**Medicinal plants. Medicinal plant materials.**

Medicinal plants (*Plantae medicinales)* are plants containing pharmacologically or biological active substances, t.i. with therapeutic effect. However it should be noted that the division of plants into medicinal and non-medicinal is conditional. Because the plant without biologically active substance does not exist. Since the chemical composition and medicinal properties of many plants are not explored scientifically, they are not included into the list of medicinal plants.

All known medicinal plants are conditionally divided into 2 groups: official and unofficial.

The plants permitted for applying with the medical purpose  by authorized bodies (by the state pharmacological committee or expert council) of the corresponding countries, are called officinal ones. (form lat. Officina – drug store). That is, an official document-instruction is produced for the use of plant materials and medications, and doctors have the right to write a prescription. Official medicinal plants are included into the State Pharmacopoeia, Governmental Standards, Registry and oth. official documents.

Medicinal plants used in traditional medicine of Azerbaijan and other countries are unofficial plants. Only official medicinal plants are studied in pharmacognosy.

Medicinal plant materials are whole medicinal plants or their parts used as a medication or for its production, which chemical composition remains unchanged, i.e. preserved the biologically active substances. Medicinal materials include dried roots, rhizomes, rhizomes with roots, bulb, bark, flower, bud, semen, fruits, stigmas, all aerial parts of herbaceous plants. Therefore, with a purpose of medical application of plants are used only those their parts which contain the maximum amount of active substances. The presence and amount of active substances, determining the basic therapeutic effects of plants, aren’t usually great and they are different in various organs. For example, large amount of active substances are accumulated in leaves of foxglove, foalfoot, mint, sage, nettle, datura, henbane and oth., in roots of marshmallow, rauwolfia, aralia, ginseng, licorice and oth., in rhizomes of shield- fern, nenuphar, iris and oth., in rhizomes with roots of juniper, burnet, madder, rhodiola and oth., in rhizomes with roots of valeriana, dioscorea, echinacea, adenostyles and oth., in flowers of chamomile, mayflower, artemisia cina, calendula, immortelle, in semends of flax, mustard, castor-oil plant and oth., in bark of alder buchthorn, oak, cinchona, in fruits of juniper, common buckthorn, rowanberry, blueberry, dog-rose and oth., in herb of milfoil, leonurus, celandine, thyme, oregano and oth. That’s why the particular parts are used as a medicinal plant material. All parts of lady’s purse, dandelion and oth. are collected and used as material. For example, black currant, sea buckthorn, fruits of strawberry, aloe, kalanchoe, leaf of cabbage, pip of colchicum and oth.

Medicinal materials of animal origin are whole animals, their parts or waste products, permitted for use by the Ministry of Health. For example, snake venom, royal jelly, leech, sponges, spain bugs and oth. Medicinal material of mineral origin includes Naftalan oil, shilajit.

Products of primary processing of medicinal plant material are essential oil, resin, gums, fixed oil; the primary products of animal origin are snake and bee venom, fats, wax, lanolin, spermaceti and oth.

Medicinal plants are divided into three groups according to the degree of exploration and practical use: effective, perspective and potential. Effective plants include the species used as official medicinal plants. Perspective plants are the species which can bed used in medicine for scientific purposes. Their use is limited due to the incompleteness of pharmacological tests, imperfect technology, the lack of a developed technological process and for other reasons. Potential plants are the species with particular pronounced pharmacological effect in experiments, but failed in clinical trials. It is necessary to conduct additional research for their use.

Some of the most commonly used terms in pharmaceutical practice is presented below.

Biologically active substances affect the biological processes in human and animal organisms.

Active or pharmacologically active constituents are biologically active substances responsible for the therapeutic activity of the medicinal plant material. They can change the condition and functions of organism or have preventive, diagnostic or therapeutic action and used as substances in the production of drugs.

Concomitant substances are the products of primary or secondary exchange contained in MP together  with the active substances. They can have positive or negative effects on living organism, impact on extractivity, pharmacodynamic and pharmacokinetic of active constituents.

**Classification systems of medicinal plants**

Classification of medicinal plant material is one of the main problems. At the present time, when very large databases of medicinal plant materials are created, classification issues have become important. It should be noted that various types of classification of medicinal plant materials have been used for many years. The classic method of medicinal plant material classification is the "commodity" method. Under this approach, the objects were grouped both by the plant organs used (roots, rhizomes, flowers, etc.), and products obtained from plants (gum, tar, essential oils, etc). Therefore, they were grouped in all textbooks of pharmacognosy of the XIX and XX centuries and in I Russian Pharmacopoeia.

The placement of materials based on Latin or other alphabets has also been used and used in various sources (European Pharmacopoa I-III, V, 1969-1975, Encyclopedia of common natural ingredients used in food, drugs and cosmetics). In addition, the systematic principle of supplying the material in accordance with any botanical system is used. The basis of this principle is the characteristic features in the morphological structure of plants. The most popular systems in Europe were the systems of A.Decondoll and A.Engler in the late 19th – early 20th century. In the middle of XX century the systems of J. Hutchinson, R. Wettstein, and others were used (Fluckiger F.A., Hanbury D. Pharmacographia, London, 1879; Trease G., Evans W. Pharmacognosy, 10 th edn, London, 1972).

Pharmacological classification "of medicinal plant materials is commonly used. According to this classification, the major emphasis is on the features of medicinal plant materials used for the treatment and prevention of various diseases. (Pratt R., Yongken H. Pharmacognosy, 2nd edn, Philadelphia, 1956). The disadvantage of this classification is the multiple pharmacological actions of most plants is not taken into account. Finally, the "chemical classification" of medicinal plants, where the plants are classified according to the most important biologically active substances contained in them. According to this principle, there are materials in many textbooks of pharmacognosy. (Tschirch A. Handbuch der Pharmakognosie, Lepzig, 1933; J. Bruneton Pharmacognosy (Phytochemistry, Medicinal plants) 2nd edn, Paris, 1999, Trease G., Evans W. Pharmacognosy, 14th edn, London, 2000; Qammerman A.F. Pharmacognosy, M., 1967; Muravyeva D.А. Samilina I.A., Yakovlev Q.P. Pharmacognosy, M., 2002).

It should be noted that the "chemical" classification of medicinal plant materials is more accurate. Thus, contemporary there are many facts that prove the close relationship between the chemical composition and pharmacological action. The presence of "chromophore groups" in medicinal plant materials determines the directions of pharmacological action. From this point of view, the classification of medicinal plant materials on the basis of biologically active substances is commonly used in modern pharmacognosy.

**In pharmacognosy, drugs may be classified** according to (1) their morphology, (2) taxonomy of plants from which they are obtained, (3) pharmacological application and (4) chemical constituents.

[**Morphological classification**](http://www.pharmacognosy.org.ua/index.files/Page6437.htm)

If a person is expected to identify specific drugs and to ascertain their adulterants, a morphological classification is applicable. In this system, the drugs are grouped according to the part of the plant represented, such as roots, rhizomes, leaves, bulbs, fruits, flowers, corms, seeds etc.

In the examination of root drugs (Radices) occurence, size, shape, colour, surface markings, fracture, internal appearance, odour and taste are first taken into consideration (e.g. Althea, Rheum, Gycyrrhiza, Rhodiola). Characters of examination of rhizomes (Rhizomata) include occurence, size, shape, direction of growth, external colour, surface markings (including stem and leaf bases and scars), fracture, internal appearance, odour and taste (Acorus calamus).

The study of bark (Cortex) characters should consist of occurence, nature of the outer and inner surfaces, fracture, internal appearance, odour and taste (Rhamnus frangula, Quercus spp., Viburnum opulus).

In the study of the characteristics of leaves and leaflets (Folia) it is important to note the general outline, apex, base, margin, nature of petiole if present, length and breadth of lamina, surfaces, texture, colour of surfaces and venation, trichomes or glands, odour and taste. The major microscopic structures to be observed in leaves are as follows: type of stomata, outline of epidermal cells, character of trichomes, type of crystals (calcium oxalate aggregates in Polygonaceae, raphides in Liliaceae s.l.). In the study of flowers (Flores), the characters of the peduncle, receptacle, calyx and bracts, corolla, stamens, pistil and pollen grains should be considered  (Helichrysum arenaria, Calendula officinalis, Chamomilla recutita).

Important characters in identification of fruits (Fructus) include type or kind, occurrence, shape, external markings and colour, internal appearance including presence or absence of dissepiments, number of cells, and character of seed, odour and taste (Anisum vulgare, Coriandrum sativum, Foeniculum vulgare, Anethum

graveolens).

[**Botanical (taxonomic) classification**](http://www.pharmacognosy.org.ua/index.files/Page6447.htm)

Consideration of the natural relationship, or phylogeny, among plants gives rise to taxonomic classification.  A large number of plant families have certain distinguishing characters, that permit drugs from these families to be studied at one time; thus, drugs consisting of cremocarp fruits (*Anisum vulgare, Foeniculum vulgare, Carum carvi*) are considered with other members of *Apiaceae*, drugs, obtained from plants having alternate leaves, cymose flowers, and fruits that are capsules or berries (*Atropa belladonna, Hyoscyamus niger, Datura stramonium*) are considered with *Solanaceae.*

This type of arrangement is sometimes called the botanic arrangement for plant drugs.

Plants possessing square stems, opposite leaves, and bilabiate flowers, diacytic stomata, their stems and leaves characterized by the presence of glandular hairs, yielding volatile oil, consisting of a short one-celled stalk and a head of one to eight cells (*Mentha piperita, Thymus spp., Origanum vulgare, Salvia officinalis*) are considered with ***Lamiaceae***. Major active principles of other *Lamiaceae* may include flavonoids (*Leonurus cardiaca*) and saponins (*Orthosiphon stamineus*).

*Asteraceae* are represented by annual or perennial herbs; inflorescence is a head, milky juice (inulin) occurs in laticiferous vessels. Plants of the family as major active substances yield volatile oil (*Chamomilla recutita*), inulin in underground portions (*Inula helenium, Taraxacum officinale*), mucilages (*Tussilago farfara*), carotenoids (*Calendula officinalis*), flavonoids (*Centaurea cyanus*), alkaloids (*Senecio platyphylloides).*

*Apiaceae.*Mostly herbs, with fistular (hollow at internodes, solid at nodes), often ridged stems. Leaves compound, leaf base ensheates the stem. Inflorescence is a compound umbel. Fruit is a dry, splitting fruit, or cremocarp. Schizogenous oleoresin canals occur in the mesocarp, calcium oxalate in rosette aggregates and solitary crystals. Plants yielding volatile oil usually exhibit spasmolytic action (*Foeniculum vulgare, Carum carvi*).  *Ammi visnaga*, *Pastinaca sativa*and *Anethum graveolens* contain coumarins and chromones (spasmolytic, photosynthesizing agents). Alkaloid containing herb *Conium maculatum* is extremely poisonous.

*Polygonaceae.* Usually herbs, leaves mostly whorled, stipulated. Stipules fused and forming a greenish, tubular upgrowth, which sheathes the stem. Inflorescence is racemose or spicoid. Calcium oxalate mostly in numerous rosette aggregates. Plants yield mostly phenolic compounds: tannins (*Polygonum bistorta*), flavonoids (other *Polygonum spp.),*anthraquinones (*Rumex confertus, Rheum palmatum*).

*Solanaceae.*Mostly herbs, leaves simple, flowers 5 merous. Fruit is a capsule (*Hyoscyamus niger*), or a berry. Most produce poisonous alkaloids, and some are commercially important in this connection (*Atropa belladonna, Hyoscyamus niger, Datura stramonium, Nicotiana tabacum*). *Capsicum annuum* yields capsainoides, *Solanum laciniatum* contains steroids. Products include potato (*Solanum spp*.), and tomato (*Lycopersicon*), other edible fruits from Capsicum (sweet and chilli peppers). Calcium oxalate occurs in the form of rosette aggregates, solitary crystals, and crystal sand.

***Fabaceae*** (formerly *Leguminosae*). Trees and shrubs, or herbs. Leaves compound (pinnate or palmate). Flowers in racemes or in heads. The form of corolla is characteristic of leguminous plants: the upper and largest, the standard (vexillum), stands erect, the lateral pair, the wings or alae, are long-clawed, while the anterior pair cohere to form the keel or carina, in which are enclosed the stamens and pistil. Fruit a dehiscentlegume. Plants contain gums (Astragalus spp.), saponins (Glycyrrhiza glabra, Astragalus spp., Trigonella foenum-graecum), anthraquinones (Senna spp.), flavonoids (Sophora japonica, Robinia pseudoacacia), fixed oils (*Arachishypogaea*), alkaloids (*Thermopsis lanceolata,* *Physostigma venenosum*). Hystological characters include fragments of vascular bundles with a crystal sheath of prismatic crystals of calcium oxalate (*Folia Sennae, Radices Glycyrrhizae*); simple hairs, bent to the leaf surface and surrounded at the base by the rosette of polygonal epidermal cells showing paracytic stomata; cluster crystals occur in parenchyma.

***Papaveraceae.*** Mostly herbs, which leaves with coarsely dentate margins. Plants yieldalkaloids of isochinoline structure (*Papaver somniferum, Macleya cordata, Glaucium flavum, Cheledonium majus).* Almost all parts of the plants contain a white milky juice, or latex, in laticiferous vessels.

***Liliaceae s.l.***Leaves simple, linear to ovate, venation parallel. Many of the plants contain raphides of calcium oxalate. Plants yield cardiac glycosides (*Convallaria majalis*), alkaloids (*Colchicum autumnale, Veratrum spp.)*

***Apocynaceae.***Trees or shrubs, or rarely lianas or herbs; mostly tropical species. Leaves simple, opposite or verticillate, rarely alternate. Flowers actinomorphic, perianth is 5-merous. Fruit - two follicles or drupes. Seeds frequently with a tuft of silky hairs at one end. Reserpine, an alkaloid of *Rauwolfia spp*., and *Vinca minor*are important hypotensive agents. Alkaloids of *Vinca rosea* are potent anticancer drugs. Cardiac glycoside strophantidine, found in *Strophanthus spp*., is widely used in cardiac insufficiency treatment.

***Brassicaceae*** (formerly *Cruciferae*). Mostly herbs, leaves radical, in a rosette, flowers 4-merous, and the fruit are capsule (silique) that bursts lengthwise by two valves. The stomatal anisocytic (the pair of guard cells is surrounded by three neighbouring cells, one of which is smaller, than the other two). Hairs are unicellular, stellate. The plants yield vitamin K (*Capsella bursa pastoris*), thioglycosides (*Brassica spp*.), cardenolides (*Erysimum canescens*).

[**Pharmacologic or Therapeutic classification**](http://www.pharmacognosy.org.ua/index.files/Page6445.htm)

Inasmuch as drugs are employed medicinally because of their therapeutic effects, a third method of study is the pharmacologic, or therapeutic, classification. All of the cathartic drugs are associated with this classification, regardless of morphology and taxonomy. Thus Senna spp., Rhamnus cathartica and oil of Ricinus communis are considered at one time because of their action on the intestinal tract. Similarly, Digitalis spp., Strophanthus spp., Convallaria majalis are grouped together because they affect cardiac muscle, due to the content of cardenolides.

                 CNS tonics are alkaloids (ephedrine, strychnine, coffeine), saponin-yielding drugs (Panax ginseng, Eleutherococcus senticosus, Aralia manshurica), phenolic compounds of Rhodiola rosea and Schizandra chinensis.

                 Sedative drugs include alkaloids of Papaver somniferum and Passiflora incarnata, volatile oils of Valeriana officinalis, Mentha piperita, Humulus lupulus, Melissa officinalis; flavonoids of Leonurus spp., Crataegus spp.

                 Tropane alkaloids (leaf extract of Atropa belladonnae, oil oinment of Hyoscyamus niger) and pepper tincture possess pain-relief action.

Spasmolytic drugs consist of platyphylline, an alkaloid of Senecio spp., papaverine, Solanaceous tropane alkaloids; coumarins and chromones of Ammi majus, Anethum graveolens, Visnaga daucoides, Pastinaca sativa.

P-vitaminic remedies rutin and quercitin, found in large quantities in Sophora japonica, Aronia melanocarpa, Citrus spp., Fagopyrum sagittatum, and aescin of Aesculus hippocastanum are prescribed as venotonic agents. The latter is active in vessel thrombosis.

Anti-sclerotic action of plant is caused by both phytoncides and volatile oil content (Allium spp., Arnica montana), steroidal saponins of Dioscorea spp. and Tribulus terrestris, polysaccharides of seaweeds.

Hypotonic activity occur in Rauwolfia spp., due to the content of alkaloid reserpine, Vinca minor,  flavonoid-yielding MPM (Aronia melanocarpa, Astragalus dasyanthus, Crataegus spp., Leonurus spp.).

Drugs, prescribed for the upper respiratory tract disorders, include anti-inflamatory (volatile oils of Folia Eucalypti, Folia Salviae, Flores Chamomillae recutitae0), expectorant (volatile oils of Herba Thymi, Herba Origani, Fructus Anisi, Herba Ledi palustris, Gemma Pini, Rhizomata et radices Inulae; saponins of Radices Glycyrrhizae, Rhizomata et radices Polemonii; mucilages of Radices Altheae, Folia Plantaginis majoris, Folia Farfarae), anti-cough (alkaloid codeine, Glaucium flavum, Thermopsis lanceolata), breath stimulators (citisine, lobeline, coffeine, camphor) and antiasthmatic MPM (Folia Daturae stramonii, Folia Hyoscyami).

Bitters stimulate gastric secrection (Herba Arthemisiae absinthii, Herba Millefolii, Herba Centaurii, Radices Taraxaci, Rhizomata Calami, Folia Menyanthidis). Anti-ulcer, anti-inflammatory and emmolient for gastrointestinal tract are polysaccharide-containing MPM (Linum usitatissimum, Succus Plantaginis), Vitamin U in Brassica spp. juice; wound-healing carotenoids in Calendula officinalis, Oleum Hippophae, Oleum Rosae, Herba Gnaphalii; volatile oils in Flores Chamomillae, Rhizomata Calami, Herba Millefolii). Cholagogue (stimulate bile secrection) MPM comprise Flores Helichrysi arenarii, Flores Tanaceti, Herba Bidentis, Flores Centaureae cyani (flavonoids), Radices Taraxaci and Radices Cichorii (inulin), alkaloid berberine of Berberis vulgaris, alkaloids of Chelidonium majus. Fruits of Apiaceae (Foeniculum vulgare, Carum carvi) exhibit carminative action. Anthraquinones cause laxative, or cathartic, action (Rheum spp., Rumex confertus, Senna spp., Rhamnus cathartica). Tannin-yielding MPM possess astrigent properties (Quercus spp., Alnus spp.). Hepatoprotective drugs include flavonolignans of Silybum marianum, flavonoids of Helichrysum arenaria, Arnica montana, Convallaria majalis. Arbutin containing plants (urinary antiseptic) are Arctostaphyllos uva ursi, Vaccinium vitis-idaea, Bergenia crassifolia, Vaccinium myrtillus. Diuretic MPM comprise Folia Orthosiphonis staminei, Herba Equiseti arvensis, Herba Astragali dasyanthi (saponins), Fructus Juniperi, Gemmae Betulae, Folia Betulae, Herba Ledi palustis (volatile oils). Herba Equiseti arvensis and alizarine-yielding Rhizomata et radices Rubiae tinctorii exhibit lytolytic activity (dissolve kidney stones).

Anti-diabetic drugs comprise Fructus et Folia Myrtylli (simple phenols), Pericarpium Phaseoli, Radices Araliae mandshuricae (saponins), Fructus Rosae, Folia Urticae (vitamins), Flores Tiliae (polysaccharides, flavonoids), Radices Taraxaci, Radices Arctii (inulin). Potentilla alba, Genista tinctoria, Fragaria vesca, Laminaria saccharina, containing large quantities of iodine, are used in goiter.

The most important anti-cancer (oncolytic) drugs include alkaloids of Catharanthus roseus vinblastine and vincristine, Chelidonium majus, Colchicum autumnale. Carotenoids containing MPM (Extractum Fructus Rosae, Oleum Hippohae, Urtica dioica); tannins, Filipendula hexapetala, epicarp extract of Punica granatum thought to be active anti-tumour agents.

Immunostimulatory action is exhibited by Echinacea spp., extract of Herba Bidentis, corn flowers, above-ground parts of Inula helenium, leaves of Ribes nigrum, flavonoid quercitin (increases non-specific infection resistance) and interferon-modulatory MPM Rhizomata Bergenia crassifolia. Major constituents of Zdrenko’s herbal collection are Allium sativum, Rubia tinctoria, Aloe arborescens, Senecio spp.

Pectins of apples and Citrus spp., vitamin P – yielding MPM, Fructus Rosae possess radioprotective properties. Succus Plantaginis is prescribed in radiation leucopenia.

[**Chemical classification**](http://www.pharmacognosy.org.ua/index.files/Page6429.htm)

Because the activity and therapetic use of drugs are based on chemical constituents, it would appear that a chemical classification is the preferred method of study. Certain plant families exhibit definite types of chemical principles; e.g. mydriatic alkaloids (atropine, scopolamine) characterize Solanaceae, volatile oils represent Apiaceae, and oleoresins are abounding in Pinaceae. Expanding knowledge of the chemical constituents of plants has revealed the existence of a close relationship between these chemicals and the taxonomic position of the plants themselves.

**Medicinal products** are substances or their mixtures of natural, synthetic, or biotechnological nature, used for prophylaxis, diagnosis and treatment of human diseases, or intended to change the physiological state and functions of the organism.

Medicinal products include active constituents (substances); preparations; homeopathic preparations; medications against parasitic infections, therapeutic cosmetics, biologically active food additives.

Pharmaceutical drug is a drug in  appropriate dosage form.

Phytopreparation – a drug of plant origin in appropriate dosage form.

Galenic formulations are preparations of plant origin included tincture or extract.

Novo-galenic formulations are phyto-preparations containing a mixture of biologically active substances that are free from inert and concomitant ingredients.

Tinctures are medicinal formulations in the form of alcoholic and aqueous/alcoholic extracts of medicinal plant materials produced without heating or removal of the extractant. Extracts are concentrated extractions from medicinal plant material. They are divided into liquid and solid extracts according to consistency. There is no more 25% water content. The dry extract  has a water content of not more than 5%. The following solvents are used for the preparation of extracts: water, alcohol, diethyl ether, fixed oils and oth.

Medical species are mixtures of several kinds of crushed or integral plant materials . Sometimes with the impurity of mineral salts, essential oil and oth. The infusions and decoctions of medical species are prepared at home.

Infusions and decoctions are aqueous extractions from medicinal plant material, which are different in infusion time. Infusions are heated in a boiling water bath for 15 minute and cooled for 5 minute, decoctions are heated for 30 minutes and cooled for 10 minute. In most cases infusions are prepared from the delicate parts of flowers, leaves and herbs, from solid parts: bark, fruits, semens, leather leaves and underground organs- root, rhizome and oth.) –decoctions.  Infusions and decoctions are extemporal pharmaceutical preparations.

**Chemical composition (structure) and pharmacological activity of medicinal plants**

The major characteristic feature of phytopreparations and many preparations of natural origin is a complex interaction of their chemical components between themselves and in patient’s organism. It’s known that set of biologically active substances in medicinal plant does not always allow to predict with absolute certainty the integral clinique effect. Flavonoids Так, флавоноиды (flavonoids, neoflavonoids, bioflavonoids, isoflavonoids) have various therapeutic effects: radioprotective, antioxidant, coronary vasodilating, cholagogue, antitoxic, diuretic, hiponitrogenic, antineoplastic and oth. In the combination of flavonoids in one plant or medical species it is difficult to predict the therapeutic effect.

The main therapeutic effect of medicinal plant material can be different in its intensity according to extracted component. For example, peppermint contain a volatile oil, in which about 60% of menthol, tannins, amares, saponins, a significant amount of flavonoids and oth. are included.

The main effect of mint and its essential oil is cholagogue and choleretic, however menthol in pure form is less effective than the equivalent amount of mint leaves. Menthol is mainly local anaesthetic. A relatively small choleretic effect of menthol is associated with spasmolysis the sphincters of biliary system. A strong choleretic effect of peppermint is associated with the presence of other biologically active substances: flavonoids, bitters and oth. Lingonberry leaf contains about 90% glycoside arbutin, organic acids, flavonoids and oth. The plant is mainly used for the treatment of kidney and bladder diseases. At the same time ascorbic acid, glucose, tannins, carotenes, organic acids and oth. are dominated in lingonberry fruits. That’s why these berries are used in the treatment of gout, rheumatism, atherosclerosis as a vitamin, astringent, diuretic in medicine.

Common licorice root contains about 23% glycoside glycyrrhizin, flavonoids and other organic substances. Glycyrrhizin stimulates the activity of the ciliary epithelium in the trachea and bronchi, stimulates the secretion and used in the treatment of upper respiratory tract infections. In addition, root extracts containing the flavonoid compounds (for example, liquiritoside) have antispasmodic action and they are used in the treatment of gastrointestinal diseases.   Anti-inflammatory action of licorice root is associated with glycyrrhizic acid and it is reflected in the reduction of reactions caused by histamine, serotonin, bradykinin. However, glycyrrhizic acid is not localized in aerial part of plants, but detected tannins, saponins, flavonoids have not therapeutic effect, inherent in plant root. That’s why this part of plant is not practically used in medicine.

Dried berries of black currant and its infusion, extract or syrup have three significant therapeutic actions: astringent, antiseptic, antidiarrheal and used in the treatment of enteritis, colitis. This is due to the presence of pectins, tannins, antocians, catechins, organic acids and oth.organic substances in berries. Fresh berries has a completely different aciton – laxative, especially by consumption with milk and sugar. This effect is most likely associated with sugars (about 9,4%), organic acids (about 7%)- citric, apple, amber, quinic and other organic acids.

Interaction of organism and medicinal plants or their biologically active substances is characterized by the fact that the clinic effect is different in the usage of medicinal plants than their separate prescription.

The therapeutic effect of the combination of medicinal plants is not an algebraic sum of the effects of each component. Due to some of them they can have multidirectional action or mutual potentiation. For example, the sedative action is significantly enhanced in the combination of peppermint and lemon balm. It is associated with **potentiation** of this effect by the components of melissa essential oil - citral, citronellal, geraniol and other substances. This property of medicinal plants was observed by joint use of matricaria chamomilla, calendula officinalis, achillea millefolium. Anti-inflammatory, anti-spasmodic and healing effects are enhanced. It is caused by the fact that anti-inflammatory action is associated by azulene and chamazulene of chamomilla, flavonoids of calendula, essential oils of milfoil; anti-spasmodic effect is associated with apigenin and apenin of chamomilla, essential oils of calendula and milfoil; healing effect – azulene and proazulene of chamomilla, vitamins and other substances of milfoil.

Herb of Melilotus officinalis contains the significant quantity of dicoumarol which prevents the blood from coagulating. Despite the possibility of provoking bleeding, the plant is widely used with certain specific dosage and in traditional medicine, empirical dosage and limited course of application. At present time it is known that the amount of dicoumarol is increased dramatically in plant only during long-term and improper storage.

The reaction of organism on biologically active substances contained in medicinal plants or their combination or the complex of biologically active substances extracted from plants is associated with their pharmacological properties and the features of organism. In that regard the following options of final therapeutic effect are possible:

1. Potentiating therapeutic effect of main ingredient due to the availability of structural analogues and metabolic inhibitor or elimination of active substance and levelling antagonistic expression of individual biologically active substances.

2. Reduction therapeutic effect of main ingredient due to the presence of componnts, which enhance its metyabolism; negative reaction on mechanism of action or conjugate systems;

 3. Multidirectional reaction due to the stimulation of conjugate functional systems.

4. The appearance of synergistic-antagonistic, as well as "paradoxical" reactions in comparison with the expected effect, taking into account the properties of the constituents.

In order for the biologically active substances reach its site of action, they have to penetrate a number of biological membranes. All existing types of the transport of substances through the biological membranes can be divided into two groups: 1) Passive transport: simple diffusion, filtration; 2) specialized transport: active transport and pinocytosis.

In passive transport, the transfer occurs in accordance with the concentration gradient on both sides of the membrane. Specialized (active) transport is carried out by special carrier. After the completion of transport of substances the concentration of active substance in plasma begin to decrease due to the elimination (metabolism and excretion).

These mechanisms of some biologically active substances are established and fairly well studied.   Pharmacokinetics of the biologically active substances of many plants is not yet established. It is known that the main part of biologically active substances of medicinal plants is absorbed in proximal part of small intestine that’s why the time of onset and intensity of the therapeutic effect depend on the evacuation rate of gastric contents. In addition, the decrease of coumarin, cardiac glycosides, salicylate activity can be occur by ph increasing of gastric content (alkalization). Contact time of medicine with intestinal mucosa followed by the changes of amount of absorbed medicinal ingredients is increased or reduced by the increasing or slowing the transmission rate. For example, the medicinal plants – M-cholinolytics (belladonna, hyoscyamus niger and oth.) and stimulating the intestinal peristalsis (alder buckthorn, common buckthorn, senna and oth.) can significantly impact on the rate of absorption of the biologically active substances.

Absorption of most medicinal substances depends on the enzyme’s activity and transport systems of membranes of intestine epithelium. For example, the mucilage extracted from flax seed covers the mucus membrane of small intestine and can reduce the absorption of other phytopreparations. On the other side, some components of medicinal plants are able to cause the cellular damage of intestinal mucus, and this prevents the penetration of biologically active substances through the intestinal epithelial barriers. Active ingredients entering the bloodstream are connected with blood proteins: albumin, lipoproteins, *а1*-glycoproteids, у-globulins. Time of onset and duration of the therapeutic effect depend on the degree of binding and subsequent release. Significant differences of the rate of onset and duration of strophanthin and digitoxin effect greatly depend on the fact that the strophanthin is weakly connected with plasm proteins (2%), but the most part of digitoxin (more than 90%) forms the complex with albumins and as a result the action of medicine is slowed down. If one component is better connected with protein than other component in the complex of biologically active substances then the pharmacological activity will be changed. This is also applied to excretion of chemical compounds. If one component is quickly excreted the medication is effective. For example, it is established, that the therapeutic effect of flavonoid compounds (glycyrrhiza glabra, glycyrrhiza uralensis, calendula officinalis and oth.) is caused by chemical structure of basic substances and their metabolic products. The substances obtained in metabolism have different activity which correlates with activity of basic substances. The biologically active substances of medicinal plants are transported by blood round the humna body after the absorption. Their distribution can be greatly modified by the condition of hemodynamics. For example, blood flow to liver and kidneys are reduced in cardiac insufficiency and it can cause the excessive accumulation of medication in organism or significantly change its activity, for example, saluretic.

Maximum effect of two or more components of certain pharmacological and plant combination in organism might not coincide. It depends on different factors, including the extent of solubility of components in water or fats, motor function, the resoption rate and oth. . Therefore, the absolute time synchronization of the maximum effect of chemically heterogeneous biologically active substances, such as alkaloids, coumarins, flavonoids, essential oils, enzymes, vitamins, bitterness, etc., is not achievable.

Generally, the influence of individual components of the complex of biologically active substances on resoption, transport, metabolism, excretion of other components in varying degrees are observed. For example, unsaturated fatty acids (linoleic, linolenic, arachidonic) contain the large number of double bonds and they are not synthesized in organism. It is necessary to introduce them into diet as indispensable components of food. If the butter contains 4%, then sunflower oil – 56%, olive oil – 15%, cottonseed oil – 50%, sesame oil – 49%. The action of unsaturated fatty acids in organism might be significantly enhanced during the add of medicinal plants containing vitamin C (various species of dog-rose) and vitamin E (schisandra chinensis, black chokeberry). The main biologically active substances necessarily combine with contaminant substances: pectins, starch, organic acids, mucilages, colors, inorganic salts, micro- and macroelements and oth. Contaminant substances can impact on pharmacokinetics of main biologically active substances. A classic example is saponins in aqueous extract of foxglove, which enhance and accelerate the resoption of the cardiac glycosides by accelerating of action. Colloidal substances in papaver somniferum which extend the effects of alkaloids, are soluble or swelling polysaccharides, tannins contribute to prolongation of therapeutic effect of biologically active substances. In addition, it is known, saponins enhance the absorption of biologically active substances in the intestien wall, and as a result they enhance its effect. A more typical example of physical-chemical interaction of biologically active substances is ability of activated carbon to adsorb chemical, biologically active substances on its surface various and the use of immiscible fluids – oil and water and diluted alcohol in one dosage form. The example of physical-chemical incompatibility may be as a result of the feculence formation ( infusion of thermopsis herb in combination with liquor amrnonii anisatus; infusion in combination with extracts or tinctures).

If biologically active substances are lypophyll they become water-soluble during biotransformation and are excreted with the urine or bile. One of the most characteristic biotransformation indicators is biological half-life or terminal half-life  (hours or minutes). This indicator reflects the dissappearance time of half of introduced medication or the plasm concentraiton is declined two times. For example, it should be understood that enzymatic degradation of arbutin occurs in alkaline urine not acid.

Certainly, the elimination of each biological active substances in medicinal plant is different and is not always available to definition. That’s why there is a difference of therapeutic effect according to drug technology, its dosage form and dosage.. Rheum root has strong laxative effect due to antraqlycosides and the stimulation of colonic motility. However, the use of rheum in small doses as a astringent and antiseptic is associated with tannoglycosides. The experimental studies have shown that the phytoncides of allium sativum have antibacterial activity against pathogens of plague, cholera, tuberculosis and oth. in vitro. However in living organism they significantly lose the force due to their chemical instability. Pharmacodynamic properties of biologically active substances of medicinal plants are highly dependent on their chemical composition. For example, the alkaloids of papaver somniferum- morphine and papaverin is used in medical practice. They cause the toal pharmacological activity of plants but they also have own mechanism of action. Morphine is predominantly narcotic anagesic, papaverine has pronounced vasodilator and anti-spasmodic properties. It was noticeable that these alkaloids are localized in one plant, their interaction in certain conditions can be antagonistic. For example, the anti-spasmodic activity of papaverine is reduced under the influence of morphine. Pharmacological effect of omnopon and opium tincture obtained from papaver somniferum is significantly different from the pharmacological effect of morphine and papaverine.

**Medicinal plants as therapeutic agents**

Healing with medicinal plants is as old as mankind itself. The link between man and his quest for medicines in nature dates back to ancient times, when there were convincing proofs from written documents, monuments, and even original plant medicines [26]. Specifically, the oldest written evidence of usage of medicinal plants for preparation of drugs was found on a Sumerian clay slab from Nagpur, approximately 5000 years old. It comprised 12 recipes for drug preparation refer- ring to over 250 plants. Awareness of medicinal plants usage is a result of the many years of struggles against illnesses, which has prompted man to seek medicines in leaves, roots, barks, and other parts of plants. The knowledge of the development of ideas related to the usage of medicinal plants, as well as the evolution of awareness, has increased the ability of health providers to respond to the challenges that have emerged with the spreading of professional services in the enhancement of man’s life. Until the advent of iatrochemistry in sixteenth century, plants had been the source of treatment and prophylaxis for many diseases. This is well exemplified globally where medicinal plants have always being an integral part of the health care system since time immemorial.

During the last decades, it has become evident that there exists a plethora of plants with medicinal potential, and it is increasingly being accepted that medicinal plants are offering potential lead compounds in the drug discovery process. In fact, the developed world has also witnessed an ascending trend in the utilization of complementary or alternative medicine (CAM) particularly herbal remedies. While over 80% of the population in Sub-Saharan African countries like Nigeria and South Africa use herbal remedies for their primary health care, reports from developed countries such as Canada, Germany, and the US revealed that more than 70% of their populations have tried CAM at least once. The most common traditional medicine in common practice across the globe is the use of medicinal plants. In most of the countries, medicinal plants are the most easily accessible health resource available to the community. In addition, they are most often the preferred option for the patients. For most of these people, traditional healers offer information, counseling, and treatment to patients and their families in a personal manner, as well as having an understanding of their patient’s environment.

Indeed, modern allopathic medicine has its roots in traditional medicine, and it is likely that many important new remedies will be developed and commercialized in the future from plant biodiversity, as it has been till now, by following the leads provided by traditional knowledge and experiences. The extensive use of traditional medicine, composed mainly of medicinal plants, has been argued to be linked to cul- tural and economic reasons. This is why the WHO encourages member states to pro- mote and integrate traditional medical practices in their health system. While a good number of plants (with only selected representatives listed here) have elicited significant therapeutic and pharmacological effects against well-known debilitating and degenerating diseases

**Drugs (medicine) discovered from natural sources and development**

The development of new drug is a complex, time-consuming, and expensive process (**Figure 1**). The time taken from discovery of a new drug to its reaching the clinic is approximately 12 years, involving more than 1 billion US dollars of invest- ments in today’s context. Essentially, the new drug discovery involves the

**Figure 1.**



identification of new chemical entities (NCEs), having the required characteristic of drug ability and medicinal chemistry. These NCEs can be sourced either through chemical synthesis or through isolation from natural products. Initial success sto- ries in new drug discovery came from medicinal chemistry inventions, which led to the need of development of higher number of chemical libraries through combina- torial chemistry. This approach, however, was proven to be less effective in terms of overall success rate. The second source of NCEs for potential use as drug molecules has been the natural products. Before the advent of high throughput screening
and the post genomic era, more than 80% of drug substances were purely natural products or were inspired by the molecules derived from natural sources (including semisynthetic analogs). There are various examples of development of new drugs from the plant sources. Morphine was isolated from opium produced from cut seed pods of the poppy plant (*Papaver somniferum*) approximately 200 years ago. Pharmaceutical research expanded after the Second World War to include massive screening of microorganisms for new antibiotics, inspired by the discovery of penicillin. Few drugs developed from natural sources have undoubtedly revolutionized medicine like antibiotics (e.g., penicillin, tetracycline, erythromy- cin), antiparasitics (e.g., avermectin), antimalarials (e.g., quinine, artemisinin), lipid control agents (e.g., lovastatin and analogs), immune-suppressants for organ transplants (e.g., cyclosporine, rapamycins), and anticancer drugs (e.g., paclitaxel, irinotecan).

The WHO has estimated that the majority of the populations in Africa, Asia, and Latin America still use TM for their primary health care needs. In indus- trialized countries, plant-based TM or phytotherapeuticals are often termed complementary or alternative medicine (CAM), and their use has increased steadily over the last 10 years. In the USA alone, the total estimated “herbal” sale for 2005 was $4.4 billion, a significant increase from $2.5 billion in 1995 while also accounting for an estimated 1 billion Malaysia ringgit annually. However, such “botanical dietary supplements” are regulated as foods rather than drugs by the United States Food and Drug Administration (US FDA).

**5. Recent developments of plant-derived active compounds in drug development**

With the recent interest in molecular modeling, combinatorial chemistry, and other synthetic chemistry techniques by pharmaceutical companies and funding organizations, natural products, and particularly medicinal plants, remains an important source of new drugs, new drug leads, and NCEs. In both 2001 and 2002, approximately one quarter of the bestselling drugs worldwide were natural products or derived from natural products. Many plant-derived compounds have been used as drugs, either in their original or semisynthetic form. Recent develop- ments in drug discovery from plants, including information on approved drugs and plant extracts or compounds now in clinical trials, are available. It is antici- pated that in the future, plant-derived compounds will still be an essential aspect of the therapeutic array of medicines available to the physician.

**6. Importance of phytotherapy (for diseases control) within the global health care system**

Phyto (plants in the form of leaves, flowers and roots) therapy (treatment) has continued to reflect a great deal of significance in health care around the world
in curing diseases while also ensuring a good state of health and/or conditions is maintained. In fact, a significant proportion of the entire global populace had found solace in phytomedicine, embracing it as a major source for their health care system as maintained by WHO in one of their submissions; hence, presenting the impactor relevance of herbal therapy in this chapter cannot be out of context with regard to medicine or medicinal products emanating from these MPs such as *Papaver somniferum*, *Cinchona*, *Hibiscus sabdariffa*, *Rosmarinus officinalis*, *Nigella sativa*, *Artemisia afra*, *Vatica rassak*, etc., some (about 5000 out over 250,000) had either being developed (as drugs or vaccines) and commercialized (morphine, quinine, ephedrine, etc.) and many others in the final process of drug development for confirmation of safety and efficacy (clinical trials) against avalanches of illnesses including but not limited to hypertension, asthma, malaria, pain, hemorrhage, psychosis, cancer, migraine, etc. This makes herbal medicine to become
a basic health service to people of diverse culture irrespective of their status (poor or rich) and location (remote or urban), and this acceptance (in use either singly or combination with orthodox medicine) has continued to escalate in recent times, thereby complementing or reducing the use of modern medicine (despite its availability) probably due to inadequacies in providing holistic healing where behavioral, emotional, and/or spiritual factors are the underlying causes of the diseases. In view of the foregoing, continents such as Asia, Africa, and Latin America with countries such as China, India, etc., had embraced the adoption of the two systems (phytotherapy and modern medicine) for their national health care needs. Although issues of safety, efficacy, and quality of herbal medicines have undermined their integration into national health care policy in some countries, this had not prevented, in any big amount, the popular use by the citizenry. Interestingly too, because MPs are core sources for pharmaceutical manufacturing, they in addi- tion to herbal medicines play an important role in pharmaceutical market (PM). In fact, in a reported submission, in 1995, they occupied 33.1% of the total PMs.

**7. Shortcomings (if available) of phytomedicine to the conventional or modern medicine**

Globally, the high demand of use for herbal medicine for the treatment of illnesses is undisputable, and one begs to ask or wonder whether these products are actually of good quality, safe, and effective. There are assumptions and/or claims that despite general usage, few of them have been attributed to illnesses and fatali- ties as some of them have reported to cause liver and kidney damage. In fact, this was also attributed to why they have not been globally accepted as par with conventional medicine within the national health care policy of many countries. The reason for this was not far-fetched. A lot of people believed that many herbal formulations lacked safety evaluations such as clinical trials as to why they can-
not be placed in the same pedigree with modern medicine, but this was somehow disagreed by some researchers and/or policy makers who opined that clinical trials may be conducted only when large batches are intended. Additionally, in clinical practice, the failure to integrate phytotherapy as one of the courses or modules in medical school was seen in some quarters as the reason why it became somehow extremely difficult for medical practitioners to prescribe it, hence, the advantage convention medicine enjoys nowadays. Other problems include but not limited to storage conditions, inexplicit dosage, wrong labeling information, individualization of prescription with numerous active ingredients and other components, lack of information on the industrial use of MPs, little or no fact on the market benefit and business potentials, etc. It is worthy of mention that despite these limitations, phytotherapy had the potentials in salvaging numerous human diseases.

# Herbal Drugs: Their Collection, Preservation, and Preparation.

The WHOs’ criteria for good herbal drug preparation include the identity of source plant, optimum time of harvest, post-harvest handling, cooking utensils etc. Natural drug products may be obtained from the wild or through cultivation, fermentation, cell or organ culture, microbial transformation as well as biologics. Right source of drug plant and harvest time are important factors for maximizing the yield of the desired phytochemical content.

Collection schedule of different plant parts are different, e.g., roots and rhizomes at the end of the vegetation period, bark in the spring, leaves and herbs at bloom, flowers at anthesis or shortly after opening, and fruits and seeds after maturity or ripe. Hand collection is preferable for wild source. Post-harvest handling including garbling, washing, drying in air, oven drying, milling and re-milling, sieving, storage, labeling with the name of the plant, place and date of collection are important for standard herbal preparation. Collected plant material must be preserved to keep the active compounds unchanged during transport and storage.

**Collection of drugs:**

Medicinal plant materials should be collected during the appropriate season or time period to ensure the best possible quality of both source materials and finished products. It is well known that the quantitative concentration of biologically active constituents varies with the stage of plant growth and development.

This also applies to non-targeted toxic or poisonous indigenous plant ingredients. The best time for collection (quality peak season or time of day) should be determined according to the quality and quantity of biologically active constituents rather than the total vegetative yield of the targeted medicinal plant parts.

In general, the collected raw medicinal plant materials should not come into direct contact with the soil. If underground parts (such as the roots) are used, any adhering soil should be removed from the plants as soon as they are collected.

Collected material should be placed in clean baskets, mesh bags, other well aerated containers or drop cloths that are free from foreign matter, including plant remnants from previous collecting activities. After collection, the raw medicinal plant materials may be subjected to appropriate preliminary processing, including elimination of undesirable materials and contaminants, washing (to remove excess soil), sorting and cutting.

The collected medicinal plant materials should be protected from insects, rodents, birds and other pests, and from livestock and domestic animals. If the collection site is located some distance from processing facilities, it may be necessary to air or sun-dry the raw medicinal plant materials prior to transport.

If more than one medicinal plant part is to be collected, the different plant species or plant materials should be gathered separately and transported in separate containers. Cross-contamination should be avoided at all times.

Collecting implements, such as machetes, shears, saws and mechanical tools, should be kept clean and maintained in proper condition. Those parts that come into direct contact with the collected medicinal plant materials should be free from excess oil and other contamination.

**Time of collection:**

The period of growth or development at which medicinal activity is highest has been carefully determined for many plants. The proportion, of alkaloid in the leaves of Hyocyamus Niger and of belladonna is largest at the beginning of flowering, whilst with Stromonium the peak coincides with full bloom.

**Example:**

Stromonium leaves, gathered in the morning, contain a higher proportion of alkaloids than those collected in the evening.

**[](http://cdn.yourarticlelibrary.com/wp-content/uploads/2015/04/image65.png)**

**Harvesting:**

Medicinal plants should be harvested during the optimal season or time period to ensure the production of medicinal plant materials and finished herbal products of the best possible quality. The time of harvest depends on the plant part to be used. Detailed information concerning the appropriate timing of harvest is often available in national pharmacopoeias, published standards, official monographs and major reference books.

However, it is well known that the concentration of biologically active constituents varies with the stage of plant growth and development. This also applies to non-targeted toxic or poisonous indigenous plant ingredients.

The best time for harvest (quality peak season/time of day) should be determined according to the quality and quantity of biologically active constituents rather than the total vegetative yield of the targeted medicinal plant parts during harvest, care should be taken to ensure that no foreign matter, weeds or toxic plants are mixed with the harvested medicinal plant materials.

Medicinal plants should be harvested under the best possible conditions, avoiding dew, rain or exceptionally high humidity. If harvesting occurs in wet conditions, the harvested material should be transported immediately to an indoor drying facility to expedite drying so as to prevent any possible deleterious effects due to increased moisture levels, which promote microbial fermentation and mould.

Cutting devices, harvesters, and other machines should be kept clean and adjusted to reduce damage and contamination from soil and other materials. They should be stored in an uncontaminated, dry place or facility free from insects, rodents, birds and other pests, and inaccessible to livestock and domestic animals.

Contact with soil should be avoided to the extent possible so as to minimize the microbial load of harvested medicinal plant materials where necessary, large drop cloths, preferably made of clean muslin, may be used as an interface between the harvested plants and the soil.

If the underground parts (such as the roots) are used, any adhering soil should be removed from the medicinal plant materials as soon as they are harvested.

The harvested raw medicinal plant materials should be transported promptly in clean, dry conditions they may be placed in clean baskets, dry sacks, trailers, hoppers or other well-aerated containers and carried to a central point for transport to the processing facility.

All containers used at harvest should be kept clean and free from contamination by previously harvested medicinal plants and other foreign matter. If plastic containers are used, particular attention should be paid to any possible retention of moisture that could lead to the growth of mould.

When containers are not in use, they should be kept in dry conditions, in an area that is protected from insects, rodents, birds and other pests, and inaccessible to livestock and domestic animals. Any mechanical damage or compacting of the raw medicinal plant materials, as a consequence, for example, of overfilling or stacking of sacks or bags that may result in composting or otherwise diminish quality should be avoided. Decomposed medicinal plant materials should be identified and discarded during harvest, post-harvest inspections and processing, in order to avoid microbial contamination and loss of product quality.

**As per WHO Guidelines:**

1. Medicinal plants/herbal drugs should be harvested when they are at the best possible quality for the proposed use.

2. Damaged plants or parts plants need to be excluded.

3. Medicinal plants/herbal drugs should be harvested under the best possible conditions avoiding wet soil, dew, rain or exceptionally high air humidity. If harvesting occurs in wet conditions possible adverse effects on the medicinal plant/herbal drug due to increased moisture levels should be counteracted.

4. Cutting devices or harvesters must be adjusted such that contamination from soil particles is reduced to a minimum.

5. The harvested medicinal plant/herbal drug should not come into direct contact with the soil. It must be promptly collected and transported in dry, clean conditions.

6. During harvesting, care should be taken to ensure that no toxic weeds mix with harvested medicinal plants/herbal drugs.

7. All containers used during harvesting must be clean and free of contamination from previous harvests. When containers are not in use, they must be kept in dry conditions free of pests and inaccessible to mice/rodents, livestock and domestic animals.

8. Mechanical damage and compacting of the harvested medicinal plant/herbal drug that would result in undesirable quality changes must be avoided. In this respect, attention must be paid to

(a) overfilling of the sacks,

(b) Stacking up of sacks.

9. Freshly harvested medicinal plants/herbal drugs must be delivered as quickly as possible to the processing facility in order to prevent thermal degradation.

10. The harvested crop must be protected from pests, mice/rodents, livestock and domestic animals. Any pest control measures taken should be documented.

**Primary processing:**

Harvested or collected raw medicinal plant materials should be promptly unloaded and unpacked upon arrival at the processing facility. Prior to processing, the medicinal plant materials should be protected from rain, moisture and any other conditions that might cause deterioration. Medicinal plant materials should be exposed to direct sunlight only where there is a specific need for this mode of drying.

Medicinal plant materials that are to be used in the fresh state should be harvested/collected and delivered as quickly as possible to the processing facility in order to prevent microbial fermentation and thermal degradation.

The materials may be stored under refrigeration, in jars, in sandboxes, or using enzymatic and other appropriate conservation measures immediately following harvest/collection and during transit to the end-user. The use of preservatives should be avoided if used, they should conform to national and/or regional regulations for growers/collectors and end-users.

Medicinal plant materials that are to be employed fresh should be stored under refrigeration, in jars, in sandboxes, or using enzymatic or other appropriate conservation measures, and transported to the end-user in the most expeditious manner possible.

The use of preservatives should be avoided. If used, this should be documented and they should conform to national and/or regional regulatory requirements in both the source country and the end-user country.

All medicinal plant materials should be inspected during the primary-processing stages of production, and any substandard products or foreign matter should be eliminated mechanically or by hand.

For example, dried medicinal plant materials should be inspected, sieved or winnowed to remove discoloured, mouldy or damaged materials, as well as soil, stones and other foreign matter. Mechanical devices such as sieves should be regularly cleaned and maintained.

All processed medicinal plant materials should be protected from contamination and decomposition as well as from insects, rodents, birds and other pests, and from livestock and domestic animals.

**Drying:**

When medicinal plant materials are prepared for use in dry form, the moisture content of the material should be kept as low as possible in order to reduce damage from mould and other microbial infestation.

**Medicinal plants can be dried in a number of ways:**

1. In the open air (shaded from direct sunlight);

2. Placed in thin layers on drying frames, wire-screened rooms or buildings.

3. By direct sunlight, if appropriate.

4. In drying ovens/rooms and solar dryers.

5. By indirect fire; baking; lyophilization; microwave; or infrared devices.

6. Vacuum drying

7. Spray dryer: Examples: Papaya latex and pectin’s, etc.

When possible, temperature and humidity should be controlled to avoid damage to the active chemical constituents. The method and temperature used for drying may have a considerable impact on the quality of the resulting medicinal plant materials.

For example, shade drying is preferred to maintain or minimize loss of colour of leaves and flowers; and lower temperatures should be employed in the case of medicinal plant materials containing volatile substances. The drying conditions should be recorded. In the case of natural drying in the open air, medicinal plant materials should be spread out in thin layers on drying frames and stirred or turned frequently.

In order to secure adequate air circulation, the drying frames should be located at a sufficient height above the ground. Efforts should be made to achieve uniform drying of medicinal plant materials and so avoid mould formation.

Drying medicinal plant material directly on bare ground should be avoided. If a concrete or cement surface is used, medicinal plant materials should be laid on a tarpaulin or other appropriate cloth or sheeting. Insects, rodents, birds and other pests, and livestock and domestic animals should be kept away from drying sites.

For indoor drying, the duration of drying, drying temperature, humidity and other conditions should be determined on the basis of the plant part concerned (root, leaf, stem, bark, flower, etc.) and any volatile natural constituents, such as essential oils.

If possible, the source of heat for direct drying (fire) should be limited to butane, propane or natural gas, and temperatures should be kept below 60°C. If other sources of fire are used, contact between those materials, smoke and medicinal plant material should be avoided.

**Vacuum drying:**

This is conducted in steam- heated ovens with perfect closure, and a pump is used to exhaust the air. The low pressure maintained within the oven ensures rapid and complete drying.

**Example:**

Digitalis

**Advantages of vacuum drying:**

**(**i) Rapid drying.

(ii) Relatively low temperature.

(iii) Cleanliness and freedom from odour and dust.

(iv) Independence of climate conditions.

(v) Control of temperature.

(vi) Elimination, of risk of fire.

(vii) Compactness.

**Specific Processing:**

Some medicinal plant materials require specific processing to: improve the purity of the plant part being employed; reduce drying time; prevent damage from mould, other microorganisms and insects; detoxify indigenous toxic ingredients; and enhance therapeutic efficacy.

Common specific processing practices include pre ­selection, peeling the skins of roots and rhizomes, boiling in water, steaming, soaking, pickling, distillation, fumigation, roasting, natural fermentation, treatment with lime and chopping. Processing procedures involving the formation of certain shapes, bundling and special drying may also have an impact on the quality of the medicinal plant materials.

Antimicrobial treatments of medicinal plant materials (raw or processed) by various methods, including irradiation, must be declared and the materials must be labelled as required.

Only suitably trained staff using approved equipment should carry out such applications, and they should be conducted in accordance with standard operating procedures and national and/or regional regulations in both the grower/collector country and the end-user country. Maximum residue limits, as stipulated by national and/or regional authorities, should be respected.

**Storage:**

1. Storage facilities for medicinal material should be well aerated, dry and protected from light, and, when necessary, be supplied with air-conditioning and humidity control equipment as well as facilities to protect against rodents, insects and livestock.

2. The floor should be tidy, without cracks and easy to clean. Medicinal material should be stored on shelves which keep the material a sufficient distance from the walls; measures should be taken to prevent the occurrence of pest infestation, mould formation, rotting or loss of oil; and inspections should be carried out at regular intervals.

3. Continuous in-process quality control measures should be implemented to eliminate substandard materials, contaminants and foreign matter prior to and during the final stages of packaging. Processed medicinal plant materials should be packaged in clean, dry boxes, sacks, bags or other containers in accordance with standard operating procedures and national and/or regional regulations of the producer and the end-user countries.

4. Materials used for packaging should be non-polluting, clean, dry and in undamaged condition and should conform to the quality requirements for the medicinal plant materials concerned. Fragile medicinal plant materials should be packaged in rigid containers.

5. Dried medicinal plants/herbal drugs, including essential oils, should be stored in a dry, well-aerated building, in which daily temperature fluctuations are limited and good aeration is ensured

6. Fresh medicinal plant materials should be stored at appropriate low temperatures, ideally at 2-8°C; frozen products should be stored at less than -20°C.

7. Small quantity of crude drugs could be readily stored in air tight, moisture proof and light proof container such as tin, cans, covered metal tins or amber glass containers.

8. Wooden boxes and paper bags should not be used for storage of crude drugs.

**Herbal preparations** are made from herbal drugs, such as whole plant, plant parts, algae, fungi, lichen, exudates, in a crude state in dried or fresh form and extracts with the help of different processes such as infusion, decoction, maceration, distillation, expression, fractionation, purification, concentration, fermentation. These herbal preparations include whole plant or parts, comminuted or powdered herbal drugs, tinctures and extracts, fatty oils, essential oils, expressed juices and processed exudates of herbal materials. Herbal preparations are the basis for finished herbal products.

**Finished herbal products** are medicinal products containing exclusively herbal drugs (active substances) and herbal drug preparations. They also include preparations made by steeping or heating herbal materials in alcoholic beverages and/or honey, or in other materials and may consist of herbal preparations made from one herb or more herbs (mixed herbal product). They may contain excipients in addition to the active ingredients or may contain natural organic or inorganic active ingredients not of plant origin (e.g., animal materials and mineral materials). Finished products or mixed products to which chemically defined active substances have been added, including synthetic compounds and/or isolated constituents from herbal materials, are not considered to be herbal.

Herbal drugs are precisely defined by the botanical scientific name according to the binominal system. Herbal medicines include herbs, herbal materials, herbal preparations and finished herbal products. Storage of crude drugs in dry condition in airtight container placed in dry dark place is very important for stability and quality maintenance.

Grinding of crude drugs by hammer-, knife- or tooth mill to a powder of suitable particle size is carried out for isolation of a pure compound or for manufacture of a simple preparation. Cold grinding is preferable for crude drugs containing heat labile compounds. Sifting to ensure particle size (course—2.00 mm to fine—0.18 mm) can be performed following the principles of sieving and blast sifting.

Extracts are preparations of crude drugs containing all the constituents soluble in the extracting solvent. Extracts may be dry (when all solvent has been removed), soft or fluid (solvent prepared with mixtures of water and ethanol).

Tinctures are prepared by extraction of the crude drug with five to ten parts of ethanol of varying concentration without concentration of the final product. For both extracts and tinctures the ratio drug to solvent should always be stated. The criteria for ideal solvent for a certain pharmacologically active constituent include high selectivity for the compound to be extracted, high capacity for extraction in terms of coefficient of saturation of the compound in the medium, nonreactive with the extracted compound or with other compounds in the plant material, low price, harmless to man and to the environment, completely volatile. Aliphatic alcohols (up to 3C) or mixtures of the alcohols with water, are the solvents with the greatest extractive power for almost all natural substances of low molecular weight such as alkaloids, saponins, and flavonoids. Ethyl alcoholis used for obtaining tinctures and fluid, soft and dry extracts. The ethanol–water mixture induces swelling of the plant particles and increases the porosity of the cell walls and thus facilitates the diffusion of extracted substances. For extraction of barks, roots, woody parts and seeds the ideal alcohol: water ratio is about 7:3 or 8:2. For leaves or aerial green parts the ratio 1:1 is usually preferred in order to avoid extraction of chlorophyll.

Herbal internal preparations include infusions, decoctions, tinctures, macerations, percolation, digestion, inhalation of powdered plants, steam inhalation, aromatherapy, dry preparations etc. and washes, compresses, poultices, salves and balms are the main external preparations. Infusions are made with leaves and flowers, while decoctions are made with roots, bark, seeds, and berries. Infusion and decoction are preferred for water soluble chemicals (e.g., anti-inflammatory plant steroids) while tincture for alcohol soluble chemicals (anti-bacterial alkaloids). This may explain why a tea of the plant is used for arthritis while a tincture is traditionally used to treat various bacterial infections. Several problems influence the quality of herbal drugs.