MEDICINAL PLANTS RESOURCE SCIENCE

for 5th year students 22 Public health 226 «Pharmacy, industrial pharmacy», educational program «Pharmacy»

Фс15(5,0д)English 1-5 groups

13.04 - 17.04**– Topic: Development of recommendations on rational procurement of medicinal plants. The ways of medicinal raw material entry to the market**

**CLASS**

**Theoretical material**

**Aim**: give characteristic of the ways of medicinal raw material entry to the Ukrainian market; characterize the ways of medicinal plant material obtaining (cultivation, collection from the wild, cell cultures); choose correct way of the raw material entry to the Ukrainian market.

**Actuality**: The collection of medicinal plants from wild populations can give rise to additional concerns related to global, regional and/or local over-harvesting, and protection of endangered species. The impact of cultivation and collection on the environment and ecological processes, and the welfare of local communities should be considered. WHO has cooperated with other United Nations specialized agencies and international organizations in dealing with the above-mentioned issues.

***Theoretical part:***

There are three main ways of obtaining medicinal plant material – from cultivated plants, from plants growing in the wild and from cell cultures.

The World Health Organization has estimated that more than 80% of the world’s population in developing countries depends primarily on herbal medicine for basic healthcare needs. The use of herbal medicines in developed countries is also growing and 25% of the UK population takes herbal medicines regularly.

More than 400,000 metric tons of medicinal and aromatic plants are traded every year, and about 80 percent of these species are harvested from the wild. Almost 70,000 species are involved, many of them in danger of over-exploitation or extinction through over-harvesting and habitat loss. In India, for instance, 319 medicinal plants are listed as Threatened by IUCN-the World Conservation Union. Of more than 400 plants species used for production of medicine by the Indian herbal industry, fewer than 20 species are currently under cultivation in different parts of the country. In China, about 5,000 medicinal plants have been identified and about 1,000 are more commonly used, but only 100–250 species are cultivated. In Hungary, a country with a long tradition of medicinal and aromatic plants (MAP) cultivation, only 40 species are cultivated for commercial production. In Europe as a whole, only 130–140 MAP species are cultivated. There is growing concern about diminishing populations, loss of genetic diversity, local extinctions and habitat degradation. Well-known species threatened by wild harvesting include *Arctostaphylos uva-ursi* (bearberry), *Piper methysticum* (kava), and *Glycyrrhiza glabra* (liquorice).

The **International Standard for Sustainable Wild Collection of Medicinal and Aromatic Plants** (ISSC-MAP) has been prepared by the Medicinal Plant Specialist Group (MPSG) of the Species Survival Commission (SSC), IUCN – The International Conservation Union, on behalf of a Steering Group consisting of the MPSG, Bundesamt für Naturschutz (BfN), WWF Germany, and TRAFFIC. An international Advisory Group of more than 150 experts from diverse backgrounds has provided guidance in drafting the ISSC-MAP.

The ISSC-MAP bridges the gap between existing broad conservation guidelines and management plans developed for specific local conditions. Adopting the principles and applying the criteria that make up the ISSC-MAP will help private companies, government agencies, research centres, and communities to identify and follow good practices for the following six key elements of sustainable wild collection of MAP:

1. Maintaining wild MAP resources

2. Preventing negative environmental impacts

3. Complying with laws, regulations, and agreements

4. Respecting customary rights

5. Applying responsible management practices

6. Applying responsible business practices

The great majority of MAP species in trade are wild-collected. This trend is likely to continue over the long term due to numerous factors, including:

- Little is known about the growth and reproduction requirements of most MAP species, which are derived from many taxonomic groups for which there is little or no experience of cultivation.

- The time, research, and experience leading to domestication and cultivation are costly, and relatively few MAP species have the large and reliable markets required to support these inputs.

- In many communities where wild collection of MAP is an important source of income, land for cultivation of non-food crops is limited.

There are many challenges to meet in developing and applying a standard set of principles and good practices leading to support of sustainable wild collection of MAP resources. These challenges include:

* Circumstances of ecology, habitat, and pressures on resources are unique for each species, requiring management plans that are specific to each MAP collection operation and area.
* The dependence of local communities on MAP resources for health and livelihood security is largely unassessed and unrecorded.
* Little research on harvesting techniques has been directed toward understanding how to collect wild MAP species sustainably.
* Maximum quotas for wild-collection of MAP species are often based on overly simple and untested assumptions about the relationship between available supply and regeneration of MAP resources.
* Products, uses, and markets based on MAP species are numerous and diverse, with similarly numerous and diverse entry points for practices supporting sustainable use.
* There is a wide proliferation of labels and claims, such as organic and fair trade, which imply but do not provide a means of verifying sustainable wild collection.
* Long and complex source-to-market supply chains make tracing a product back to its source extremely difficult.

**Challenges of harvesting sustainably from the wild**

Sustainable harvest is increasingly seen to be the most important conservation strategy for most wild-harvested species and their habitats, given their current and potential contributions to local economies and their greater value to harvesters over the long term. The basic idea is that non-destructive harvests and local benefits will maintain population, species and ecosystem diversity. Besides poverty and the breakdown of traditional controls, the major challenges for sustainable wild-collection include: lack of knowledge about sustainable harvest rates and practices, undefined land use rights and lack of legislative and policy guidance.

*Lack of information on the wild resource*

“The most important ingredient required to achieve a truly sustainable form of resource use is information”. In reality, resource managers are always confronted with the lack of adequate information about the plants used, their distribution, the genetic diversity of wild populations and relatives and, above all, the annual sustained yield that can be harvested without damaging the populations. Research on the conservation and sustainable use of medicinal plants and their habitats has fallen far behind the demand for this globally important resource. Each species has unique ecological, socioeconomic, health and cultural associations that must be understood.

*Problems of open access*

In many cases, access to the resource is open to everybody, rather than a limited access or private ownership. To make a living, commercial medicinal-plant gatherers therefore ‘mine’ rather than manage these resources. Open-access schemes to harvestable plant populations prevent rational and cautious use and make it difficult to adhere to quotas and closed seasons.

*Lack of legislative and policy support for wild-harvesting schemes*

Information on trade in MAP is scarce and data are rarely collected or published at a national level. Much production and consumption is at subsistence level and as a consequence the economic importance of these activities is largely under-estimated in government decision making regarding rural development, natural-resource management planning and in government budget allocations. Therefore, national legislation and policies mostly fail to provide frameworks for a rational and sustainable use of wild resources.

Opportunities for governments to develop legislation to control and monitor harvest and trade of medicinal plant species and to consider conservation and sustainable use of medicinal plants as a priority in establishing protected areas have been greatly enhanced by two developments in international legislation: the addition of medicinal plant species to the Convention on International Trade of Endangered Species (CITES) and the entry into force of the CBD.

Controlled growth systems make it feasible to contemplate manipulation of phenotypic variation in the concentration of medicinally important compounds present at harvest. The aim is to increase potency, reduce toxin levels and increase uniformity and predictability of extracts. The target compounds are almost invariably secondary metabolites, which, for the plant, frequently serve as adaptations to ﬂuctuating temperature and light conditions (e.g. antioxidants), stress (e.g. proline), infection (e.g. ﬂavonoids) or herbivory (e.g. alkaloids). For example, Caucasian-grown *Atropa belladonna* has an alkaloid content of 1.3%, compared to 0.3% in plants grown in Sweden. Shade-grown *Mentha piperita* has a lower essential oil content (1.09% vs 1.43%) and lower menthol content within the oil (57.5% vs 61.8%) compared with light-grown *Mentha piperita*. Cool-grown *Papaver somniferum* (poppy) contains more morphine but has a lower alkaloid content than warm-grown *P. somniferum*. Secondary metabolite accumulation is similarly affected by water availability, exposure to soil microorganisms and variations in soil pH and nutrients.

Many medicinal plants, especially the aromatic herbs, are grown in home gardens, some are cultivated as field crops, either in sole cropping or in intercropping systems and rarely as plantation crops.

But why are so few species cultivated? Why are some species cultivated and so many others not? One explanation may be found in the observation that cultivated plants are sometimes considered qualitatively inferior when compared with wild-gathered specimens. For instance, wild ginseng roots are 5–10 times more valuable than roots produced by artificial propagation. The reason is primarily cultural, as the Chinese community, which is the largest consumer group of wild ginseng, believes that the similarity in appearance of gnarled wild roots to the human body symbolizes the vitality and potency of the root. Cultivated roots lack the characteristic shape of wild roots and are therefore not as highly coveted by consumers. Scientific studies partly support this. Medicinal properties in plants are mainly due to the presence of secondary metabolites which the plants need in their natural environments under particular conditions of stress and competition and which perhaps would not be expressed under monoculture conditions. Active-ingredient levels can be much lower in fast-growing cultivated stocks, whereas wild populations can be older due to slow growth rates and can have higher levels of active ingredients. While it can be presumed that cultivated plants are likely to be somewhat different in their properties from those gathered from their natural habitats it is also clear that certain values in plants can be deliberately enhanced under controlled conditions of cultivation.

In general, in all countries, the trend is towards a greater proportion of cultivated material. The majority of companies, the mass-market, over-the-counter pharmaceutical companies as well as the larger herb companies, prefer cultivated material, particularly since cultivated material can be certified ‘biodynamic’ or ‘organic’.

*Organic farming* is the form of agriculture that relies on techniques such as crop rotation, green manure, compost and biological pest control. Organic farming uses fertilizers and pesticides but excludes or strictly limits the use of manufactured (synthetic) fertilizers, pesticides (which include herbicides, insecticides and fungicides), plant growth regulators such as hormones, livestock antibiotics, food additives, genetically modified organisms, human sewage sludge, and nanomaterials.

*Biodynamic agriculture* is a method of organic farming that emphasizes the holistic development and interrelationships of the soil, plants and animals as a self-sustaining system. Biodynamic farming has much in common with other organic approaches, such as emphasizing the use of manures and composts and excluding of the use of artificial chemicals on soil and plants. Central features of biodynamic agriculture include crop diversification, the avoidance of chemical soil treatments, decentralized production and distribution, and the consideration of celestial and terrestrial influences on biological organisms. A farm is conceived of as a holistic, self-contained entity, within which soil, crops, animals, and the farmers are interdependent parts. Important features include the use of livestock manures to sustain plant growth (recycling of nutrients), maintenance and improvement of soil quality, and the health and well being of crops and animals.

From the perspective of the market, domestication and cultivation provide a number of advantages over wild-harvest for production of plant-based medicines:

* While wild-collection often offers material adulterated with unwanted, sometimes harmful other plant species, cultivation provides reliable botanical identification;
* Wild-harvest volumes are dependent on many factors that cannot be controlled, and irregularity of supply is a common feature. Cultivation guarantees a steady source of raw material;
* Wholesalers and pharmaceutical companies can agree on volumes and prices over time with the grower;
* The selection and development of genotypes with commercially desirable traits from the wild or managed populations may offer opportunities for the economic development of the medicinal plant species as a crop;
* Cultivation allows controlled post-harvest handling and, therefore, quality controls can be assured, and product standards can be adjusted to regulations and consumer preferences;
* Cultivated material can be easily certified ‘organic’ or ‘biodynamic’ although certifiers and other agencies are also presently developing wildcrafting standards.

However, domestication of the resource through farming is not always technically possible. Many species are difficult to cultivate because of certain biological features or ecological requirements (such as slow growth rate, special soil requirements, interactions with pollinators and other species, low germination rates, susceptibility to pests). Lack of secure, long-term tenure over high-value, long-lived species is also often a concern amongst farmers. These social and biological factors in turn affect the economic viability of medicinal-plant cultivation.

The World Health Organization has worked out the Guidelines on good agricultural and collection practices (GASP) for medicinal plants which indicate the way of proper cultivation of plants. The requirements described in this document are the following.

**Selection of medicinal plants**

Where applicable, the species or botanical variety selected for cultivation should be the same as that specified in the national pharmacopoeia or recommended by other authoritative national documents of the end-user's country. In the absence of such national documents, the selection of species or botanical varieties specified in the pharmacopoeia or other authoritative documents of other countries should be considered.

**Botanical identity**

The botanical identity – scientific name (genus, species, subspecies/variety, author, and family) – of each medicinal plant under cultivation should be verified and recorded. If available, the local and English common names should also be recorded. Other relevant information, such as the cultivar name, ecotype, chemotype or phenotype, may also be provided, as appropriate.

**Seeds and other propagation materials**

Seeds and other propagation materials should be specified, and suppliers of seeds and other propagation materials should provide all necessary information relating to the identity, quality and performance of their products, as well as their breeding history, where possible. Seeds and other propagation materials used for organic production should be certified as being organically derived. The quality of propagation material − including any genetically modified germplasm − should comply with regional and/or national regulations and be appropriately labelled and documented, as required.

**Cultivation**

Cultivation of medicinal plants requires intensive care and management. The conditions and duration of cultivation required vary depending on the quality of medicinal plant materials required. If no scientific published or documented cultivation data are available, traditional methods of cultivation should be followed, where feasible.

**Harvest**

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.

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.

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.

**Personnel**

Growers and producers should have adequate knowledge of the medicinal plant concerned. This should include botanical identification, cultivation characteristics and environmental requirements (soil type, soil pH, fertility, plant spacing and light requirements), as well as the means of harvest and storage. All personnel (including field workers) involved in the propagation, cultivation, harvest and post-harvest processing stages of medicinal plant production should maintain appropriate personal hygiene and should have received training regarding their hygiene responsibilities.

Only properly trained personnel, wearing appropriate protective clothing (such as overalls, gloves, helmet, goggles, face mask), should apply agrochemicals.

Each plant should have documents that identify it, ensures the quality of its propagation materials and the process of growing so that we receive a plant material of good quality.







The following table illustrates some data about plant material collection from cultivated and wild growing plants in Europe.

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| --- | --- | --- |
| **Country** | **Cultivated plants** | **Wild growing plants** |
| Austria | Pumpkin, mustard, caraway, poppy, parsley, fennel, milk thistle, St. John’s wort, coriander | Mountain pine (*Pinus mugo*) |
| Bulgaria | Coriander, lavender, fennel, lime, lemon balm, peppermint, Damask rose, milk thistle, sage | Dog rose, nettle, elder |
| Finland | Caraway, mustard, onion, sea buckthorn, poppy, rhodiola | Nettle, birch, bearberry, common juniper, yarrow, meadowsweet, dandelion |
| France  | Lavender, clary sage, poppy, ginkgo, thyme, parsley, basil | Daffodil, oak moss |
| Germany | Parsley, marjoram, dill, basil, celery, coriander, caraway, chamomile, mint, thyme, St. John’s wort, valerian, sage, purple coneflower, milk thistle, sea buckthorn | Small for special purposes |
| Greece  | Garlic, oregano, clary sage, gum mastic tree, rosemary, sweetleaf, purple coneflower, milk thistle, basil | Oregano, thyme, chamo-mile, mint, sage,  |
| Italy | Parsley, basil, bergamot, peppermint, chamomile, lavender, liquorice, immortelle |  |
| The Netherlands | Caraway, flax, poppy, celery, lovage, foxglove, purple coneflower, valerian | There is no serious wild collection for business purposes. |
| Romania | Coriander, caraway, fennel, aniseed, hops, lemon balm, sage, marigold, artichoke, narrowleaf plantain, milk thistle | Rose hip, hawthorn, sea buckthorn, elder, St. John’s wort |
| United Kingdom | Hops, borage, parsley, coriander, lavender, chamomile, mint | Elder, bog myrtle |

**PLANT CELL CULTURE**

Tissue culture techniques are becoming increasingly popular as an alternative means of plant vegetative propagation, mass production of chemicals, and genetic engineering. The primary goal of plant tissue culture is crop management. This involves asexual methods of propagation to generate whole plants from single cells.

The term “plant cell culture” is generally used for the aseptic culture of cells, tissues, organs, and their components under defined physical and chemical conditions *in vitro*. The concept is primarily based on the idea that a plant body can be dissected into smaller parts termed “explants” and that any explant can be developed into a whole plant. This idea is based on the phenomenon of totipotency – the ability of a single cell to divide and produce all the differentiated cells in an organism, for example, a plant cutting or callus can be used to grow an entire plant.

***Література для підготовки до занять***:

1. Medicinal plants resource science : handbook for higher school students / V.S. Kyslychenko, L.V. Upyr, I. G. Zinchenko, O.A. Kyslychenko, S.I. Stepanova; ed. by V.S. Kyslychenko. – Kharkiv: NUPh : Golden Pages, 2012. – 168 p.
2. Державний реєстр лікарських засобів України [http://www.drlz.kiev.ua/](https://docviewer.yandex.ru/r.xml?sk=19fd962ce10e1af9fb80ca6bac31bc79&amp;url=http://www.drlz.kiev.ua/)
3. Закон України „Про рослинний світ” // Вiдомостi Верховної Ради (ВВР). – 1999. - № 22-23
4. Ивашин Д.С., Катина З.Ф., Рыбачук И.З., Бутенко Л.Т., Иванов В.С., Никольская Л.С. Справочник по заготовкам лекарственных растений. – Киев: Урожай, 1983. – С. 53-54