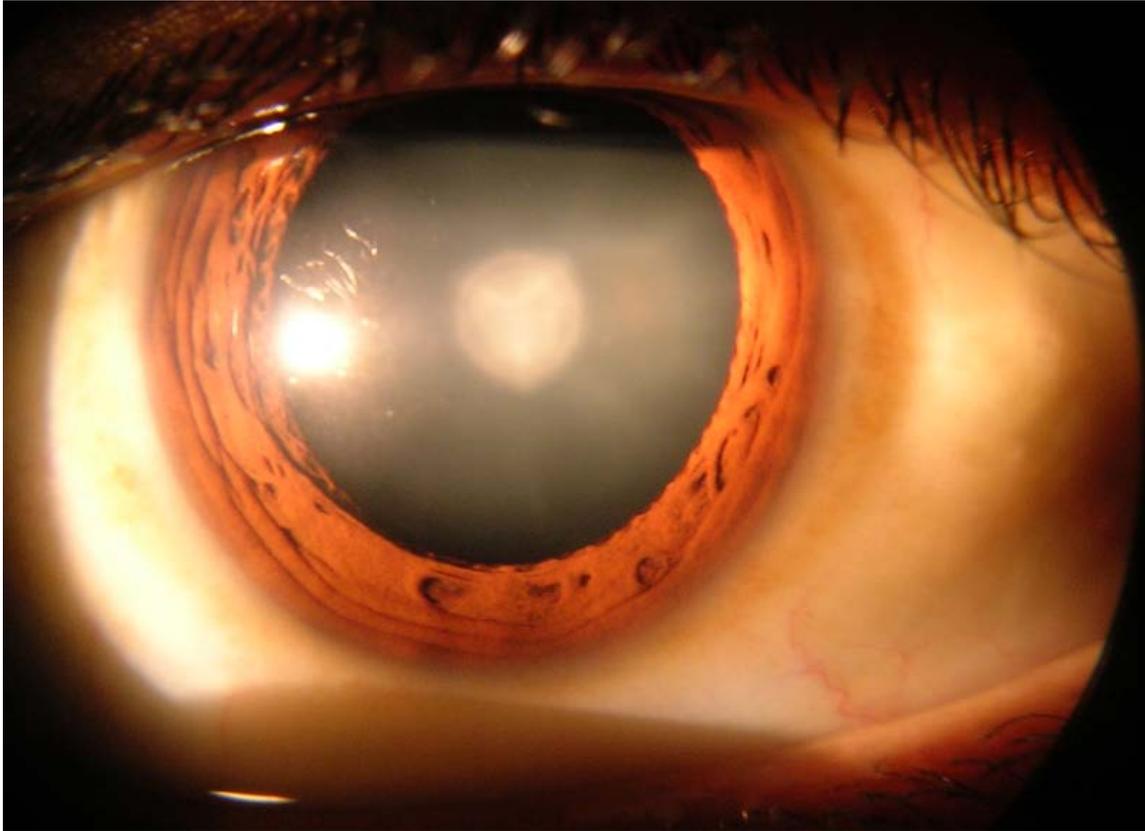


Chanting mantras has been a feature of ayurveda since the *Atharvaveda*, a largely religious text, was compiled.

Around 1500 BC, ayurveda's fundamental and applied principles got organised and enunciated. Ayurveda traces its origins to the Vedas, *Atharvaveda* in particular, and is connected to Hindu religion. *Atharvaveda* (one of the four most ancient books of Indian knowledge, wisdom and culture) contains 114 hymns or formulations for the treatment of diseases. Ayurveda originated in and developed from these hymns. In this sense, ayurveda is considered by some to have divine origin. Indian medicine has a long history, and is one of the oldest organised systems of medicine. Its earliest concepts are set out in the sacred writings called the Vedas, especially in the metrical passages of the *Atharvaveda*, which may possibly date as far back as the 2nd millennium BC. According to a later writer, the system of medicine was received by Dhanvantari from Brahma, and Dhanvantari was deified as the god of medicine. In later times his status was gradually reduced, until he was credited with having been an earthly king. The *Sushruta Samhita* of Sushruta appeared during the 1st millennium BC. Dwivedi & Dwivedi (2007) – on the work of the surgeon Sushruta – write:

The main vehicle of the transmission of knowledge during that period was by oral method. The language used was Sanskrit — the vedic language of that period (2000–500 BC). The most authentic compilation of his teachings and work is presently available in a treatise called *Sushruta Samhita*. This contains 184 chapters and description of 1,120

illnesses, 700 medicinal plants, 64 preparations from mineral sources and 57 preparations based on animal sources.



Cataract in human eye – magnified view seen on examination with a slit lamp. Cataract surgery was known to the physician Sushruta in the first millennium BC, and was performed with a special tool called the *jabamukhi salaka*, a curved needle used to loosen the lens and push the cataract out of the field of vision. The eye would later be soaked with warm butter and then bandaged.

Underwood & Rhodes (2008) hold that this early phase of traditional Indian medicine identified 'fever (takman), cough, consumption, diarrhea, dropsy, abscesses, seizures, tumours, and skin diseases (including leprosy)'. Treatment of complex ailments, including angina pectoris, diabetes, hypertension, and stones, also ensued during this period. Plastic surgery, cataract surgery, puncturing to release fluids in the abdomen, extraction of foreign elements, treatment of anal fistulas, treating fractures, amputations, cesarean sections, and stitching of wounds were known. The use of herbs and surgical instruments became widespread. The *Charaka Samhita* text is arguably the principal classic reference. It gives emphasis to the triune nature of each person: body care, mental regulation, and spiritual/consciousness refinement.

Other early works of ayurveda include the *Charaka Samhita*, attributed to Charaka. The earliest surviving excavated written material which contains the works of Sushruta is the *Bower Manuscript*, dated to the 4th century AD. The Bower manuscript quotes directly

from Sushruta and is of special interest to historians due to the presence of Indian medicine and its concepts in Central Asia. Vagbhata, the son of a senior doctor by the name of Simhagupta, also compiled his works on traditional medicine. Early ayurveda had a school of physicians and a school of surgeons. Tradition holds that the text *Agnivesh tantra*, written by the sage Agnivesh, a student of the sage Bharadwaja, influenced the writings of ayurveda.

The Chinese pilgrim Fa Hsien (ca. 337–422 AD) wrote about the health care system of the Gupta empire (320–550) and described the institutional approach of Indian medicine, also visible in the works of Charaka, who mentions a clinic and how it should be equipped. Madhava (fl. 700), Sarnghadhara (fl. 1300), and Bhavamisra (fl. 1500) compiled works on Indian medicine. The medical works of both Sushruta and Charaka were translated into the Arabic language during the Abbasid Caliphate (ca. 750). These Arabic works made their way into Europe via intermediaries. In Italy, the Branca family of Sicily and Gaspare Tagliacozzi (Bologna) became familiar with the techniques of Sushruta.

British physicians traveled to India to see rhinoplasty being performed by native methods. Reports on Indian rhinoplasty were published in the *Gentleman's Magazine* in 1794. Joseph Constantine Carpue spent 20 years in India studying local plastic surgery methods. Carpue was able to perform the first major surgery in the western world in 1815. Instruments described in the *Sushruta Samhita* were further modified in the Western World.

Current status



A typical ayurvedic Pharmacy, Rishikesh

Within India

In 1970, the Indian Medical Central Council Act which aims to standardize qualifications for ayurveda and provide accredited institutions for its study and research was passed by the Parliament of India. In India, over 100 colleges offer degrees in traditional ayurvedic medicine. The Indian government supports research and teaching in ayurveda through many channels at both the national and state levels, and helps institutionalize traditional medicine so that it can be studied in major towns and cities. The state-sponsored Central Council for Research in Ayurveda and Siddha (CCRAS) is the premier institution for promotion of traditional medicine in India. The studies conducted by this institution encompass clinical, drug, literary, and family welfare research. To fight biopiracy and unethical patents, the Government of India, in 2001, set up the Traditional Knowledge Digital Library as repository of 1200 formulations of various systems of Indian medicine, such as ayurveda, unani and siddha. The library also has 50 traditional ayurveda books digitized and available online.

Central Council of Indian Medicine (CCIM) a statutory body established in 1971, under Department of Ayurveda, Yoga and Naturopathy, Unani, Siddha and Homoeopathy (AYUSH), Ministry of Health and Family Welfare, Government of India, monitors higher education in ayurveda. The Bachelor of Ayurveda, Medicine and Surgery (BAMS) degree is the basic five-and-a-half year course of graduation. It includes eighteen different subjects comprising courses on anatomy with cadaver dissections, physiology, pharmacology, pathology, modern clinical medicine & clinical surgery, pediatrics, along with subjects on ayurveda like *Charaka Samhita*, history and evolution of ayurveda, identification and usage of herbs (*dravyaguna*), and ayurvedic philosophy in diagnostics and treatment.

Many clinics in urban and rural areas are run by professionals who qualify from these institutes. Mukherjee & Wahile cite World Health Organization statistics to demonstrate the popularity of traditional medicine as the primary system of health care.

Outside India

Academic institutions related to traditional medicine in India have contributed to ayurveda's international visibility. Kurup (2003) comments on the role of Gujarat Ayurved University:

Several international and national initiatives have been formed to legitimize the practice of ayurvedic medicine as CAM in countries outside India:

- WHO policy of traditional medicine practice
- The US National Center for Complementary and Alternative Medicine
- The National Institute of Ayurvedic Medicine
- The National Ayurvedic Medical Association
- The European Federation for Complementary and Alternative Medicine
- The European Ayurveda Association

In 2009, the United States of America National Center for Complementary and Alternative Medicine (NCCAM) of the National Institutes of Health expended \$1.2 million of its \$123 million annual budget on ayurvedic medicine-related research.

In Sri Lanka

- Institute of Indigenous Medicine affiliated to University of Colombo
- Gampaha Wickramarachchi Ayurveda Institute affiliated to University of Kelaniya
- Ayurveda Lanka Hospital Pvt Ltd.

Due to different laws and medical regulations in the rest of the world, the unregulated practice and commercialization of ayurvedic medicine has raised ethical and legal issues; in some cases, this damages the reputation of ayurvedic medicine outside India.

Journals

A variety of peer reviewed journals focus on the topic of ayurvedic medicine:

- Ancient Science of Life
- Theoretical and Experimental Journal of Ayurveda and Siddha
- Journal of Research & Education in Indian Medicine (*JREIM*),
- AYU
- The International Journal for Ayurveda Research

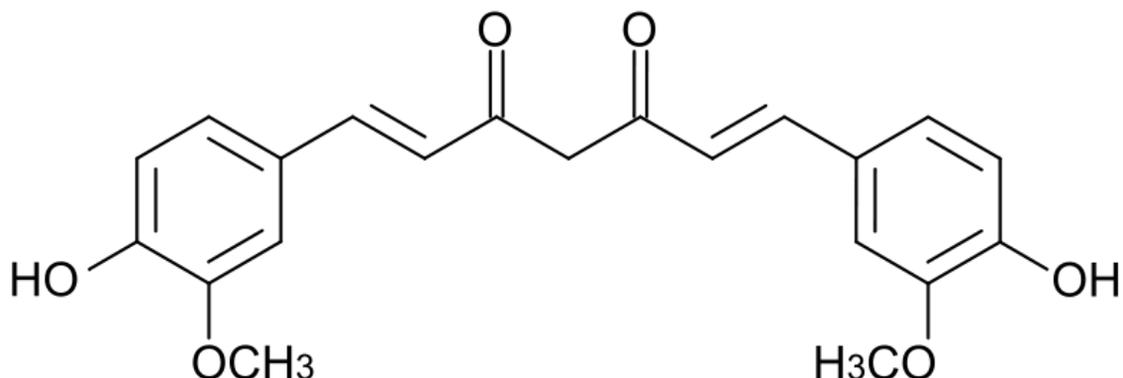
None of the journals except IJAR are PubMed indexed. The first subspeciality journal for the field of ayurvedic medicine was launched in July 2010. It's focus is rheumatology and it is titled the Journal of Clinical Rheumatology in Ayurveda.

Patents

In December 1993, the University of Mississippi Medical Center had a patent issued to them by United States Patent and Trademark Office on the use of turmeric for healing. The patent was contested by India's industrial research organization, Council for Scientific and Industrial Research (CSIR), on the grounds that traditional ayurvedic practitioners were already aware of the healing properties of the substance for centuries, and that this prior art made the patent a case of bio-piracy. The Government of India had become involved in promoting traditional medicine by 1997. R A Mashelkar, director-general of the Indian Council of Scientific and Industrial Research, made the following observation:

This is a significant development of far-reaching consequences for the protection of the traditional knowledge base in the public domain, which has been an emotional issue for not only the people of India but also for the other third world countries.

Scientific evidence



Chemical structure of curcumin used in ayurvedic medicine. Shown here in its ketone form.

As a traditional medicine, many ayurveda products have not been tested in rigorous scientific studies and clinical trials. In India, research in ayurveda is largely undertaken by the statutory body of the Central Government, the Central Council for Research in Ayurveda and Siddha (CCRAS), through a national network of research institutes. A systematic review of ayurveda treatments for rheumatoid arthritis concluded that there was insufficient evidence, as most of the trials were not done properly, and the one high-quality trial showed no benefits. A review of ayurveda and cardiovascular disease concluded that while the herbal evidence is not yet convincing, the spices are appropriate, some herbs are promising, and yoga is also a promising complementary treatment.

Some ayurvedic products, mainly herbs used for phytotherapy, have been tested with promising results. Studies suggest that Turmeric and its derivative curcumin are antioxidants. *Tinospora cordifolia* has been tested. Among the medhya *rasayanas* (intellect rejuvenation), two varieties of *Salvia* have been tested in small trials; one trial provided evidence that *Salvia lavandulifolia* (Spanish sage) may improve word recall in young adults, and another provided evidence that *Salvia officinalis* (Common sage) may improve symptoms in Alzheimer's patients. In some cases, ayurvedic medicine may provide clues to therapeutic compounds. For example, derivatives of snake venom have various therapeutic properties. Many plants used as *rasayana* (rejuvenation) medications are potent antioxidants. Neem appears to have beneficial pharmacological properties.

Mitra & Rangesh (2003) hold that cardamom and cinnamon stimulate digestive enzymes that break down polymeric macromolecules in the human body. Research suggests that *T. arjuna* is useful in alleviating the of angina pectoris and in treating heart failure and coronary artery disease. *T. arjuna* may also be useful in treating hypercholesterolemia.



Azadirachta indica—believed to have immunopotentiating abilities and used often as an anti-infective—has been found to enhance the production of IL-2 and increase immunity in human volunteers by boosting lymphocyte and T-cell count in three weeks.



Black pepper and long pepper are combined with ginger to form the traditional *trikatu* mixture in ayurveda. This mixture increases appetite, promotes the secretion of digestive juices, and cures certain gastric disorders, particularly achlorhydria and hypochlorhydria.

Safety

Rasa shastra, *the practice of adding metals, minerals or gems to herbs*, is a source of toxic heavy metals such as lead, mercury and arsenic. Adverse reactions to herbs due to their pharmacology are described in traditional ayurvedic texts, but ayurvedic practitioners are reluctant to admit that herbs could be toxic and the reliable information on herbal toxicity is not readily available.

A 2004 study found such toxic metals in 20% of ayurvedic preparations that were made in South Asia for sale around Boston and extrapolated the data to the United States more broadly. It concluded that excess consumption of these products could cause health risks. A 2008 study of more than 230 products found that approximately 20% of remedies (and 40% of *rasa shastra* medicines) purchased over the Internet from both US and Indian suppliers contained lead, mercury or arsenic.

Traditionally the toxicity of these materials are believed to be reduced through purification processes such as *samskaras* or *shodhanas* (for metals), which is similar to the Chinese *pao zhi*, although the ayurvedic technique is more complex and may involve prayers as well as physical pharmacy techniques. One medical journal reported:

Crude aconite is an extremely lethal substance, yet ayurveda looks upon it as a therapeutic entity. Crude aconite is always processed, i.e. it undergoes 'samskaras' before being utilised in the ayurvedic formulations. This study was undertaken in mice, to ascertain whether "processed" aconite is less toxic as compared to the crude or unprocessed one. It was seen that crude aconite was significantly toxic to mice (100% mortality at a dose of 2.6 mg/mouse) whereas the fully processed aconite was absolutely non-toxic (no mortality at a dose even 8 times as high as that of crude aconite). Further, all the steps in the processing were essential for complete detoxification.

Following concerns about metal toxicity, the Government of India ruled that ayurvedic products must specify their metallic content directly on the labels of the product. The harmful effects of the samples is attributed in part to the adulterated raw material and lack of workers trained in traditional medicine. In a letter to the Indian Academy of Sciences, director of the Interdisciplinary School of Health Sciences, University of Pune Patwardhan Bhushan stated that the metal adulteration is due to contamination and carelessness during the much faster modern manufacturing processes, and does not occur with traditional methods of preparation.