



Active Plant Principles and Applications in Plant Medicine

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Abstract

The active principles from the medicinal plants are what give the quality of the product. They determine its purgative, emollient, expectorant, choleric, carminative, antidiabetic, purgative, laxative, etc. characteristics, which we read about in the properties. The role of active principles can be played by a single substance or a complex of substances. They are rarely located throughout the plant and accumulate in different component parts. That is why, when the plant is harvested, it is important to document beforehand and what to use from it so that we benefit from the maximum accumulated active substances. The classification of active principles from medicinal and aromatic plants is based on the following criteria: chemical nature, physico-chemical properties, biological action. The most important groups of active principles are: glucides, pectins, mucilages and gums, fatty oils, volatile oils, resins, organic acids, glycosides, saponins, astringents, bitter principles, vitamins, alkaloids, vegetable dyes, antibiotics and phytoncides, substances minerals. We have detailed them below because they help us make the connections between the constituent substances and their properties. The classification of active principles from medicinal and aromatic plants is based on the following criteria: chemical nature, physico-chemical properties, biological action. The most important groups of active principles are: glucides, pectins, mucilages and gums, fatty oils, volatile oils, resins, organic acids, glycosides, saponins, astringents, bitter principles, vitamins, alkaloids, vegetable dyes, antibiotics and phytoncides, substances minerals. We have detailed them below because they help us make the connections between the constituent substances and their properties.

Keywords: Active Principles; Biological Action; Therapeutic Quality; Phytotherapy; Therapeutic Actions; Human Health

Introduction

For a plant to be considered medicinal, it must contain certain chemical substances developed by it, which give therapeutic quality to the respective product. These are called active substances. And although medicinal plants (MPs) have been used for thousands of years to improve human health, only recently have these active elements, which underlie the origin of the therapeutic actions of plants, been isolated and studied. We must not forget that, although modern medicine has recently made obvious progress, Phytotherapy offers multiple advantages; Let's remember that at all times, except for the last 60-100 years, people only had MPs at hand to care for themselves, and today, herbal treatment has returned to the fore, because the effectiveness of chemical drugs, such as anti-

otics - considered as a universal solution for all serious infections - has decreased because bacteria and viruses have gradually adapted to these antibiotics and are increasingly resistant to them [1].

The Active Principles

Glucides

Glucides are a class of ternary products, made up of the chemical elements Carbon, Hydrogen and Oxygen - very widespread in nature and of particular biological importance; they are formed in the process of photosynthesis and undergo numerous transformations and degradations in the living plant organism. They are also known as glucides and have a content in the plant body of approx.

50% dry matter. Glucides are divided into two large groups: ose and polyuronides. Oses are solid, colorless, crystallized substances with a sweet taste: xylose, galactose, glucose, etc. Polyuronides in turn are composed of:

1. Pectins - are substances that weld cells in the tissue complex and have a hemostatic action - they increase the speed of blood coagulation and are used in hemoptysis, gastric treatments, ulcers, diarrhea.
2. Mucilages - are another component of polyuronides - which have the quality to swell (swell) in contact with water or cellular fluid - which causes them to line the digestive or pulmonary mucous membranes and have an emollient and analeptic action, stimulating the system at the level of the centers: cardiac, muscular and respiratory, so they have a protective action.
3. Gums - represent the third element of polyuronides, composed of hybrid mixtures of some polymers in which the molecules of the beads vary in the respective gums depending on the polymerization. They are topical and emollient and maintain water on the surface of the skin, being therefore used in the treatment of dermatological conditions.

In recent decades, the immunomodulatory qualities of several plants have been more clearly defined, that is, they intervene in the regulation of immune processes, precisely because of their content in polyuronides - heavy polymers - that is, substances from the group of carbohydrate-based active principles. Among the main MPs, the following products are based on the active principle of polyuronides: *Plantaginis folium* - (plantain leaves), medicinal product derived from leaves harvested from three species of *Plantago* - namely: *Plantago lanceolata*, *Plantago media* and *Plantago major*. *Verbasci flos* - what represents the flowers (corolla only) of the candlestick species: *Verbascum thapsus*, *Verbascum thapsiforme*, *Verbascum speciosum*, *Verbascum phlomoides*. The leaves of *Verbascum* species also contain bitter active principles. The primary role of glucides in the human body is energy. They provide more than half of the energy needed by the human body in 24 hours, and at the same time have a plastic role, entering into the composition of cells and tissues. The need for glucides is 4-5 g/kg - body - in 24 hours [2].

Heterosides

Heterosides are a group of substances of vegetable nature that, through hydrolysis, set free one or more oses and a non-carbohydrate part called aglycone. The aglycon is the specific part of the combination and can have a very varied structure. According to the chemical nature of the aglycone, heterosides are divided into several subgroups: aliphatic, seneval, cyanogenetic, glycoalkaloids, anthracenosides, cardiotonic heterosides, saponosides, flavonoids and heterosides of unknown structure. Glycosides of salicylic acid derivatives are found in poplar species - namely in bark, buds, and leaves, so: *Populus cortex*, *Populus gemma* and *Populus folium* - the poplar species that have this therapeutic quality are: *Populus nigra*, *Populus tremula* and *Populus pyramidalis*. Also, heterosides are also found in willow species: *Salix alba*, *Salix caprea*, *Salix fragilis*, *Salix*

purpurea, as well as in other lesser known and less used willow species - over 20 willow species have been described - including *Salix babylonica* and *Salix viminalis*. Methyl salicylate glycosides are very widespread in nature - also found in the leaves of oak species, the best known of which is *Quercus robur*. The best-known glycoside is monotroposide. In the case of poplar species, it is called populoside, and of willow species it is called salicoside. Thanks to these active principles, the vegetable product is endowed with astringent properties and thanks to the phenols they have an antiseptic action, and the flavones give the diuretic property to populi gemma [3].

Lignan compounds

Lignans - represent phenylpropane condensation compounds that exist in macromolecular form and enter the intimate structure of the cell membrane, along with cellulose and pectins. In the form of simpler molecules, they can be constituents of cellular juice, and therefore valuable active principles. They are formed in the cambial tissue, starting from coniferyl alcohol. For some time now, the use of lignan compounds in the therapeutic sphere has been discussed, highlighting the immunomodulatory action, as a strengthening of the immune system in humans. In the human body, lignin has the ability to absorb bile acids and degradation products. Lignin, celluloses and hemicelluloses are part of food fibers that have the property of absorbing water, and in addition of "binding" various harmful substances that are then eliminated through feces. As active principles, lignan compounds are particularly found in Burdock, *Arctium lappa* and its vegetable product *Bardane radix* (burdock root), but also in the other species of burdock - *Arctium tomentosum*, *Arctium minus* and *Arctium majus*. In their leaves and a lignin called arctioside. This product existing in burdock species has properties: diuretic, sudorific, hypoglycemic, stimulating hepatobiliary functions and antitumor [4].

Flavonoids

Flavonoids are present in many substances and have anti-inflammatory properties that ensure good peripheral blood circulation (like vitamin P or "permeability factor"). Flavonoids represent a group of natural substances, of plant origin, derivatives of benzopyr, having a phenyl radical and are part of the colored pigments in flowers and fruits. They are very widespread substances in nature, and to date more than 500 natural flavonoids have been identified, in various families and plant species, and their number is constantly increasing. Depending on the degree of oxidation, flavonoids are subdivided into several series of compounds: flavones and anthocyanins. Flavonoids increase the resistance of blood capillary walls, preventing hemorrhages. Some flavonoids possess antibiotics and even antiviral properties. Also, by weakening the action of histamine, it protects the human body against the harmful action of radiation. The most important plants from the forest area, spontaneous, which base their phytotherapeutic action on flavonoids are:

1. *Rosae petalum* (*Rosae flos*) - petals or flowers of various species of wild rose or rose hip, which are used as an astringent or antiseptic due to the presence of tannins, but also anthocyanins.

2. *Crataegi folium, flos, fructus* - leaves, flowers and fruits of hawthorn from the following species: *Crataegus monogyna* and *Crataegus laevigata* (syn. *C. oxyantha*). The main pharmacodynamic action of *Crataegus* preparations is that of a cardiac and nervous sedative, followed by the vasodilatory action on the coronary arteries and, finally, the hypotensive action.

Basically, it is assumed that the pharmacodynamic action of the plant product from this species does not boil down to a single active principle, but an association of several - considered a phytocomplex. By *Sambuci flos* we mean the elder flowers of the *Sambucus nigra* shrub. It is about the inflorescences, without the peduncles (green), harvested from the elder when 75% of them are open, their gathering is done on sunny days and after the dew has lifted. At the same time, elderflowers also contain cyanogenetic glucides as an active principle. These substances, under certain conditions, elaborate hydrocyanic acid, one of the most powerful poisons that exist in the vegetable kingdom. The cyanogenetic glycosides of the elder species are called sambunigrasides and, although this has no therapeutic importance, it is of great toxicological interest because products containing such substances can become toxic to the human body by ingestion. Elderflowers also contain active, immunomodulatory principles, as recently claimed. Flavones, as an active principle, are also present in the flowering aerial part of the species *Polygonum aviculare*, and the active plant product, in scientific language, *Polygoni avicularis herba*. Its pharmacodynamic properties are astringent and hemorrhagic. *Hyperici herba* - a herbaceous species *Hypericum perforatum*, St. John's wort, St. John's wort, also contains flavonoids, the most important of which is called rutoside, and burdock root, *Arctium lappa*, as well as the other "sister" species contain flavonoids, arctein [5].

Tannins

Tannins are substances of vegetable nature that do not contain nitrogen in their molecule and belong to the class of polyphenones. They are amorphous products (in general), soluble in water and have the property of forming impermeable and putrefactive compounds with proteins. Tannins are very widespread substances in the plant kingdom and all plants produce tannins to a greater or lesser degree. They give a bitter taste to the bark of trees and leaves and make them unfit for consumption by insects or animals, being therefore a means of defense of the plant against external aggressions.

Therapeutically, tannins are used as astringent, hemostatic, antidiarrheal. Among polyphenol-carboxylic acids, the most widespread constituent in the composition of tannins is gallic acid. Due to their properties to precipitate with protein substances, tannins are strongly astringent, acting in the gastrointestinal tract as an antidiarrheal, but be careful in large doses, tannins have the opposite effect - laxative or emetic. Plant products containing tannins as active principles are *Quercus cortex*, oak bark, mainly from *Quercus robur* and *Quercus sessiliflora* (syn. *Q. petraea*), but also other *Quercus* species. At the same time, acorns, under the name of *Quercus semen*, containing tannin and starch, are used as ground, in the form of flour, in children's diarrhea. *Salicis cortex* are the barks that

are harvested from various willow species and that base their action on active principles and tannins. These species, as a rule, are *Salix alba*, *S. caprea*, *S. fragilis*, *S. purpurea* and still other species of *Salix*, less used. *Salix alba*, the best-known species of willow, contains up to 10% tannin, especially of a Gallic nature. Tannins give willow bark its tonic and astringent, anti-inflammatory and antipyretic properties. *Thymi vulgaris herba*, so the aerial part of the garden thyme, *Thymus vulgaris*, bases a number of its phytotherapeutic properties also on tannins, due to its content in thymol, a phenol. It gives it antiseptic, soothing, diuretic, choleric and anthelmintic actions. In some specialized works it is mentioned to know the active principles in plants with their properties, because we can be wrong if we judge them separately. Thus, the case of the Chinese tea *Camellia sinensis* which contains the same proportions of caffeine as coffee, *Coffea arabica*, but the tea has more tannin in its composition, which gives this drink its astringent and acidic taste, which prevents the blood from taking in less caffeine. This fact demonstrates one of the fundamental truths of phytotherapy, namely that the value of a medicinal plant cannot be reduced to the list of active principles it contains and that the practitioner's experience is the surest guide to know the therapeutic effect of whole MPs. *Hyperici herba* represents the aerial part, the flowering seeds of St. John's wort, *Hypericum perforatum*, contains between 13 and 17% tannins in the dry plant product [6].

Anthraquinones - Anthraderivatives

This group of active principles represents the glycosides of the phenolic derivatives of anthrax. From a therapeutic point of view, only the 1- and 8-oxylated derivatives of anthraquinone and its reduction products are important. The general action of these active principles is laxative and purgative, depending on the dose. They have an irritating and laxative effect on the large intestine, causing a contraction of its walls and stimulating its action to evacuate its contents 10 hours after taking the dose. They thus transform the stools into more liquid ones, facilitating their evacuation, which makes them used in constipation. Since anthraderivatives have a congestive action on the pelvic organs, they are not administered to the elderly, small children, pregnant women and those who are breastfeeding in order not to create accidents. Anthraquinones are passed on to the mother's milk and then to the baby who eats them, which can lead to diarrhea or other unwanted effects. Regarding the toxicity of anthraquinones, too few studies have been undertaken to draw a definitive conclusion. Among the plants that grow here, the most well-known that has anthraquinones as its active principle is the *St. John's wort*, *Hypericum perforatum*, namely, its aerial part, called *Hyperici herba* in phytotherapy. The main component is hypericin, which has a reddish-purple color, but does not have a laxative-purgative effect. The recognized properties of St. John's wort plant extracts, in literature, are antidepressant, antispasmodic, stimulation of bile secretions, astringent, sedative, pain reliever, cicatrizing. Anthraquinones also include a number of well-known plants that grow in our country or abroad, which contain active principles from this group, namely: buckthorn bark (dogwood or patachin), the fruits of verdigris, stevia and aloe [7].

Coumarins and Derivatives

Coumarins are natural derivatives of benzopyran, which gives them a lactonic structure and, as a result of this characteristic structure, they differ from each other by the type and number of substituents grafted onto the basic nucleus. An increasing number of coumarins have been found, following research undertaken in the last thousand years, starting from algae, mushrooms, lichens and higher plants from the families *Leguminosae*, *Umbelliferae*, *Labiatae*, etc. In some plants, such as *Daphne odorata*, coumarins reach up to 20% of their content. Coumarins are odorous substances, with a specific, aromatic smell of fresh hay. All coumarins show UV (ultraviolet) absorption spectra, characterized by a band in the 320 nm wavelength region. The actions of coumarins are variable: inhibitors of seed germination or plant growth, but in small amounts, they can stimulate plant growth. Through assiduous research, coumarins have marked the emergence of a new class of sun tanning drugs following the phenomenon of hyperpigmentation. But with the intensification of research in the field of coumarins, their hepatotoxic and even cancerous effect was also established. Large cattle on the prairies of Canada and North America, eating red clover stored in improper conditions, have been observed to experience excessive or even fatal bleeding after injury or surgery. This condition was due to the toxic degradation of coumarins in red clover, which developed an anticoagulant action. This led to a new class of anticoagulant drugs, particularly valuable in current therapeutics. But these coumarin anticoagulants are not without inconveniences, especially in pregnant women where they can cause thromboembolic complications. Other natural compounds with a coumarinic structure show an antibiotic-type antimicrobial action, but in very low doses, they exert the skin photosensitizing property, sometimes even phototoxic. However, furano-coumarinic derivatives have been used in the preparation of cosmetics, used in the summer, for the purpose of tanning the skin. In reality, they do not protect the skin against radiation, but stimulate the formation of pigments. However, most coumarins have, after a long exposure to the sun, a skin-carcinogenic action, which is why furano-coumarins are prohibited by law for cosmetic purposes. Instead, they were widely used as a food flavoring, but this process was also prohibited, in order to obtain aromatic wines. However, coumarins remain one of the main flavorings of fine tobaccos. The best-known plants containing furano-coumarins with the property of sensitizing human skin are the extracts whose phytocomplex contains psoralen, namely, *Achillea millefolium* (mousetail), *Hypericum perforatum* (*St. John's wort*), as well as chamomile and hawthorn, but also others spontaneous plants [8].

Saponins or Saponosides

Saponins are a group of natural substances of vegetable origin, in glycosidic form, whose aqueous solutions, by stirring, produce an abundant and persistent foam and have the property of hemolyzing erythrocytes. Since other substances that foam in the presence of water are known, in order to be grouped in the class of saponosides, they must, first of all, be plant substances, have a sterol (or triterpenic) structure and, at the same time, fulfill the three conditions: to be heterozygous; to foam; and to hemolyze the erythrocytes. This implies that a suspension of red blood cells treated with an herbal

decoction containing saponosides should become transparent, clear and red, and not deposit a red sediment of red blood cells on rest. Some works even divide saponoids into two classes:

1. Triterpenoids are strongly expectorant, but can, at the same time, facilitate the absorption of nutrients. Steroids that are similar to natural human steroid hormones and act like human hormones.
2. The pharmacodynamic action depends on the type of saponin, the dose and the route of administration (oral or otherwise) as follows: In small doses, saponides are used therapeutically, as expectorants, administered orally or in large doses, however, they can produce toxic phenomena; They also produce increased diuresis and sweating; Intravenous administration of saponides causes death, and in sublethal doses, ingestion of saponins produces: salivation, vomiting, sneezing, bleeding gums, diarrhea, loss of appetite, paralysis. In pharmaceutical technology, saponides are used as emulsifying agents, and in the textile industry, as washing agents. In the food industry, saponides are used to obtain sparkling drinks, pastry creams, halva and halva, and in cosmetics, for the preparation of toothpastes, creams and foaming sprays. Among the MPs, the saponide group includes *Calendula flos*, the marigold flowers (*Calendula officinalis*) which, in treatments, impress the patient with emmenagogue, choleric, cicatrizing, anti-inflammatory and hypoglycemic action - attributed to the saponosidic fraction of the marigold flowers. Another product with triterpenoid saponosides that has positive attributes in the expectorant action is the vegetable product *Verbasci flos* - the flowers of the "candlestick" species: *Verbascum thapsus*, *Verbascum thapsiforme*, *Verbascum speciosum* and *Verbascum phlomoides*. Only the petals of the flowers are collected from these for phytotherapeutic use, but let's not forget the plants that gave the name to the metabolite group itself - *Saponaria officinalis* [9].

Volatile (essential) oils

Volatile oils extracted from plants (essences) by distillation are considered among the most important active principles. These are complex mixtures of aliphatic aromatic and hydroaromatic hydrocarbons, aldehydes, alcohols, esters and other constituents in which, in general, compounds of the terpenoid class predominate. Formerly called essences, and by foreign literature essential oils, they are liquids with a characteristic, aromatic, pleasant smell, which can be drawn with water vapor, in their pure state irritating and flammable. Volatile oils have been known since antiquity (5th century BC), and they have occupied an important place in the history of human civilization.

In general, plants containing volatile oils are said to be aromatic, but they must be present in a concentration of 0.1-0.2%, have a perceptible odor and lend themselves to economically profitable exploitation. The location of the formation of volatile oils is very different: in the oil cells, in the intracellular space, in the glandular brushes, etc. The combinations found in the composition of volatile oils are only mono and sesquiterpenes (the latter having 15 carbon atoms in the molecule). Volatile oils are liquid substances (after ex-

traction), very volatile with an aromatic, pleasant smell, flammable substances, sometimes with an irritating smell, although aromatic, and a burning taste. The pharmacodynamic action of volatile oils is very different from one plant species to another, but in general they are: irritant, vesicant, antiseptic and toxic - in their pure state producing deep damage to the internal organs - if ingested. At the same time, they also have a high capacity for percutaneous penetration through the skin when incorporated into shampoos or bath emulsions. They also have a bactericidal action - a fact that can be explained by the use of fatty oils soaked with plant essences for anointing the body after bathing, hence the use of deodorants, which have taken on a great extension, as well as perfumes. Recently, some volatile oils have been shown to have antitumor activity, and others have insecticidal properties. Therefore, volatile oils are used in the production of medicinal products, as aromatizers and taste correctors in cosmetics and perfumery, in the maintenance of public premises (fir oil), in the varnish and paint industry, in tooth and hair care - and with a preventive role or curative in dermatology. Here are some examples of plants whose active principles are also based on volatile oils. From the group of products that contain volatile oils that have the structure of monoterpenes, we mention isma leaves - *Mentha piperita*. The active principle from *Mentha piperita* leaves - the volatile oil - can reach up to 2% in the dry product, or 0.2 - 0.4% in fresh leaves where menthol is in the percentage of 35 - 55%, and menthone between 10 and 40%. The main actions of volatile mint oils are antiemetic action, producing slight anesthesia of the gastric mucosa, stimulates biliary and liver function and has antifermentative, disinfectant action [10].

Bicyclic monoterpenes. The *Rosmarini folium* or in other words: *Folia Anthos* which are the leaves of *Rosmarinus officinalis* - an ornamental cultivated plant known in several varieties and forms. In this vegetable product, in the fresh plant the volatile oil content reaches 0.22 - 1.20%, while in the dried and conditioned leaves, up to 2%, and in the flowers - 1.44%. Its actions are stimulating blood circulation, general stimulant, stimulates bile secretion, cicatrizing, geriatric action, combats senescence processes.

Acylic monoterpenes. The *Melissa officinalis* belongs to this group - the nightshade, the beehive herb, whose volatile oil is extracted from the leaves - *Melissa folium*, and which has a sedative, stomachic action. Plants with volatile oils that contain sesquiterpene substances *Chamomile* belongs to this group - under the scientific name of *Chamomille flos*, which bases some of its therapeutic properties precisely on the volatile oil contained in the flowers. A good chamomile essential oil should contain at least 1% camazulene. Camazulene is a sesquiterpene, cyclic, unsaturated hydrocarbon that is formed during distillation. It is endowed with the properties: anti-inflammatory, anti-allergic and stimulating in tissue repair. Another specific product of this group consists of the floral somites of the *Achillea millefolium* plant - the mouse's tail, under the name *Millefolium flos*, in which the volatile oil is in a percentage of 0.1 - 0.5%.

Under the supervision of the doctor, the volatile oil of the mouse tail is administered as: digestive, aperitif, in flatulence, cramps and gastric pains of nervous women, in hemorrhoids, as hepato-biliary,

intestinal hemostatic, anal, vesical and nasal. It stimulates circulation and is a sedative regulator of menstrual disorders. However, it is contraindicated for pregnant women as it can cause dizziness and headaches. The *Candle species* also contain volatile oils - in the petals: *Verbascum species*, black poplar buds - *Populus gemma*, and many other plants that contain volatile oils in a significant amount and whose properties interfere and combine with the other principles specific - or basic - actives such as in walnut leaves, hawthorn flowers, elderberry, wort, nettle, garlic and many others that you can discover in specialist textbooks if you want to enrich your personal knowledge [11].

Concluding Remarks and Future Perspectives

The information in this manuscript is not a medical manual, but only an information guide, containing data of a general nature and not specific to a particular individual and the particular circumstances in which you find yourself. Therefore, the information does not attempt to replace any treatment given by a doctor. You should know that certain parts of the plant, which you may ingest or use medicinally or cosmetically, internally or externally may cause allergic manifestations or active unpleasant reactions in certain people.

Authors' contributions

Conceptualization, D.R.A.; R.S. and M.B.; data curation, D.R.A.; and M.B.; writing-original draft preparation, D.R.A.; M.B.; writing-review and editing, D.R.A. R.S. and M.B.; visualization, M.B.; supervision, R.S. and M.B. All authors have read and agreed to the published version of the manuscript.

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Conflicts of Interest

No conflict of interest.

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