WHO guidelines on good agricultural and collection practices (GACP) for medicinal plants

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The photograph on the front cover was kindly provided by Dr. Setsuko Sekita, Director, Tsukuba Medicinal Plant Research Station, National Institute of Health Sciences, Ministry of Health, Labour and Welfare, Tsukuba, Japan.

Foreword

Traditional medicines, particularly herbal medicines, have been increasingly used worldwide during the last two decades. Unfortunately, the number of reports of patients experiencing negative health consequences caused by the use of herbal medicines has also been increasing. Analysis and studies have revealed a variety of reasons for such problems. One of the major causes of reported adverse events is directly linked to the poor quality of herbal medicines, including raw medicinal plant materials. It has therefore been recognized that insufficient attention has been paid to the quality assurance and control of herbal medicines.

By resolution WHA56.31 on traditional medicine, Member States requested WHO "to provide technical support for development of methodology to monitor or ensure product safety, efficiency and quality, preparation of guidelines, and promotion of exchange of information". WHO has developed a series of technical guidelines relating to the quality control of herbal medicines of which these WHO guidelines on good agricultural and collection practices (GACP) for medicinal plants are the latest. The guidelines provide a detailed description of the techniques and measures required for the appropriate cultivation and collection of medicinal plants and for the recording and documentation of necessary data and information during their processing.

Despite such guidelines, there is still considerable disparity between knowledge and implementation. For example, it is a difficult task to train farmers and other relevant persons as producers, handlers and processors of medicinal plant materials. While pharmaceutical and other companies are striving to meet the requirements for the quality control of herbal medicines, they cannot force farmers, producers, handlers and processors to follow good agricultural and collection practices for medicinal plants. The training of farmers and other relevant persons is therefore one of many important measures to be taken to ensure that good agricultural and collection practices are adopted in order that medicinal plant materials of high quality are obtained.

Quality control directly impacts the safety and efficacy of herbal medicinal products. Good agricultural and collection practices for medicinal plants is only the first step in quality assurance, on which the safety and efficacy of herbal medicinal products directly depend upon, and will also play an important role in the protection of natural resources of medicinal plants for sustainable use. Until now, only the European Union and a few countries, such as China and Japan have developed regional and national guidelines for good agricultural and collection practices for medicinal plants.

We believe that more countries will develop their own guidelines for the quality control of medicinal plants based on the guidelines developed by WHO. However, there is still a long way to go before such guidelines are implemented worldwide, and cooperative efforts on the part of national authorities, including health, agricultural, trade and research institutes, and nongovernmental organizations will be needed to enable us to reach our goal.

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1. General introduction

1.1 Background

Interest in traditional systems of medicine and, in particular, herbal medicines, has increased substantially in both developed and developing countries over the past two decades. Global and national markets for medicinal herbs have been growing rapidly, and significant economic gains are being realized. According to the Secretariat of the Convention on Biological Diversity, global sales of herbal products totalled an estimated US$ 60 000 million in 2000. As a consequence, the safety and quality of herbal medicines have become increasingly important concerns for health authorities and the public alike (*1*).

Some reported adverse events following the use of certain herbal medicines have been associated with a variety of possible explanations, including the inadvertent use of the wrong plant species, adulteration with undeclared other medicines and/or potent substances, contamination with undeclared toxic and/or hazardous substances, overdosage, inappropriate use by health-care providers or consumers, and interaction with other medicines, resulting in an adverse drug interaction. Among those attributable to the poor quality of finished products, some clearly result from the use of raw medicinal plant materials that are not of a sufficiently high quality standard.

The safety and quality of raw medicinal plant materials and finished products depend on factors that may be classified as intrinsic (genetic) or extrinsic (environment, collection methods, cultivation, harvest, post-harvest processing, transport and storage practices). Inadvertent contamination by microbial or chemical agents during any of the production stages can also lead to deterioration in safety and quality. Medicinal plants collected from the wild population may be contaminated by other species or plant parts through misidentification, accidental contamination or intentional adulteration, all of which may have unsafe consequences.

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. All intellectual property rights with regard to source materials must be respected. WHO has cooperated with other United Nations specialized agencies and international organizations in dealing with the above-mentioned issues. Such cooperation will be further strengthened through the development and the updating of relevant technical guidelines in these areas.

Safety and quality assurance measures are needed to overcome these problems and to ensure a steady, affordable and sustainable supply of medicinal plant materials of good quality. In recent years, good agricultural practices have been recognized as an important tool for ensuring the safety and quality of a variety of food commodities, and many Member States have established national good agricultural practice guidelines for a range of foods. However, quality control for the cultivation and collection of medicinal plants as the raw materials for herbal medicines may be more demanding than that for food production; possibly for this reason, only China, the European Union, and Japan have recently developed guidelines on good agricultural practices for medicinal plants (Annexes 1, 2 and 3, respectively). Since their guidelines were established to meet the requirements of specific regions or countries, they may not be universally applicable or acceptable.

At a WHO Informal Meeting on Methodologies for Quality Control of Finished Herbal Products, held in Ottawa, Canada from 20 to 21 July 2001, the entire process of production of herbal medicines, from raw materials to finished herbal products, was reviewed. It was recommended that WHO should give high priority to the development of globally applicable guidelines to promote the safety and quality of medicinal plant materials through the formulation of codes for good agricultural practices and good collection practices for medicinal plants. It was envisaged that such guidelines would help to ensure safety and quality at the first and most important stage of the production of herbal medicines.

1.2 Objectives

Within the overall context of quality assurance, the *WHO guidelines on good agricultural and collection practices (GACP) for medicinal plants* are primarily intended to provide general technical guidance on obtaining medicinal plant materials of good quality for the sustainable production of herbal products classified as medicines. They apply to the cultivation and collection of medicinal plants, including certain post-harvest operations. Raw medicinal plant materials should meet all applicable national and/or regional quality standards. The guidelines therefore may need to be adjusted according to each country's situation.

The main objectives of these guidelines are to:

- contribute to the quality assurance of medicinal plant materials used as the source for herbal medicines, which aims to improve the quality, safety and efficacy of finished herbal products;
- guide the formulation of national and/or regional GACP guidelines and GACP monographs for medicinal plants and related standard operating procedures; and
- encourage and support the sustainable cultivation and collection of medicinal plants of good quality in ways that respect and support the conservation of medicinal plants and the environment in general.

These guidelines should be considered in conjunction with the existing documents and publications relating to the quality assurance of herbal medicines and to the conservation of medicinal plants (for details, see Bibliography below), for example:

- Good Manufacturing Practices for pharmaceutical products: main principles (*2*)
- Good manufacturing practices: supplementary guidelines for manufacture of herbal medicinal products (*3*)
- *Quality control methods for medicinal plant materials* (*4*)
- Guide to good storage practices for pharmaceuticals (*5*)
- Good trade and distribution practices (GTDP) for pharmaceutical starting materials (*6*)
- *General guidelines for methodologies on research and evaluation of traditional medicine* (*7*)
- Guidelines for the assessment of herbal medicines (*8*)
- *WHO monographs on selected medicinal plants* (*9*, *10*)
- *WHO/IUCN/WWF Guidelines on the conservation of medicinal plants* (*12*).

In addition, these guidelines should be seen in the context of the relevant guidelines and codes of practices developed by the Joint FAO/WHO Codex Alimentarius Commission, particularly as medicinal plants may be subject to general requirements for foods under some national and/or regional legislation. Examples of Codex Alimentarius texts that may be applicable to medicinal plants include:

- *Codex Alimentarius Code of Practice - General Principles of Food Hygiene* (*13*)
- *Codex Alimentarius Guidelines on production, processing, labelling and marketing of organically produced foods* (*14*)
- *Codex Alimentarius Code of hygienic practice for spices and dried aromatic plants* (*15*).

The *WHO guidelines on good agricultural and collection practices (GACP) for medicinal plants* do not provide sufficient guidance for the production of organic herbal medicines, and other national, regional and/or international guidelines should be consulted.

1.3 Structure

The guidelines are divided into five sections: section 1 provides a general introduction, sections 2 and 3 discuss good agricultural practices for medicinal plants and good collection practices for medicinal plants, respectively. Section 4 outlines common technical aspects of good agricultural practices for medicinal plants and good collection practices for medicinal plants, while section 5 considers other relevant issues. A glossary for relevant terms used in these guidelines is provided in section 1. There are five annexes, which set out a sample record for cultivated medicinal plants (Annex 5) and a model structure for monographs on good agricultural practices for specific medicinal plants (Annex 4), as well as national and regional documents on good agricultural practices for medicinal plants from the People's Republic of China, the European Agency for Evaluation of Medicinal Products, and Japan (Annexes 1, 2 and 3, respectively).

1.4 Glossary

The terms used in these guidelines are defined below. The terms and their definitions have been selected and adapted from other WHO documents and guidelines that are widely used by WHO Member States. The citation numbers in parentheses following a term refer to the publications, listed in the References below, from which that term has been derived. The footnotes in this section refer to recommendations on the terminology made by the participants in the WHO Consultation on Good Agricultural and Field Collection Practices for Medicinal Plants (Geneva, 7–9 July 2003) for consideration when those documents and guidelines are updated.

1.4.1. Terms relating to herbal medicines:

Contamination[1] *(2)*
The undesired introduction of impurities of a chemical or microbiological nature, or of foreign matter, into or on to a starting material or intermediate during production, sampling, packaging or repackaging, storage or transport.

Cross-contamination *(2)*
Contamination of a starting material, intermediate product or finished product by another starting material or product during production.

Herbal medicines include herbs, herbal materials, herbal preparations and finished herbal products. *(7)*

Herbs *(7)*
Herbs include crude plant material such as leaves, flowers, fruit, seed, stems, wood, bark, roots, rhizomes or other plant parts, which may be entire, fragmented or powdered.

Herbal materials[2] *(7)*
Herbal materials include, in addition to herbs, fresh juices, gums, fixed oils, essential oils, resins and dry powders of herbs. In some countries, these materials may be processed by various local procedures, such as steaming, roasting, or stir-baking with honey, alcoholic beverages or other materials.

Herbal preparations *(7)*
Herbal preparations are the basis for finished herbal products and may include comminuted or powdered herbal materials, or extracts, tinctures and fatty oils of herbal materials. They are produced by extraction, fractionation, purification or concentration or by other physical or biological processes. They also include

[1] The participants in the WHO Consultation on Good Agricultural and Field Collection Practices for Medicinal Plants (Geneva, 7–9 July 2003) recommended that radioactive impurities should also be included under *contamination*.

[2] The participants in the WHO Consultation on Good Agricultural and Field Collection Practices for Medicinal Plants (Geneva, 7–9 July 2003) recommended that latexes, fats, and waxes should also be included in *herbal materials.*

preparations made by steeping or heating herbal materials in alcoholic beverages and/or honey, or in other materials.

Finished herbal products *(7)*
Finished herbal products consist of herbal preparations made from one or more herbs. If more than one herb is used, the term ***mixed herbal product*** can also be used. Finished herbal products and mixed herbal products may contain excipients in addition to the active ingredients. In some countries, herbal medicines may contain, by tradition, natural organic or inorganic active ingredients that are not of plant origin (e.g. animal materials and mineral materials). Generally, however, 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.

Medicinal plant materials See Herbal materials

Medicinal plant**:** A plant (wild or cultivated) used for medicinal purposes. *(3)*

1.4.2. Terms relating to medicinal plant cultivation and collection activities:

The definitions below have been adapted from terms included in the glossary compiled by the Food and Agriculture Organization of the United Nations (FAO), available at the time of preparation of these guidelines.[3]

Erosion
The process whereby water or wind moves soil from one location to another. Types of erosion are (1) sheet and rill—a general washing away of a thin uniform sheet of soil, or removal of soil in many small channels or incisions caused by rainfall or irrigation run-off; (2) gully—channels or incisions cut by concentrated water run-off after heavy rains; (3) ephemeral—a water-worn, short-lived or seasonal incision, wider, deeper and longer than a rill, but shallower and smaller than a gully; and (4) wind—the carrying away of dust and sediment by wind in areas of high prevailing winds or low annual rainfall.

Integrated pest management (IPM)
The careful integration of a number of available pest-control techniques that discourage pest-population development and keep pesticides and other interventions to levels that are economically justified and safe for human health and the environment. IPM emphasizes the growth of a healthy crop with the least disruption to agro-ecosystems, thereby encouraging natural pest-control mechanisms.

Landrace
In plant genetic resources, an early, cultivated form of a crop species, evolved from a wild population, and generally composed of a heterogeneous mixture of genotypes.
Plant genetic resources
The reproductive or vegetative propagating material of: (1) cultivated varieties (***cultivars***) in current use and newly developed varieties; (2) obsolete cultivars; (3) primitive cultivars

[3] The glossary can be found at http://www.fao.org/glossary/

(***landraces***); (4) wild and weed species, near relatives of cultivated varieties; and (5) special genetic stocks (including elite and current breeders' lines and mutants).

Propagule
Any structure capable of giving rise to a new plant by asexual or sexual reproduction, including bulbils, leaf buds, etc.

Standard operating procedure (SOP)
An authorized written procedure giving instructions for performing an operation.

Sustainable use
The use of components of biological diversity in a way and at a rate that does not lead to the long-term decline of biological diversity, thereby maintaining its potential to meet the needs and aspirations of present and future generations.

2. Good agricultural practices for medicinal plants

This section presents general guidelines on good agricultural practices for medicinal plants. It describes general principles and provides technical details for the cultivation of medicinal plants. It also describes quality control measures, where applicable.

2.1 Identification/authentication of cultivated medicinal plants

2.1.1 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. In the case of newly introduced medicinal plants, the species or botanical variety selected for cultivation should be identified and documented as the source material used or described in traditional medicine of the original country.

2.1.2 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.

For commercially available cultivars, the name of the cultivar and of the supplier should be provided. In the case of landraces collected, propagated, disseminated and grown in a specific region, records should be kept of the locally named line, including the origin of the source seeds, plants or propagation materials.

2.1.3 Specimens

In the case of the first registration in a producer's country of a medicinal plant or where reasonable doubt exists as to the identity of a botanical species, a voucher botanical

specimen should be submitted to a regional or national herbarium for identification. Where possible, a genetic pattern should be compared to that of an authentic specimen. Documentation of the botanical identity should be included in the registration file.

2.2 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. The propagation or planting materials should be of the appropriate quality and be as free as possible from contamination and diseases in order to promote healthy plant growth. Planting material should preferably be resistant or tolerant to biotic or abiotic factors.

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.

Care should be taken to exclude extraneous species, botanical varieties and strains of medicinal plants during the entire production process. Counterfeit, substandard and adulterated propagation materials must be avoided.

2.3 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. Otherwise a method should be developed through research.

The principles of good plant husbandry, including appropriate rotation of plants selected according to environmental suitability, should be followed, and tillage should be adapted to plant growth and other requirements.

Conservation Agriculture (CA) techniques should be followed where appropriate, especially in the build-up of organic matter and conservation of soil humidity. Conservation Agriculture also includes "no-tillage" systems.[4]

[4] Conservation Agriculture (CA) aims to conserve, improve and make more efficient use of natural resources through integrated management of available soil, water and biological resources combined with external inputs. It contributes to environmental conservation as well as to enhanced and sustained agricultural production. It can also be referred to as resource-efficient/resource- effective agriculture. More information can be found at www.fao.org/ag/AGS/AGSE/main.htm

2.3.1 Site selection

Medicinal plant materials derived from the same species can show significant differences in quality when cultivated at different sites, owing to the influence of soil, climate and other factors. These differences may relate to physical appearance or to variations in their constituents, the biosynthesis of which may be affected by extrinsic environmental conditions, including ecological and geographical variables, and should be taken into consideration.

Risks of contamination as a result of pollution of the soil, air or water by hazardous chemicals should be avoided. The impact of past land uses on the cultivation site, including the planting of previous crops and any applications of plant protection products, should be evaluated.

2.3.2 Ecological environment and social impact

The cultivation of medicinal plants may affect the ecological balance and, in particular, the genetic diversity of the flora and fauna in surrounding habitats. The quality and growth of medicinal plants can also be affected by other plants, other living organisms and by human activities. The introduction of non-indigenous medicinal plant species into cultivation may have a detrimental impact on the biological and ecological balance of the region. The ecological impact of cultivation activities should be monitored over time, where practical.

The social impact of cultivation on local communities should be examined to ensure that negative impacts on local livelihood are avoided. In terms of local income- earning opportunities, small-scale cultivation is often preferable to large-scale production, in particular if small-scale farmers are organized to market their products jointly. If large-scale medicinal plant cultivation is or has been established, care should be taken that local communities benefit directly from, for example, fair wages, equal employment opportunities and capital reinvestment.

2.3.3 Climate

Climatic conditions, for example, length of day, rainfall (water supply) and field temperature, significantly influence the physical, chemical and biological qualities of medicinal plants. The duration of sunlight, average rainfall, average temperature, including daytime and night-time temperature differences, also influence the physiological and biochemical activities of plants, and prior knowledge should be considered.

2.3.4 Soil

The soil should contain appropriate amounts of nutrients, organic matter and other elements to ensure optimal medicinal plant growth and quality. Optimal soil conditions, including soil type, drainage, moisture retention, fertility and pH, will be dictated by the selected medicinal plant species and/or target medicinal plant part.

The use of fertilizers is often indispensable in order to obtain large yields of medicinal plants. It is, however, necessary to ensure that correct types and quantities of fertilizers are used through agricultural research. In practice, organic and chemical fertilizers are used.

Human excreta must not be used as a fertilizer owing to the potential presence of infectious microorganisms or parasites. Animal manure should be thoroughly composted to meet safe sanitary standards of acceptable microbial limits and destroyed by the germination capacity of weeds. Any applications of animal manure should be documented. Chemical fertilizers that have been approved by the countries of cultivation and consumption should be used.

All fertilizing agents should be applied sparingly and in accordance with the needs of the particular medicinal plant species and supporting capacity of the soil. Fertilizers should be applied in such a manner as to minimize leaching.

Growers should implement practices that contribute to soil conservation and minimize erosion, for example, through the creation of streamside buffer zones and the planting of cover crops and "green manure" (crops grown to be ploughed in), such as alfalfa.

2.3.5 Irrigation and drainage

Irrigation and drainage should be controlled and carried out in accordance with the needs of the individual medicinal plant species during its various stages of growth. Water used for irrigation purposes should comply with local, regional and/or national quality standards. Care should be exercised to ensure that the plants under cultivation are neither over- nor under-watered.

In the choice of irrigation, as a general rule, the health impact of the different types of irrigation (various forms of surface, sub-surface or overhead irrigation), particularly on the risks of increased vector-borne disease transmission, must be taken into account.

2.3.6 Plant maintenance and protection

The growth and development characteristics of individual medicinal plants, as well as the plant part destined for medicinal use, should guide field management practices. The timely application of measures such as topping, bud nipping, pruning and shading may be used to control the growth and development of the plant, thereby improving the quality and quantity of the medicinal plant material being produced.

Any agrochemicals used to promote the growth of or to protect medicinal plants should be kept to a minimum, and applied only when no alternative measures are available. Integrated pest management should be followed where appropriate. When necessary, only approved pesticides and herbicides should be applied at the minimum effective level, in accordance with the labelling and/or package insert instructions of the individual product and the regulatory requirements that apply for the grower and the end-user countries. Only qualified staff using approved equipment should carry out pesticide and herbicide applications. All applications should be documented. The minimum interval between such treatments and harvest should be consistent with the labelling and/or package insert instructions of the plant protection product, and such treatments should be carried out in consultation and with the by agreement of the buyer of the medicinal plants or medicinal plant materials. Growers and producers should comply with maximum pesticide and herbicide residue limits, as stipulated by local, regional and/or national regulatory authorities of both the growers' and the end-users' countries and/or regions. International agreements such as the International Plant Protection Convention[5] and Codex Alimentarius should also be consulted on pesticide use and residues.

2.4 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. 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.

[5] More information on the International Plant Protection Convention is available via the Internet at http://www.ippc.int/IPP/default.htm

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.

2.5 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.

Growers and producers should receive instruction on all issues relevant to the protection of the environment, conservation of medicinal plant species, and proper agricultural stewardship.

For further information, see section 4.7.

3. Good collection practices for medicinal plants

This section describes the general strategies and basic methods for small- and large-scale collection of fresh medicinal plant materials. Collection practices should ensure the long-term survival of wild populations and their associated habitats. Management plans for collection should provide a framework for setting sustainable harvest levels and describe appropriate collection practices that are suitable for each medicinal plant species and plant part used (roots, leaves, fruits, etc.). Collection of medicinal plants raises a number of complex environmental and social issues that must be addressed locally on a case-by-case basis. It is acknowledged that these issues vary widely from region to region and cannot be fully covered by these guidelines.

More guidance can be found in the *WHO/IUCN/WWF Guidelines on the conservation of medicinal plants* (*12*), which are currently under revision to deal comprehensively with the sustainable use and conservation of medicinal plants.

3.1 Permission to collect

In some countries, collection permits and other documents from government authorities and landowners must be obtained prior to collecting any plants from the wild. Sufficient time for the processing and issuance of these permits must be allocated at the planning stage. National legislation, such as national "red" lists, should be consulted and respected.

For medicinal plant materials intended for export from the country of collection, export permits, phytosanitary certificates, Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) permit(s) (for export and import), CITES certificates (for re-export), and other permits must be obtained, when required.

3.2 Technical planning

Prior to initiating a collection expedition, the geographical distribution and population density of the target medicinal plant species should be determined. Distance from home base and quality of the target plant(s) available are factors to be considered. When the collection sites have been identified, local and/or national collection permits should be obtained, as indicated in section 3.1.

Essential information on the target species (taxonomy, distribution, phenology, genetic diversity, reproductive biology and ethnobotany) should be obtained. Data about environmental conditions, including topography, geology, soil, climate and vegetation at

the prospective collecting site(s), should be collated and presented in a collection management plan.

Research on the morphology of the target medicinal plant species and variability of its populations should be carried out in order to develop a "search image" for the species. Copies of photographs and other illustrations of the target medicinal plant(s) from books and herbarium specimens, and ethnographical information (common or local names) of the target species and plant parts are useful field instruments, especially for untrained workers. Botanical keys and other taxonomic identification aids are useful at collection sites where either related species, or unrelated species of similar morphological characteristics, may be found.

Rapid, safe and dependable transportation to carry personnel, equipment, supplies and collected medicinal plant materials should be arranged in advance.

A collection team familiar with good collecting techniques, transport, and handling of equipment and medicinal plant materials, including cleaning, drying and storage, should be assembled. Training of personnel should be conducted regularly. The responsibilities of all those involved in collection should be clearly set out in a written document. All stakeholders, in particular, manufacturers, traders and government, are accountable for the conservation and management of the targeted medicinal plant species.

The social impact of field collection on local communities should be examined and the ecological impact of field collection activities should be monitored over time. The stability of the natural habitat(s) and the maintenance of sustainable populations of the target species in the collection area(s) must be ensured.

3.3 Selection of medicinal plants for collection

Where applicable, the species or botanical variety selected for collection should be the same as that specified in the national pharmacopoeia or recommended by other authoritative national documents of the end-user's country, as the source for the herbal medicines concerned. 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. In the case of newly introduced medicinal plants, the species or botanical variety selected for collection should be identified and documented as the source material used or described in traditional medicine in original countries.

Collectors of medicinal plants and producers of medicinal plant materials and herbal medicines should prepare botanical specimens for submission to regional or national herbaria for authentication. The voucher specimens should be retained for a sufficient period of time, and should be preserved under proper conditions. The name of the botanist or other experts who provided the botanical identification or authentication should be recorded. If the medicinal plant is not well known to the community, then documentation of the botanical identity should be recorded and maintained.

3.4 Collection

Collection practices should ensure the long-term survival of wild populations and their associated habitats. The population density of the target species at the collection site(s) should be determined and species that are rare or scarce should not be collected. To encourage the regeneration of source medicinal plant materials, a sound demographic structure of the population has to be ensured. Management plans should refer to the species and the plant parts (roots, leaves, fruits, etc.) to be collected and should specify collection levels and collection practices. It is incumbent on the government or environmental authority to ensure that buyers of collected plant material do not place the collected species at risk.

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.

Only ecologically non-destructive systems of collection should be employed. These will vary widely from species to species. For example, when collecting roots of trees and bushes, the main roots should not be cut or dug up, and severing the taproot of trees and bushes should be avoided. Only some of the lateral roots should be located and collected. When collecting species whose bark is the primary material to be used, the tree should not be girdled or completely stripped of its bark; longitudinal strips of bark along one side of the tree should be cut and collected.

Medicinal plants should not be collected in or near areas where high levels of pesticides or other possible contaminants are used or found, such as roadsides, drainage ditches, mine tailings, garbage dumps and industrial facilities which may produce toxic emissions. In addition, the collection of medicinal plants in and around active pastures, including riverbanks downstream from pastures, should be avoided in order to avoid microbial contamination from animal waste.

In the course of collection, efforts should be made to remove parts of the plant that are not required and foreign matter, in particular toxic weeds. Decomposed medicinal plant materials should be discarded.

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.

3.5 Personnel

Local experts responsible for the field collection should have formal or informal practical education and training in plant sciences and have practical experience in fieldwork. They should be responsible for training any collectors who lack sufficient technical knowledge to perform the various tasks involved in the plant collection process. They are also responsible for the supervision of workers and the full documentation of the work performed. Field personnel should have adequate botanical training, and be able to recognize medicinal plants by their common names and, ideally, by their scientific (Latin) names.

Local experts should serve as knowledgeable links between non-local people and local communities and collectors. All collectors and local workers involved in the collection operation should have sufficient knowledge of the species targeted for collection and be able to distinguish target species from botanically related and/or morphologically similar species. Collectors should also receive instructions on all issues relevant to the protection of the environment and the conservation of plant species, as well as the social benefits of sustainable collection of medicinal plants.

The collection team should take measures to ensure the welfare and safety of staff and local communities during all stages of medicinal plant sourcing and trade. All personnel must be protected from toxic and dermatitis-causing plants, poisonous animals and disease-carrying insects. Appropriate protective clothing, including gloves, should be worn when necessary.

For further information, see section 4.7.

4. Common technical aspects of good agricultural practices for medicinal plants and good collection practices for medicinal plants

4.1 Post-harvest processing

4.1.1 Inspection and sorting

Raw medicinal plant materials should be inspected and sorted prior to primary processing. The inspection may include:

- visual inspection for cross-contamination by untargeted medicinal plants and/or plant parts;
- visual inspection for foreign matter;
- organoleptic evaluation, such as: appearance, damage, size, colour, odour, and possibly taste.

4.1.2 Primary processing

Appropriate measures of primary processing are dependent on the individual materials. These processes should be carried out in conformity with national and/or regional quality standards, regulations and norms. In some cases, purchasers may request that specific protocols are followed. These protocols should also comply with national and/or regional regulatory requirements that apply in the producer and the purchaser countries.

As far as possible, standard operating procedures should be followed. If modifications are made, they should be justified by adequate test data demonstrating that the quality of the medicinal plant material is not diminished.

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.

4.1.3 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. Information on the appropriate moisture content for particular medicinal plant materials may be available from pharmacopoeias or other authoritative monographs.

Medicinal plants can be dried in a number of ways: in the open air (shaded from direct sunlight); placed in thin layers on drying frames, wire-screened rooms or buildings; by direct sunlight, if appropriate; in drying ovens/rooms and solar dryers; by indirect fire; baking; lyophilization; microwave; or infrared devices. 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.[6] If other sources of fire are used, contact between those materials, smoke and medicinal plant material should be avoided.

4.1.4 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.

4.1.5 Processing facilities

The following elements should be considered when establishing a quality assurance system and be adapted to the different steps of production and production sites.

[6] Reference: Heber W. Youngken. *Textbook of Pharmacognosy, 6th ed.* (*16*).

Location

Facilities should preferably be located in areas that are free from objectionable odours, smoke, dust or other contaminants, and are not subject to flooding.

Roadways and areas used by wheeled vehicles

Roadways and areas serving the establishment, within its boundaries or in the immediate vicinity, should have a hard paved surface suitable for wheeled vehicles. There should be adequate drainage, and provision should be made for cleaning.

Buildings

Buildings should be of sound construction and maintained in good repair. Dirty areas, such as those used for drying and milling, must be isolated from clean areas, preferably in separate buildings. All construction materials should be such that they do not transmit any undesirable substance to medicinal plant materials. Once construction is completed, construction materials should not emit toxic vapours. The use of materials that cannot be adequately cleaned and disinfected, such as wood, should be avoided unless they would clearly not be a source of contamination.

Buildings should be designed to:

- provide adequate working space and storage room to allow for satisfactory performance of all operations;
- facilitate efficient and hygienic operations by allowing a regulated flow in processing from the arrival of the raw medicinal plant materials at the premises to the dispatch of the processed medicinal plant materials;
- permit appropriate control of temperature and humidity;
- permit the separation by partition or other means of processes that may cause cross-contamination, especially to isolate dirty areas (drying and milling) from clean areas;
- permit control of access to different sections, where appropriate;
- permit easy and adequate cleaning and facilitate proper supervision of hygiene;
- prevent the entry of environmental contaminants such as smoke, dust, etc.;
- prevent the entrance and harbouring of pests, livestock and domesticated animals;
- where appropriate, prevent direct sunlight from entering a particular section.

Medicinal plant material handling areas

- *Floors*, where appropriate, should be of waterproof, non-absorbent, washable, non-slip and non-toxic material, without crevices, and should be easy to clean and disinfect. Where appropriate, floors should slope sufficiently for liquids to drain into trapped outlets.
- *Walls*, where appropriate, should be covered with waterproof, non-absorbent and washable materials, sealed and free from insects, and should be light coloured. Up to a height appropriate for handling operations, they should be smooth and without crevices, and should be easy to clean and disinfect. Where appropriate, angles between walls, between walls and floors, and between walls and ceilings should also be sealed and covered to facilitate cleaning.
- *Ceilings* should be designed, constructed and finished so as to prevent the accumulation of dirt and minimize condensation, mould development and flaking, and should be easy to clean.

- *Windows and other openings* should be constructed so as to avoid accumulation of dirt, and those that open should be fitted with insect-proof screens. Screens should be easily removable for cleaning and kept in good repair. Internal window sills, if present, should be sloped to prevent use as shelves.
- *Doors* should have smooth, non-absorbent surfaces and, where appropriate, be self-closing and close-fitting.
- *Stairs, lift cages and auxiliary structures* such as platforms, ladders and chutes should be situated and constructed so as not to cause contamination to medicinal plant materials. Chutes should be constructed with inspection and cleaning hatches.
- *Overhead structures and fittings* should be installed in such a manner as to avoid contamination of medicinal plant materials (both raw and processed) by condensation and drip, and should be protected to prevent contamination in case of breakage. They should not hamper cleaning operations. They should be insulated, where appropriate, and be designed and finished so as to prevent the accumulation of dirt and to minimize condensation, mould development and flaking. They should be easy to clean.
- *Living quarters, food preparation and eating areas, changing facilities, toilets and areas where animals are kept* should be completely separated from and should not open directly on to medicinal plant material handling areas.

Water supply

An ample supply of water, under adequate pressure and at suitable temperature, should be available with appropriate facilities for its storage, where necessary, and distribution, and with proper protection against contamination.

- *Ice* should be made from potable water; it should be manufactured, handled and stored so as to protect it against contamination.
- *Steam* used in direct contact with medicinal plant materials or surfaces in contact with medicinal plant materials should contain no substances that may be hazardous to health or may contaminate the medicinal plant materials.
- *Non-potable water* used for steam production, refrigeration, fire control and other similar purposes not connected with processing should be carried in completely separate pipes, identifiable preferably by colour, and with no cross-connection with or back siphonage into the system carrying potable water.
- *Potable water* should be used for washing and wet sterilization procedures.

Effluent and waste disposal

Facilities should have an effective effluent and waste disposal system, which should at all times be maintained in good order and repair. All effluent pipes (including sewerage systems) should be large enough to carry peak loads and should be constructed so as to avoid contamination of potable water supplies.

Changing facilities and toilets

Adequate, suitable and conveniently located changing facilities and toilets should be provided. Toilets should be designed so as to ensure hygienic removal of waste matter. These areas should be well lit, ventilated and, where appropriate, heated. Hand-washing facilities with warm or hot and cold water, a suitable hand-cleaning preparation and

hygienic means of drying should be provided adjacent to toilets and located so that employees have to pass them when returning to the processing area. Elbow-operated taps are desirable and, where hot and cold water is available, mixer taps should be fitted. If paper towels are supplied, a sufficient number of towel dispensers and waste receptacles should be provided near to each washing facility. Notices should be posted directing personnel to wash their hands after using the toilet.

Hand-washing facilities in processing areas

Adequate and conveniently located facilities for hand-washing and a hygienic means of drying should be provided whenever the process demands. Where appropriate, facilities for hand disinfection should also be provided. Warm or hot and cold water and a suitable hand-cleaning preparation should be provided. Elbow-operated taps are desirable and, where hot and cold water is available, mixer taps should be fitted. If paper towels are supplied, a sufficient number of towel dispensers and waste receptacles should be provided adjacent to each washing facility. The facilities should be furnished with properly trapped waste pipes leading to drains.

Disinfection facilities

Where appropriate, adequate facilities for cleaning and disinfection of working implements and equipment should be provided. These facilities should be constructed of corrosion-resistant materials, should be easy to clean, and should be fitted with hot and cold water supplies.

Lighting [7]

Adequate natural or artificial lighting should be fitted throughout the facility. Where appropriate, the lighting should not alter colours and the intensity should be not less than:

- 540 lux at all inspection points
- 220 lux in work rooms
- 110 lux in other areas.

Lighting fixtures and light bulbs suspended over medicinal plant materials at any stage of processing should be of a safety type and protected to prevent contamination of the medicinal plant materials in case of breakage.

Ventilation

Adequate ventilation should be provided to prevent excessive heat, steam condensation and dust and to remove contaminated air. Air should never flow from a dirty area to a clean area. Ventilator openings should be provided with a screen or other protective enclosure of non-corrosive material. Screens should be easily removable for cleaning.

[7] These values have been adapted from *Codex Alimentarius Code of Practice - General Principles of Food Hygiene* (13).

Storage of waste and unusable materials

Facilities should be provided for the storage of waste and unusable materials prior to removal from the premises. These facilities should be designed so as to prevent access to the waste or unusable materials by pests and to avoid contamination of medicinal plant materials, potable water, equipment and buildings of the premises. Clearly marked waste bins should be provided and emptied daily.

4.2 Bulk packaging and labelling

Processed medicinal plant materials should be packaged as quickly as possible to prevent deterioration of the product and to protect against unnecessary exposure to potential pest attacks and other sources of contamination.

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. 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. Whenever possible, the packaging used should be agreed upon between supplier and buyer.

Reusable packaging material such as jute sacks and mesh bags should be well cleaned (disinfected) and thoroughly dried prior to reuse, so as to avoid contamination by previous contents. All packaging materials should be stored in a clean and dry place that is free from pests and inaccessible to livestock, domestic animals and other sources of contamination.

A label affixed to the packaging should clearly indicate the scientific name of the medicinal plant, the plant part, the place of origin (cultivation or collection site), the cultivation or collection date and the names of the grower/collector and the processor, and quantitative information. The label should also contain information indicating quality approval and comply with other national and/or regional labelling requirements.

The label should bear a number that clearly identifies the production batch. Additional information about the production and quality parameters of the medicinal plant materials may be added in a separate certificate, which is clearly linked to the package carrying the same batch number.

Records should be kept of batch packaging, and should include the product name, place of origin, batch number, weight, assignment number and date. The records should be retained for a period of three years or as required by national and/or regional authorities.

4.3 Storage and transportation

Conveyances used for transporting bulk medicinal plant materials from the place of production to storage for processing should be cleaned between loads. Bulk transport, such as ship or rail cars, should be cleaned and, where appropriate, well ventilated to remove moisture from medicinal plant materials and to prevent condensation.

Organically grown medicinal plant materials should be stored and transported separately or in a manner that ensures their integrity.

Appropriate security measures should be applied to the storage and transport of medicinal plant materials that are potentially toxic or poisonous.

Whenever required and when possible, 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.

Fumigation against pest infestation should be carried out only when necessary, and should be carried out by licensed or trained personnel. Only registered chemical agents authorized by the regulatory authorities of the source country and the countries of intended end-use should be used. All fumigation, fumigation agents, and dates of application should be documented. When freezing or saturated steam is used for pest control, the humidity of the materials should be checked after treatment.

4.4 Equipment

4.4.1 Materials

All equipment and utensils used in the handling of medicinal plants should be made of materials that do not transmit toxic substances, odour or taste, are non-absorbent, are resistant to corrosion and are capable of withstanding repeated cleaning and disinfection. Surfaces should be smooth and free from pits and crevices. The use of wood and other materials that cannot be adequately cleaned and disinfected should be avoided, except when their use would clearly not be a source of contamination. The use of different metals in such a way that contact corrosion may occur should be avoided.

4.4.2 Design, construction and installation

All equipment and utensils should be designed and constructed so as to prevent hygienic hazards and permit easy and thorough cleaning and disinfection. Where practicable, they should be accessible for visual inspection. Stationary equipment should be installed in such a manner as to permit easy access and thorough cleaning.

Containers for unusable materials or waste should be leak-proof, constructed of metal or other suitable impervious materials, should be easy to clean or be disposable, and should close securely.

All refrigerated spaces should be equipped with temperature measurement or recording devices.

4.4.3 Identification

Equipment used for waste or unusable medicinal plant materials should be identified and not be used for usable medicinal plant materials.

4.5 Quality assurance

Compliance with quality assurance measures should be verified through regular auditing visits to cultivation or collection sites and processing facilities by expert representatives of producers and buyers and through inspection by national and/or local regulatory authorities.

4.6 Documentation

Standard operating procedures should be adopted and documented. All processes and procedures involved in the production of medicinal plant materials and the dates on which they are carried out should be documented. An example of a cultivation record is provided in Annex 5. The types of information that should be collected include:

- seeds and other propagation materials
- propagation
- cultivation or collection site
- crop rotation at the site
- cultivation
- application of fertilizers, growth regulators, pesticides and herbicides
- unusual circumstances that may influence the quality (including chemical composition) of the medicinal plant materials (e.g. extreme weather conditions, exposure to hazardous substances and other contaminants, or pest outbreaks)
- harvest or collection
- all processing
- transportation
- storage
- application of fumigation agents.

Multiple sets of good herbarium specimens should be prepared and preserved for confirmation of plant identity and reference use. A photographic record (including film, video, or digital images) of the cultivation or collection site and the medicinal plants under cultivation or collection should be made, whenever possible.

All agreements between the grower or collector, processor and purchaser, and intellectual property and benefit-sharing agreements should be recorded.

Batch numbers should unambiguously and clearly identify all batches from each cultivation or collection area. Assignment of batch numbers should take place at an early stage of production. Collected and cultivated medicinal plant materials should carry different batch numbers.

Where applicable, the results of audits should be documented in an audit report which contains copies of all documents, analysis reports, and local, national and/or regional regulations, and which are stored according to their requirements.

4.7 Personnel (growers, collectors, producers, handlers, processors)

4.7.1 General

All personnel should receive adequate botanical and agricultural or collection training. All personnel required to apply agrochemicals should be trained in their use. Producers and collectors should receive adequate training and possess sufficient knowledge about appropriate harvesting and techniques employed for plant maintenance and protection for the medicinal plants to be cultivated.

To avoid deterioration of harvested medicinal plant materials during the post-harvest handling and primary processing stages, proper training of all personnel involved is required.

Personnel should be instructed on all relevant issues regarding environmental protection, the conservation of plant species and proper soil management to conserve fields for cultivation and for soil erosion control. The prevention of environmental degradation is an essential requirement to ensure the sustainable long-term use of medicinal plants resources.

National and/or regional regulations governing labour should be respected in the employment of staff for all phases of medicinal plant materials production.

4.7.2 Health, hygiene and sanitation

All production of medicinal plant materials by agriculture and collection should conform to national and/or regional regulations on safety, materials handling, sanitation and hygiene.

All those involved in the handling and processing of cultivated or collected medicinal plants should in all processing procedures comply with national and/or regional regulations on hygiene.

All personnel should be protected from contact with toxic or potentially allergenic herbs by means of adequate protective clothing, including gloves.

Health status

All personnel known, or suspected, to be suffering from or to be a carrier of a disease or illness likely to be transmitted through medicinal plant material, should not be allowed to enter any harvest, production or processing area if there is a likelihood of their contaminating medicinal plant materials. Any persons suffering from diseases or symptoms of illness should immediately report to the management. A medical examination of personnel should be carried out if clinically or epidemiologically indicated.

Illness and injuries

All personnel with open wounds, inflammations or skin diseases should be suspended from work or required to wear protective clothing and gloves until full recovery. Persons suffering from known airborne or food-borne communicable diseases, including dysentery and diarrhoea, should be suspended from work in all areas of production and processing, in accordance with local and/or national regulations.

Health conditions that should be reported to the management for consideration regarding medical examination and/or possible exclusion from handling of medicinal plant materials include: jaundice, diarrhoea, vomiting, fever, sore throat with fever, visibly infected lesions (boils, cuts, etc.) and discharges from the ear, nose or eye. Any personnel who have cuts or wounds and are permitted to continue working should cover their injuries with suitable waterproof dressings.

Personal cleanliness

Personnel who handle medicinal plant materials should maintain a high degree of personal cleanliness, and, where appropriate, wear suitable protective clothing and gloves, including head covering and footwear.

Personnel should always wash their hands at the start of handling activities, after using the toilet, and after handling medicinal plant materials or any contaminated material.

Personal behaviour

Smoking and eating should not be permitted in medicinal plant processing areas. Personnel who handle medicinal plant materials should refrain from behaviours that could result in contamination of the materials, for example, spitting, sneezing or coughing over unprotected materials.

Personal effects such as jewellery, watches or other items should not be worn or brought into areas where medicinal plant materials are handled if they pose a threat to the safety or quality of the materials.

Visitors

Visitors to processing and handling areas should wear appropriate protective clothing and adhere to all of the personal hygiene provisions mentioned above.

5. Other relevant issues

5.1 Ethical and legal considerations

The cultivation, collection and harvesting of medicinal plants, as well as the post-harvest processing of medicinal plant materials, must be carried out in accordance with legal and environmental requirements and with the ethical codes or norms of the community and country in which the activities take place. The provisions of the Convention on Biological Diversity must be respected.

5.1.1 Intellectual property rights and benefits-sharing

Agreements on the return of immediate and/or long-term benefits and compensation for the use of source medicinal plant materials must be discussed and concluded, in writing, prior to collection or cultivation. Contract cultivation of medicinal plants from propagation materials obtained from indigenous medicinal plants of a given country may carry varying degrees of property rights. The issue of rights of access to genetic resources is more complex, especially if the propagation materials have a long history as an item of international commerce, and are not indigenous to a given country.

5.1.2 Threatened and endangered species

Medicinal plants that are protected by national and international laws, such as those listed in national "red" lists, may be collected only by relevant permission according to national and/or international laws. The provisions of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) must be complied with. Endangered medicinal plant species must be sourced only in accordance with national and/or regional legislation.

When medicinal plant materials from threatened, endangered or protected medicinal plant species are obtained through cultivation, they should be accompanied by appropriate documentation in accordance with national and/or regional regulations, to certify that no such medicinal plant materials collected from the wild are included.

5.2 Research needs

A national and/or regional inventory of medicinal plants may facilitate the identification of medicinal plants used by communities (including endangered species), outline their distribution and assess their abundance. It can also be used as a tool in tackling questions concerning intellectual property rights issues. Member States are encouraged to establish such inventories.

Research is greatly needed to improve the agronomy of cultivated medicinal plants, promote the exchange of information on agricultural production and investigate the social and environmental impact of medicinal plant cultivation and collection.

Data sheets and monographs should be developed on medicinal plants that take into account the particular situation of regions and countries. Such information materials can be useful instruments for promoting technical advancement. General as well as specific education and training materials should be developed for local growers and collectors of medicinal plants.

Bibliography

(1) *WHO Traditional Medicines Strategy: 2002–2005*. Geneva, World Health Organization, 2002 (document WHO/EDM/TRM/2002.1).

(2) Good Manufacturing Practices for pharmaceutical products: main principles. In: *WHO Expert Committee on Specifications for Pharmaceutical Preparations. Thirty-seventh report.* Geneva, World Health Organization, 2003, Annex 4 (WHO Technical Report Series, No. 908).

(3) Good manufacturing practices: supplementary guidelines for manufacture of herbal medicinal products. In: *WHO Expert Committee on Specifications for Pharmaceutical Preparations. Thirty-fourth report*. Geneva, World Health Organization, 1996, Annex 8 (WHO Technical Report Series, No. 863). (These guidelines are also included in *Quality Assurance of Pharmaceuticals: A compendium of guidelines and related materials, Vol. 2: Good manufacturing practices and inspection.* Geneva, World Health Organization, 1999.)

(4) *Quality control methods for medicinal plant materials*. Geneva, World Health Organization, 1998.

(5) Guide to good storage practices for pharmaceuticals. In: *WHO Expert Committee on Specifications for Pharmaceutical Preparations. Thirty-seventh report*. Geneva, World Health Organization, 2003, Annex 9 (WHO Technical Report Series, No. 908).

(6) Good trade and distribution practices (GTDP) for pharmaceutical starting materials. In: *WHO Expert Committee on Specifications for Pharmaceutical Preparations. Thirty-eighth report*. Geneva, World Health Organization, in press, Annex 2 (WHO Technical Report Series).

(7) *General guidelines for methodologies on research and evaluation of traditional medicine*. Geneva, World Health Organization, 2000 (document WHO/EDM/TRM/2000.1).

(8) Guidelines for the assessment of herbal medicines. In: *WHO Expert Committee on Specifications for Pharmaceutical Preparations. Thirty-fourth report*. Geneva, World Health Organization, 1996, Annex 11 (WHO Technical Report Series, No. 863). (These guidelines are also included in *Quality Assurance of Pharmaceuticals. A compendium of guidelines and related materials, Vol. 1*. Geneva, World Health Organization, 1997.)

(9) *WHO monographs on selected medicinal plants, Vol. 1.* Geneva, World Health Organization, 1999.

(10) *WHO monographs on selected medicinal plants, Vol. 2*. Geneva, World Health Organization, 2002.

(11) *Report of the Inter-Regional Workshop on Intellectual Property Rights in the Context of Traditional Medicine, Bangkok, Thailand, 6–8 December 2000.* Geneva, World Health Organization, 2001 (document reference WHO/EDM/TRM/2001.1).

(12) *WHO/IUCN/WWF Guidelines on the conservation of medicinal plants*. Gland, Switzerland, IUCN - The World Conservation Union (formerly known as the International Union for Conservation of Nature and Natural Resources), 1993 (currently being updated).

(13) *Codex Alimentarius Code of Practice - General Principles of Food Hygiene*, 2nd ed. Rome, Joint FAO/WHO Food Standards Programme, 2001 (document Codex Alimentarius GL 33).

(14) *Codex Alimentarius Guidelines on production, processing, labelling and marketing of organically produced foods*. Rome, Joint FAO/WHO Food Standards Programme, 2001 (document Codex Alimentarius GL 32-1999, Rev. 1-2001).

(15) *Codex Alimentarius Code of hygienic practice for spices and dried aromatic plants.* Rome, Joint FAO/WHO Food Standards Programme, 1995 (document Codex Alimentarius CAC/RCP 42-1995).

(16) Youngken, HW. *Textbook of Pharmacognosy,* 6th ed. Philadelphia, Blakiston, 1950.

(17) *Cultivation of medicinal plants and quality control, Vols. 1–10*. Tokyo, Ministry of Health, Labour and Welfare Ed. Yakuji Nippo, 1992–2001 (in Japanese).

Annex 1. Good Agricultural Practice for Traditional Chinese Medicinal Materials, People's Republic of China

Decree
by
State Administration of Pharmaceutical Supervision

No. 32

Good Agricultural Practice for Traditional Chinese Medicinal Materials (Trial Edition), adopted after consideration by the General Committee of the State Administration of Pharmaceutical Supervision on 18 March 2002, is hereby issued and will come into force on 1 June 2002.

Director-General

17 April 2002

Good Agricultural Practice for Traditional Chinese Medicinal Materials

(Trial Edition)

Chapter I General Provisions

Article 1 The purpose of this document is to standardize the production of traditional Chinese medicinal material, guarantee its quality, and facilitate the standardization and modernization of traditional Chinese medicines.

Article 2 This document elucidates the basic guidelines for the production and quality control of traditional Chinese medicinal material which are applicable to the entire production process of traditional Chinese medicinal material, including both herbs and animal parts for medicinal use, by manufacturers of traditional Chinese medicinal material.

Article 3 Manufacturers should adopt measures for standardized management and quality surveillance, conserve natural medicinal resources and the ecological environment, and follow the principle of "maximizing sustainable output", so as to ensure sustainable use of resources.

Chapter II Ecological Environment of Production Sites

Article 4 Following the principle of optimizing the suitability of production sites for traditional Chinese medicinal material, manufacturers should make the best of existing conditions and rationalize overall arrangements.

Article 5 The environmental conditions of production sites for traditional Chinese medicinal material should conform to relevant national standards:

The atmospheric conditions should meet the B level standard for atmospheric environment quality; the soil should meet the B level standard for soil quality; water for irrigation should meet the quality standard for agricultural irrigation water; and drinking water for animals intended for medicinal use should meet the quality standard of drinking water for human consumption.

Article 6 Farms breeding animals intended for medicinal use should satisfy the needs of animal populations in relation to ecological factors, as well as corresponding conditions for life and reproduction.

Chapter III Seeds and Propagation Material

Article 7 The species, subspecies, variety or type of bred animals, cultivated herbs or those collected from wild life which are intended for medicinal use should be accurately identified with both the Chinese name and the scientific name recorded.

Article 8 A system of inspection and disease control should be enforced for seeds, fungal spores and propagation material during their production, storage and

transportation processes, so as to ensure quality and prevent the spread of plant diseases, insect pests and weeds, and to prevent the trading and distribution of substandard seeds, fungal spores and propagation material.

Article 9 The introduction and domestication of animals used for medicinal purposes should be in accordance with the habits of these animals. Care should be taken to protect the animals from physical and sensory injury during trapping and transportation. Stringent epidemic control measures must be carried out for the introduction of animal species, with a specific period of quarantine and observation.

Article 10 Efforts should be made to improve the selection and breeding of fine varieties of traditional Chinese medicinal material by developing designated sites for the production of high quality medicinal material and conserving animal and plant resources used for medicinal purposes.

Chapter IV Management of Cultivation and Animal Husbandry

Section One Management in Cultivation of Medicinal Herbs

Article 11 Appropriate areas for cultivation should be identified and corresponding agricultural practices determined on the basis of the specific requirements for growth and development of medicinal herbs.

Article 12 The type, timing and quantity of fertilization should be determined by the nutritional requirements of medicinal herbs and the supporting capacity of the soil. The type of fertilizer used should be largely organic in nature, while limited use may be made of chemical fertilizer according to the needs of various species of medicinal herbs for their growth and development.

Article 13 It is permissible to use farm manure which has been thoroughly composted to meet harm-free sanitary standards. It is prohibited to use urban household garbage, industrial and hospital wastes or human faeces as fertilizer.

Article 14 Timely and proper irrigation and drainage should be carried out in accordance with the pattern of water requirements for medicinal herbs during different periods of growth and development, as well as with climatic conditions and soil dampness, so as to maintain good soil ventilation.

Article 15 In consideration of the growth and development characteristics of medicinal herbs as well as the different parts to be used, field management should be enhanced by the timely application of cultivation measures, such as topping, nipping buds, pruning and shading, so as to control the growth and development of the plant, increase production and keep the quality at a stable level.

Article 16 Comprehensive prevention and control strategies should be used against diseases and insect pests which affect medicinal herbs. If it is necessary to apply

pesticides, the smallest effective dosage should be used and highly effective, low-toxicity and low-residue pesticides should be selected in accordance with the provisions of the Regulations for Pesticide Management in the People's Republic of China, so as to reduce pesticide residue and pollution by heavy metals, and protect the ecological environment.

Section Two Management of Animal Husbandry for Medicinal Purposes

Article 17 Methods and practices of animal husbandry should be identified on the basis of such characteristics as the living environment, food habits and behaviour of animals intended for medicinal purposes and their ability to adapt to the environment, and corresponding animal husbandry regulations and management systems should be determined.

Article 18 Animal feed should be scientifically prepared and given at regular intervals in regular quantities according to the patterns of seasonal and daily activity as well as the different life cycles and physiological characteristics of the animals intended for medicinal purposes. Supplements such as fine feed, vitamins, minerals and other essential additives should be given at appropriates times and in appropriate quantities, but no additives containing hormones or hormone-like substances should be given. The feed and additives should not cause pollution.

Article 19 In animal husbandry for medicinal purposes, the timing and frequency of water supply should be determined with conditions such as the season, air temperature and ventilation in mind. Herbivores should, as far as possible, meet their needs for water through eating large quantities of green and juicy fodder.

Article 20 Fixed structures with adequate space and necessary safety facilities should be set up in accordance with the resting habits, behaviour and other characteristics of animals intended for medicinal purposes.

Article 21 Animals should be raised in a clean environment. A disinfection system should be established, and appropriate disinfectants should be selected for regular disinfection of sites and equipment used in animal husbandry. Management of personnel with access to such sites should be strengthened.

Article 22 Disease control in animals intended for medicinal purposes should mainly rely on prevention, including vaccination at regular intervals.

Article 23 Animal husbandry quarters should be rationally designed with consideration given to appropriate population density in the case of gregarious animals. If sick animals are found, they should be promptly put into quarantine. Animals suffering from infectious diseases should be immediately put to death and incinerated or deeply buried.

Article 24 The composition and structure of animal populations should be determined in accordance with animal husbandry plans and breeding needs, and turnovers should be made at appropriate intervals.

Article 25 It is prohibited to produce traditional Chinese medicinal materials from intoxicated or diseased animals intended for medicinal purposes.

Chapter V Harvesting and Primary Processing

Article 26 The principle of "maximizing sustainable output" should be adhered to in the collection of wild or semi-wild medicinal herbs, with planned cultivation of wild herbs, collection rotation and periods of protected growth, so as to facilitate biological propagation and resource renewal.

Article 27 The appropriate harvesting time (including harvesting seasons and years) and methods should be identified in accordance with the quality of the product and the yield of the plants per unit area or number of animals raised, and with consideration of factors such as conventional harvesting practices.

Article 28 Machinery and instruments used for harvesting should be clean, free of contamination and kept in a dry place free of insects, rodents and livestock.

Article 29 During harvesting and primary processing, efforts should be made, as far as possible, to remove non-medicinal parts and foreign objects, in particular weeds and toxic substances, and to discard damaged or rotten parts.

Article 30 After harvesting, the medicinal parts should be subject to appropriate processing, such as selection, washing, cutting, or trimming. When drying is required, they should be promptly dried by way of appropriate measures and techniques. The temperature and humidity should be controlled to avoid pollution of the medicinal material or damage to active ingredients.

Article 31 Fresh products may be stored by refrigeration, in sand, in jars, by biological conservation and other appropriate conservation methods. The use of conservatives and preservatives should be avoided to the extent possible, and, if their use is requisite, it should conform to relevant national regulations on food additives.

Article 32 Processing sites should be clean, well ventilated, and have the facilities for protection against sunlight, rain, rodents, insects and livestock.

Article 33 Conventional methods should be used for processing genuine medicinal material. If modifications are made, adequate testing data should be provided and the quality of the medicinal material should not be affected.

Chapter VI Packaging, Transportation and Storage

Article 34 Inspection is necessary before packaging to eliminate substandard products and foreign objects. Packaging should be done in accordance with standard operational regulations and records should be kept of batch packaging, including the product name, specifications, origin, batch number, weight, packaging assignment number and packaging date.

Article 35 The material used for packaging should be clean, dry, non-polluted, undamaged and in conformity with the quality requirements for the medicinal material.

Article 36 The product name, specifications, origin, batch number, packaging date and manufacturer should be indicated on each package of medicinal material, and there should also be a label indicating quality approval.

Article 37 Fragile medicinal material should be packaged in strong boxes; toxic, narcotic and valuable medicinal material should be specially packaged with corresponding labels.

Article 38 In the case of bulk transport, medicinal material should not be placed in the vicinity of toxic or noxious substances or those which may affect the taste or smell of the material. Transport containers should be relatively well aerated to maintain dryness, and there should be means of protection against humidity.

Article 39 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. 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.

While using conventional methods of storage, attention should be given at the same time to the selective use of modern and novel storage technology and new equipment.

Chapter VII Quality Control

Article 40 Quality control departments should be set up by manufacturers to oversee the supervisory management and quality control of the entire production process of traditional Chinese medicinal material, and should be supplied with staff, sites, instruments and equipment corresponding to the scale of production and the inspection requirements for the products.

Article 41 The principal functions of the quality control department are:

1. Environmental surveillance and hygiene control;
2. Inspecting production resources, packaging material and medicinal material, and issuing inspection reports;
3. Developing training programmes and supervising their implementation;

4. Preparing and managing quality control documentation, and managing all kinds of original records concerning production, packaging and inspection, etc.

Article 42 Before packaging, an inspection should be made of each batch of medicinal material by the quality control department on the basis of national standards for traditional Chinese medicinal material or standards reviewed and approved by the authorities. The extent of the inspection should at least include the properties and identification of the medicinal material, foreign matter, moisture content, ash content and content of ash insoluble in acids, seepage, marker substances or content of active ingredients. Restrictions on the content of pesticide residue, heavy metals and microorganisms should be in line with national standards and relevant regulations.

Article 43 Inspection reports should be signed by personnel who carried out the inspection and persons in charge of the quality control department. Such inspection reports should be placed on file.

Article 44 Sub-standard traditional Chinese medicinal material is not to be distributed and sold.

Chapter VIII Personnel and Equipment

Article 45 Persons in charge of technological matters at production sites for medicinal material should have received at least two years of higher education in pharmacy or agronomy, animal husbandry or other relevant fields, and should have practical experience in the production of medicinal material.

Article 46 Persons in charge of quality control departments should have completed at least two years of higher education, and should have experience in the quality control of medicinal material.

Article 47 All personnel involved in the production of traditional Chinese medicinal material should have a basic understanding of Chinese pharmacy, agronomy or animal husbandry, and should have received training in production techniques, safety and hygiene. Personnel working in the fields should have good knowledge of cultivation techniques, particularly the use of pesticides and protection techniques; personnel involved in animal husbandry should have a good understanding of animal husbandry techniques.

Article 48 Personnel involved in processing, packaging and inspection should receive medical check-ups at regular intervals. Persons suffering from infectious diseases, skin disease or open wounds should not be allowed to perform functions which involve direct contact with medicinal material. Specific persons should be designated by the manufacturer to be responsible for inspecting environmental sanitation and personnel hygiene.

Article 49 Relevant personnel involved in the production of traditional Chinese medicinal material should receive training and be examined at regular intervals.

Article 50 Production sites for traditional Chinese medicinal material should be furnished with toilets or washrooms, and excreta should not lead to pollution of the environment and the products.

Article 51 The extent of application and precision of instruments, meters, measuring tools and weighing equipment used in production and inspection at production sites should be in line with the requirements for production and inspection. Such equipment should carry clearly marked labels indicating their status, and be regularly calibrated.

Chapter IX Documentation

Article 52 Manufacturers should have standard operational regulations for production management and quality control.

Article 53 There should be detailed records kept of the entire production process for each kind of traditional Chinese medicinal material, with photographs or pictures when necessary. The records should include:

1. The origin of seeds, fungal spores and propagation material;
2. Production techniques and processes:
   (1) The planting time, quantity and area of medicinal herbs; the growth of seedlings, transplantation, the kind of fertilizer used, and the time, amount and method of its use; the type of pesticide used - including insecticides, fungicides and herbicides – and the amount, time and method of its use.
   (2) In the case of animals intended for medicinal purposes, daily records of animal husbandry, turnover plans, records of selection and breeding, records of births and the production of eggs, records of diseased cases, death reports, death registration forms, statistical forms for disease control and vaccination, feed preparation forms, feed consumption records, pedigree registration forms, offspring identification forms, etc.;
   (3) The time of collection, collected amount, fresh weight, processing, drying, reduced weight after drying, transportation, and storage of medicinal parts;
   (4) Meteorological data and micro-climatic records;
   (5) Evaluation of the quality of the medicinal material: records of the properties and inspection results of the medicinal material.

Article 54 All original records, production plans and records of their implementation, contracts and written agreements should be put on file and kept for at least 5 years. Files and archives should be maintained by designated persons.

Chapter X Supplementary Articles

Article 55 Glossary:

(1) **Traditional Chinese medicinal material** refers to raw medicinal material produced by primary processing at the place of origin after collecting the medicinal parts of plants and animals intended for medicinal purposes.

(2) **Manufacturers of traditional Chinese medicinal material** refer to enterprises of a certain scale which follow certain procedures in the production process, such as the cultivation of medicinal herbs or animal husbandry, primary processing, packaging and storage of medicinal material.

(3) **Maximizing sustainable output** refers to the maximum output of sustainable production (collection) with no harm caused to the ecological environment.

(4) **Genuine medicinal material** refers to traditional Chinese medicinal material with specific properties, originating from specific locations or produced through specific production techniques and processing methods.

(5) **Seeds, fungal spores and propagation material** refer to parts, tissues and cells of plants as well as hyphae and fungal seeds which can be used for propagation; and breeding stock, young animals and eggs.

(6) **Comprehensive prevention and control of diseases and insect pests** refers to keeping the harm caused by diseases and insect pests below the economic threshold by appropriately implementing biological, agricultural and chemical methods as well as other effective ecological measures that are safe, efficient, affordable, easy to use, and suitable for local conditions with an overall view of biological and environmental circumstances and based on the principle of giving priority to prevention, so as to achieve the aim of improving economic efficiency and increasing ecological benefits.

(7) **Semi-wild animals and plants intended for medicinal purposes** refer to wild animals and plants intended for medicinal purposes or those which have reverted to wild life, but which have been subject to appropriate human care and management, such as intertilling, weeding, fertilization or feeding.

Article 56 The power of interpreting this present document lies with the State Administration of Pharmaceutical Supervision.

Article 57 The provisions of this document shall come into force on 1 June 2002.

Annex 2. Points to Consider on Good Agricultural and Collection Practice for Starting Materials of Herbal Origin

The European Agency for Evaluation of Medicinal Products (EMEA), Working Party on Herbal Medicinal Products (HMPWP)

London, 2 May 2002
EMEA/HMPWP/31/99 Rev.3

POINTS TO CONSIDER ON GOOD AGRICULTURAL AND COLLECTION PRACTICE FOR STARTING MATERIALS OF HERBAL ORIGIN

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The views presented in this document are those of the HMPWP, which has been created as a forum for exchange of experience in the field of herbal medicinal products. This document is released for the purposes of transparency and has no legal force with respect to Directive 2001/83/EC.

General note:

The EMEA Working Party on Herbal Medicinal Products hereby acknowledges the fact that the document on "Good Agricultural Practice (GAP)" issued by the European Herb Growers Association (Europam) of 5 August 1998 has formed the basis for this document.

This guidance replaces previous comments released by the working party:

- Comments on the Draft Directive on the Good Manufacturing Practice (GMP) Guide for Starting Materials of Medicinal Products and Inspection of Manufacturers (EMEA/HMPWP/17/99).
- Comments on the document Good Agricultural Practice (GAP) from the European Herb Growers Association (Europam) of 5 August 1998 (EMEA/HMPWP/18/99).

POINTS TO CONSIDER ON GOOD AGRICULTURAL AND COLLECTION PRACTICE FOR STARTING MATERIALS OF HERBAL ORIGIN

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1. INTRODUCTION

Examples of adulteration of medicinal plants/herbal drugs with toxic herbal drugs demonstrate the need to establish good manufacturing practice for herbal starting materials. The concept of Good Manufacturing Practice for the manufacture, processing, packaging and storage of Active Pharmaceutical Ingredients (APIs) should thus also apply to medicinal plants/herbal drugs.

In the case of herbal drug preparations the production and primary processing of the medicinal plant/herbal drug has a direct influence on the quality of the API. Due to the inherent complexity of naturally grown medicinal plants/herbal drugs and the limited analytical techniques to characterise constituents solely by chemical or biological means, reproducible quality of starting materials of herbal origin requires an adequate quality assurance system for the collection and/or cultivation, harvest and primary processing.

Collection in wild habitats, often in developing countries, presents special problems, especially with regard to confusion with similar plants, environmental damage, lack of control and poorly qualified personnel.

The following "Points to Consider" on good agricultural and collection practice does not fall directly under GMP guidelines in the traditional sense. However, these considerations should be used as a basis for the establishment of such an appropriate quality assurance system.

2. GENERAL

2.1 This "Points to Consider" document is intended to address the specific concerns of growing, collecting and primary processing of medicinal plants/herbal drugs that are used for medicinal purposes. It addresses specific issues associated with agricultural production and collection of medicinal plants/herbal drugs in the wild. These considerations should be read in connection with GMP guidelines for APIs and should apply to all methods of production including organic production in accordance with regional and/or national regulations. These provide additional standards for the production and processing of medicinal plants/herbal drugs insofar as they mainly focus on identifying those critical production steps that are needed to ensure good quality.

2.2 The main aim is to ensure consumer safety by establishing appropriate quality standards for medicinal plants/herbal drugs. Especially important aspects are that medicinal plants/herbal drugs:

- are produced hygienically, in order to reduce microbiological load to a minimum,
- are handled with care so that medicinal plants/herbal drugs are not adversely affected during collection, cultivation, processing and storage.

During the course of the production process medicinal plants/herbal drugs and their preparations are exposed to a large number of microbiological and other contaminants. This "Points to Consider" provides recommendations for producers to reduce contamination to a minimum.

2.3 These "Points to Consider" are intended for all participants from primary producers to traders and processors.
Therefore, producers, traders and processors of medicinal plants/herbal drugs should comply with these considerations, document all relevant activities in batch documentation and demand that their partners do likewise, unless it can be justified otherwise.

Growers and collectors of medicinal plants/herbal drugs must insure that they avoid damage to existing wildlife habitats. CITES (Convention on International Trade in Endangered species of Wild Fauna and Flora) must be adhered to.

3. QUALITY ASSURANCE

Agreements between producers and buyers of medicinal plants/herbal drugs with regard to quality such as content of active principle, macroscopical and olfactory properties, limit values for microbial contamination, chemical residues and heavy metals etc., must be based on recognised regional and/or national specifications and should be laid down in written form.

4. PERSONNEL AND EDUCATION

4.1 All primary processing procedures should fully conform with regional and/or national guidelines on food hygiene and personnel entrusted with handling of medicinal plants/herbal drugs should be required to have a high degree of personal hygiene (including personnel working in the field) and have received adequate training regarding their hygiene responsibilities.

4.2 The welfare of all staff involved in growing and processing should be ensured.

4.3 Personnel must be protected from contact with toxic or potentially allergenic medicinal plants/herbal drugs by means of adequate protective clothes.

4.4 Persons suffering from known infectious diseases transmittable via food, including diarrhoea, or being transmitters of such diseases, must be suspended from areas where they are in contact with medicinal plants/herbal drugs, according to regional and/or national regulations.

4.5 Persons with open wounds, inflammations and skin-infections should be suspended from areas where the plant processing takes place or should have to wear appropriate protective clothing/gloves until their complete recuperation.

4.6 Personnel should receive adequate botanical training before performing tasks that require this knowledge.

4.7 Collectors must have sufficient knowledge of the plant they have to collect. This includes identification, characteristics and habitat requirements such as shade, humidity, soil etc. The collectors must be able to differentiate between the collected species and botanically related and/or morphologically similar species to avoid any risk to public health. Collectors should have sufficient knowledge about the best time to harvest and harvesting technique and the importance of primary processing to guarantee the best possible quality.

4.8 If collectors are without sufficient knowledge, a local supervisor should guarantee the education, supervision and documentation.

4.9 It is advisable to educate all personnel dealing with the medicinal plant/herbal drug and all those engaged in its cultivation regarding cultivation techniques including the appropriate use of herbicides and pesticides.

4.10 Collectors of medicinal plants/herbal drugs should be instructed on all issues relevant to the protection of the environment and conservation of plant species. This will include information on regulations related to protected species.

5. BUILDING AND FACILITIES

5.1 Buildings used in the processing of harvested medicinal plants/herbal drugs must be clean, as well as thoroughly aerated and must never be used for housing livestock.

5.2 Buildings must provide adequate protection for the harvested medicinal plants/herbal drugs against birds, insects, rodents and domestic animals. In all storage and processing areas suitable pest control measures such as baits and electric insect killing machines must be operated and maintained by professionally qualified staff or contractors.

5.3 It is recommended that the packaged medicinal plant/herbal drug be stored:

- in buildings with concrete or similar easy to clean floors,
- on pallets,
- with a sufficient distance from the wall,
- well separated from other herbal drugs to avoid cross-contamination.

Organic products must be stored separately.

5.4 Buildings where plant processing is carried out must have changing facilities as well as toilets including hand-washing facilities, according to regional and/or national regulations.

6. EQUIPMENT

Equipment used in plant cultivation and processing should:

6.1 Be clean, regularly serviced and oiled to ensure good working order and mounted, where applicable, in an easily accessible way. Furthermore, machinery used in fertiliser and pesticide application must be regularly calibrated.

6.2 Those machine parts that are in direct contact with the harvested medicinal plant/herbal drugs, must be cleaned after use to ensure that remaining residue does not result in subsequent cross-contamination.

6.3 The equipment should be made from appropriate materials so that cross-contamination of medicinal plants/herbal drug with chemicals and other non-desirable substances is prevented.

7. DOCUMENTATION

7.1 All processes and procedures that could affect the quality of the product must be documented.

7.2 Extraordinary circumstances during the growth period that may influence the chemical composition of the medicinal plant/herbal drug such as extreme weather conditions and pests, particularly in the harvest period must be documented.

7.3 For cultivated medicinal plants/herbal drugs all processing steps have to be documented including the location of cultivation. Field records showing previous crops and plant protect products used should be maintained by all growers.

7.4 For cultivated medicinal plants/herbal drugs, it is essential to document the type, quantity and the date of harvest as well as the chemicals and other substances used during production such as fertilizers, pesticides, herbicides and growth promoters.

7.5 The application of fumigation agents must be documented.

7.6 The geographic location of the collection area and the harvest period should be described as precise as possible.

7.7 All batches from each designated area should be unambiguously and unmistakably identified by batch number. Assignment of batch number should take place at an early stage. Collected and cultivated medicinal plant/herbal drug material should carry different batch numbers.

7.8 Batches from different geographical areas shall be mixed only if it can be guaranteed that the mixture itself will be homogenous. Such processes should be well documented.

7.9 All agreements (production guidelines, contracts etc.) between producer or collector and buyer should be in written form. It should be documented that cultivation, harvesting and production have been performed in accordance with these agreements. Minimum information included in the documentation should cover geographical location, country of origin and responsible producer.

7.10 The results of audits should be documented in an audit report (copies of all documents, audit reports, analysis reports) to be stored for a minimum of 10 years.

8. SEEDS AND PROPAGATION MATERIAL

8.1 Seeds should be verified botanically, indicating genus, species, variety/cultivar/chemotype and origin and should be traceable. The same applies to vegetatively propagated medicinal plants. Seeds and/or vegetatively propagated medicinal plants used in organic production have to be certified as organic. The starting material should be as free as possible from pests and diseases in order to guarantee healthy plant growth. Species resistant or tolerant to disease should preferably be used.

8.2 The presence of different species, varieties or different plant parts has to be controlled during the entire production process, and such adulteration should be avoided. The use of genetically modified medicinal plants or seeds must comply with regional and/or national regulation

9. CULTIVATION

Different Standing Operating Procedures may be acceptable depending on whether conventional or organic methods of cultivation are employed. However, care should be taken to avoid any environmental impact. The principles of good crop husbandry must be followed including appropriate rotation of crops.

9.1 Soil and fertilisation

9.1.1 Medicinal plants should not be grown in soil contaminated with sludge, heavy metals, residues, plant protection products or other chemicals etc. Any chemicals used in the growth or protection of the crop should be kept to a minimum.

9.1.2 Manure applied should be thoroughly composted and should be void of human faeces.

9.1.3 All other fertilising agents should be applied sparingly and in accordance with the needs of the particular species. Fertilisers should be applied in such a manner as to minimise leaching.

9.2 Irrigation

9.2.1 Irrigation should be controlled and carried out according to the needs of the medicinal plant.

9.2.2 Water used in irrigation should comply with regional/national quality standards.

9.3 Crop maintenance and plant protection.

9.3.1 Tillage should be adapted to plant growth and requirements.

9.3.2 Pesticide and herbicide applications should be avoided as far as possible. When necessary approved plant protection products should be applied at the minimum effective level in accordance with the recommendations from the manufacturer and authorities. The application should be carried out only by qualified staff using approved equipment. The minimum interval between such treatment and harvest time must be stipulated by the buyer or be consistent with recommendations from the manufacturer of the plant protection product. Regional and/or national regulations on maximum residue limits in the European Pharmacopoeia, European Directives, Codex Alimentarius etc should be complied with.

10. COLLECTION

10.1 Individuals should be designated to identify and verify collected medicinal plants/herbal drugs and to supervise collectors. (see 4.7 and 4.8)

10.2 Collection must be carried out in compliance with existing regional and national and/or national species conservation legislation. Collection methods must not damage the growth environment ensuring optimum conditions for regeneration of the medicinal plant/herbal drug harvested.

10.3 Medicinal plants/herbal drugs from species that are listed as endangered (CITES, Convention on International Trade in Endangered Species of Wild Fauna and Flora) must not be collected unless the relevant competent authority has given its authorisation. (see 4.10)

10.4 The recommendations in sections 3, 5, 6, 7, 11, 12, 13 and 14 have to be followed.

11. HARVEST

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

11.2 Damaged plants or parts plants need to be excluded.

11.3 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.

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

11.5 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.

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

11.7 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.

11.8 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

- overfilling of the sacks,
- stacking up of sacks.

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

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

12. PRIMARY PROCESSING

12.1 Primary processing includes washing, cutting before drying, fumigation, freezing, distillation, drying, etc. All of these processes must conform to regional and/or national regulations.

12.2 On arrival at the processing facility the harvested medicinal plant/herbal drug has to be promptly unloaded and unpacked. Prior to processing the material should not be exposed directly to the sun, except in cases where there is a specific need, and must be protected from rainfall

12.3 In the case of natural open air drying, the medicinal plant/herbal drug must be spread out in a thin layer. In order to secure adequate air circulation, the drying frames must be located at a sufficient distance from the ground. Drying directly on the ground or under direct exposure to the sunlight should be avoided unless specifically required. Attempts must be made to achieve uniform drying of the medicinal plant/herbal drug and thus avoid mould formation.

12.4 Except in the case of open air drying, the drying conditions such as temperature, duration etc must be selected taking into consideration the medicinal plant part such as root, leaf or flower and the nature of its active constituent, such as essential oils. The source of heat in direct drying should be limited to butane, propane or natural gas. Individual conditions must be recorded in detail.

12.5 All materials must be inspected and where necessary sieved in order to eliminate sub-standard product and foreign bodies. Sieves must be maintained in a clean state and should be serviced regularly.

12.6 Clearly marked waste-bins should be available, emptied daily and cleaned.

13. PACKAGING

13.1 In order to protect the product and to reduce the risk of pest attacks, early packaging is advisable.

13.2 Following processing monitored by in-process controls, the product should be packaged in clean and dry, preferably new sacks, bags or cases. The label must be clear, permanently fixed and made from non-toxic material. Information must conform with regional and/or national labelling regulations.

13.3 Reusable packaging material should be well cleaned and perfectly dried prior to use. No contamination should occur through reusing of bags.

13.4 Packaging materials must be stored in a clean and dry place that is free of pests and inaccessible to livestock and domestic animals. It must be guaranteed that no contamination of the product occurs by the use of packaging materials, particularly in the case of fibre bags.

14 STORAGE AND DISTRIBUTION

14.1 Packaged 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.
Fresh products should be stored between 1°C and 5°C while frozen products should be stored below -18°C (or below -20°C for long term storage).

14.2 In the case of bulk transport, it is important to secure dry conditions. Furthermore, in order to reduce the risk of mould formation or fermentation it is advisable to use aerated containers. As a substitute, the use of sufficiently aerated transport vehicles and other aerated facilities is recommended. Essential oil transport must conform with appropriate regulations. Regional and/or national regulations on transport have to be respected.

14.3 Fumigation against pest attack should be carried out only where necessary and must be carried out exclusively by licensed personnel. Only registered chemicals must be used. Any fumigation against pest attack should be reported in the documentation.

14.4 For fumigation of warehouses, only substances permitted by the regional and/or national regulations should be used.

14.5 When frozen storage or saturated steam is used for pest control, the humidity of the material must be controlled after treatment.

GLOSSARY

Herbal drugs are mainly whole, fragmented or cut, plants, parts of plants, algae, fungi, lichen in an unprocessed state, usually in dried form but sometimes fresh. Certain exudates that have not been subjected to a specific treatment are also considered to be herbal drugs. Herbal drugs are precisely defined by the botanical scientific name according to the binomial system (genus, species, variety and author).

Herbal drug preparations are obtained by subjecting herbal drugs to treatment such as extraction, distillation, expression, fractionation, purification, concentration or fermentation. These include comminuted or powdered herbal drugs, tinctures, extracts, essential oils, expressed juices and processed exudates.

Annex 3. Good Agricultural and Collection Practices for Medicinal Plants (GACP), Japan

September 2003

(Original in Japanese; Unofficial translation of an abridged version)

General Remarks

Preface

0.1 Good agricultural and collection practices for medicinal plants (GACP) is a technical guideline on the production of medicinal plant materials as starting materials for crude drugs, finished crude drugs and Kampo medicines, and deal with the following areas:

- Cultivation and collection of medicinal plants and production of medicinal plant materials;
- Post-harvest processing required for medicinal plant materials;
- Quality control of medicinal plant materials.

The GACP is based on *Guidelines on cultivation and quality control of medicinal plants, volumes 1−10* (17), whose development were supported by a research grant provided by the Ministry of Health, Labour and Welfare of Japan, with reference to Japanese national quality standards such as *The Japanese Pharmacopoeia* and *Japanese Standards for Herbal Medicines*. .

0.2 If produced in compliance with this guideline, the medicinal plant materials shall:

- be a high quality product;
- be produced and stored according to good practice and hygiene standards, such that the microbiological load is below the minimum contamination level;
- be produced and stored according to good practice and hygiene standards, such that they should be either free from pesticide residues and other foreign matter or below the minimum level of contamination by pesticide residues and other foreign matter.

0.3 With regard to the minimum level of contamination by microbiological organisms, pesticide residues and other foreign matter, the general principles given in *The Japanese Pharmacopoeia* should be followed. The actual producer of medicinal plant materials should understand the general principles and should bear in mind the issues associated with the cultivation of medicinal plants as well as post-harvest processing of medicinal plants.

0.4 If medicinal plant materials are produced in compliance with this guideline, they should be described as "products produced in compliance with the guideline" for the information of the general public.

0.5 This guideline should be widely disseminated both nationwide and worldwide in order to promote understanding of the importance of the issues involved.

1. Introduction

1.1 In the production processes, including cultivation and collection of medicinal plants and post-harvest processing of the medicinal plant parts, undergone by the raw materials for use in the production of Kampo medicines and crude drug products, the raw materials should be kept as free as possible from microbial and other contaminants and residues such as pesticides.

1.2 In order to produce high quality raw materials, the following procedures should be considered:

- Materials should be well washed in case of possible contaminants;
- The skin of the material should be peeled and the materials should be dried at low temperature in order to avoid any change in the colour and odour of materials, where necessary and appropriate.

1.3 The guideline serve as the standard for the level of microbial contamination in the production of raw materials for crude drugs.

2. Cultivation

2.1 Medicinal plants should not be cultivated in areas where the land and/or the soil is in a hazardous condition. By hazardous condition of land and/or soil is meant those that are at high risk of contamination by hazardous substances, including heavy metals, agricultural chemical agents, and other industrial waste.

2.2 The preferred soil conditions for the cultivation of medicinal plants are well drained and well irrigated soils.

2.3 Water for irrigation should not be contaminated by domestic animals and human materials.

2.4 Organic compost: the land should be manured with well fermented organic compost either prior to planting or immediately after the first harvest.

2.5 Cows should be prohibited from entering cultivation sites.

2.6 Contaminated water should not be used at the time of harvest.

2.7 Medicinal plants should be planted in an area of land where weeds can grow. Weeds could be an indicator of good cultivation conditions.

2.8 Pesticides and herbicides should be handled only by experienced personnel. The spraying of these chemical agents should be carried out by trained personnel, prior to the harvest at an appropriate interval, and with consideration of the effective duration of the agent used.

3. Harvesting

3.1 Crop harvesting should not be carried out in wet conditions (dew or rain) or in conditions of high humidity. Whenever possible, harvesting should be carried out in dry, low humidity conditions.

3.2 Harvesting equipment should be clean and well maintained.

3.3 Where mechanical cutters/harvesters are used, the machine parts in contact with the crop, together with their housing, should be cleaned regularly and kept free from accumulated plant material and other debris.

3.4 Cutter blades should be adjusted to avoid soil pick-up.

3.5 All containers used for primary collection of the crop must be kept free from previously accumulated plant material, and when not in use they must be kept in a dry place free from vermin and inaccessible to farm and domestic animals.

3.6 Damaged and spoiled crop material should be sorted and discarded.

3.7 Harvested material should be collected in dry sacks, baskets, trailers or hoppers. It must not be collected on the ground.

3.8 Mechanical damage, high compaction and storage which promotes composting should be avoided:

- plastic sacks should not be used during harvesting;
- sacks must not be overfilled;
- stacking should avoid compaction.

3.9 The time between harvest and transport of crop to the drying site should be kept as short as reasonably practicable.

3.10 The harvested crop should be protected from pests and farm and domestic animals.

4. Drying

4.1 The crop should be unpacked as soon as possible on arrival at the drying facilities. It must not be allowed to stand for extended periods in direct sunlight and must be protected from rain.

4.2 Buildings used for drying crops should be well ventilated and never used for livestock.

4.3 The building should be constructed so as to protect the crop from birds, insects, farm and domestic animals.

4.4 Drying racks should be kept clean and regularly maintained.

4.5 Crops should be placed in thin layers, on wire mesh racks standing off the floor to allow free air circulation, and stirred intermittently to ensure uniform drying and prevent composting.

4.6 Drying on the floor and in direct sunlight is not recommended.

4.7 Dried crops should be inspected and sieved or winnowed to remove discoloured, mouldy and damaged material and soil, stones and other foreign matter. Sieves should be kept clean and maintained regularly.

4.8 Clearly marked waste bins should be provided, emptied daily and cleaned.

4.9 Dried and drying crops should be protected from pests and farm and domestic animals.

4.10 Dried crops should be packed as soon as possible for protection and to lessen the opportunity of pest infestation.

5. Packing

5.1 After removal of damaged material and foreign matter, the sound dried crop should be packed in clean, dry sacks, bags or boxes, preferably new.

5.2 Packing materials should be stored in a clean dry place free from pests and inaccessible to animals.

5.3 Reusable packaging materials such as jute sacks, plastic bags, etc., should be well cleaned and dried before re-use.

5.4 The packed crop should be stored in a dry place away from the wall and off the ground and be protected from pests and farm and domestic animals.

5.5 Whenever possible, the packaging materials used should be agreed between the supplier and the buyer.

6. Storage and Transport

6.1 Packed dried crop should be store in a dry, well ventilated building, with minimal variation in diurnal temperature and with good air ventilation.

6.2 Shutter and door openings should be protected by wire screens to keep out pests and farm and domestic animals.

6.3 It is recommended that packed dried crops should be stored:

- in a building with concrete floors;
- on pallets;
- away from the wall;
- well separated from all other crops.

6.4 For bulk deliveries, the use of vented containers for transport and storage in temporary warehousing is highly recommended to minimize contamination risks. Alternatively, suitable vented transport vehicles and temporary storage facilities are recommended.

6.5 Whenever possible, the conditions for transport and temporary storage should be agreed between supplier and buyer.

6.6 Fumigation to control pests should be applied only where necessary; trained personnel should carry out fumigation. Only approved fumigants should be applied (see also 9.2).

6.7 Chemicals used as pesticides, fumigants, etc., should be kept in a separate area.

7. Equipment

7.1 Equipment used for the production and handling of crops should be easily cleaned to minimize contamination. Dry cleaning is recommended. Where the use of water is unavoidable, equipment should be dried as quickly as possible.

7.2 All equipment should be installed to allow easy access and should be well maintained and cleaned regularly.

7.3 The use of wood should be avoided wherever possible.

7.4 Wooden equipment (e.g., pallets, hoppers etc.), if used, should not have chemical treatments, such as chemical fungicides, which could be the source of taint, e.g., chlorophenols.

8. Personnel

8.1 Personnel handling medicinal plant material should:

- maintain a high degree of personal hygiene;
- be provided with suitable changing facilities and toilets with hand washing facilities.

8.2 Personnel should not be permitted to work in the herbal material handling area if they are known to be suffering from, or to be carriers of, a disease likely to be transmitted through medicinal plant materials, including diarrhoea.

8.3 Personnel with open wounds, sores, and skin infections should be transferred away from herbal materials handling areas until completely recovered.

9. Documentation

9.1 Keeping records of fertilizer, pesticide and herbicide used on each batch of harvested material is highly desirable.

9.2 The use of methylbromide or phosphine for fumigation of herbal materials should be:

- notified to the buyer;
- recorded in shipment papers.

10. Training and Education

10.1 Training and education of personnel, whether handling crops or managing crop production, in appropriate production techniques is highly recommended. This can be achieved by using experts from local agricultural institutes or those provided by the buyers.

11. Quality Control

11.1 Compliance with the recommendations of the GACP should be checked through regular inspection visits by the producer's and the buyer's representatives with expertise in good agricultural and hygiene practice.

11.2 Specifications for herbal materials should be agreed between the producer and the buyer; these may include, for example, active principles and characteristic constituents, microbial load, visual and sensory properties, pesticide residues and heavy metals.

Annex 4. A model structure for monographs on good agricultural practices for specific medicinal plants

The guidelines for cultivation of medicinal plants and quality control in Japan set out the recommendations for the cultivation of specific plants in a series of monographs.[1] The monographs are structured along the following lines**:**

1. Name of medicinal plant:

(1) *Japanese name of the medicinal plant*

If no Japanese name for the medicinal plant has been established and the compendium name (see below for definition) has been used as equivalent to the plant name in Japan, the compendium name is given instead.

(2) *Compendium name*

The Japanese name for the medicinal plant material used for medicinal purposes (crude drug name)

(3) *Scientific name*

As defined in *The Japanese Pharmacopoeia*. For plants not included in *The Japanese Pharmacopoeia*, the established and widely used botanical name is given.

2. Part to be employed as the medicinal plant material

Description of the part of the medicinal plant used for medicinal purposes.

3. Characteristics of the medicinal plant

Description of the major morphological and botanical characteristics of the medicinal plant concerned.

[1] *Cultivation of medicinal plants and quality control, Vols. 1–10*. Tokyo, Ministry of Health, Labour and Welfare Ed.. Yakuji Nippo, 1992–2001 (in Japanese) (*17*).

4. Characteristics of the medicinal plant material and major production areas

(1) *Characteristics of the medicinal plant material*

As defined in *The Japanese Pharmacopoeia* or as widely acknowledged/ recognized

(2) *Major production areas of the medicinal plant material*

The major cultivating sites in Japan and in other countries.

5. Characteristics of strain(s) for cultivation

(1) Morphological characteristics

(2) Ecological characteristics

(3) Composition of characteristic chemical ingredients of medicinal plant materials

(4) Preferred growing conditions

a) Climatic conditions

Indicated by code according to attached classifications showing:

– Temperature coldness/warmth

– Daylight length

b) Soil conditions

Indicated by code according to attached classifications showing:

– Soil type

– Soil conditions drainage/moisture retention

suitability to fertile soil

c) Shade requirements

6. Cultivation methods

(1) Species and strains

(2) Propagation methods

(3) Cultivation

a) Suitable cultivation conditions:

b) Propagation

c) Sowing /nursery/plantation

d) Fertilizer

e) Care and management

f) Diseases and pests

g) Harvest method and procedure

h) After-harvest processing

i) Expected yield

7. Quality evaluation of the medicinal plant material

(1) *National quality standard of the medicinal plant material*

Defined as the quality and quantity standard given in *The Japanese Pharmacopoeia* or *Japanese Standards for Herbal Medicines*.

(2) *Name of major chemical constituents*

As indicators for quality evaluation.

(3) *Chemical structure of selected major constituents*

Drawings of chemical structures where appropriate.

8. Comparative summary table of the characteristics of different cultivated strains

Morphological characteristics of each strain being cultivated, including height, growth speed, morphology/shape of root, stem, leaf, flower, fruit and seed, resistance/tolerance to characteristic diseases/pests, and composition and quantitative indications of major chemical constituents of the medicinal plant material.

9. Cultivation calendar

A tabulated schedule of cultivating procedures for the medicinal plant, indicating the type of care and management work/actions and their timing during the entire cultivation process.

10. Background data and other information

(1) *Origin of seed, medicinal plant, propagation material, etc.*

(2) *Cultivation for confirmation*

To assess the appropriateness/suitability of cultivation and characteristics of seed/propagation material. Cultivation should be carried out according to the established cultivation method.

(3) *Intended medical indication (s) of the medicinal plant material*

(4) *Names of Kampo formulae*

(5) *Photographs (5–10)*

Of the medicinal plant and the medicinal plant material; also showing working methods/equipment as appropriate.

Attachments:

Geographical classification maps showing (1) warmth, (2) coldness, (3) daylight length and (4) soil type.

Annex 5. Sample record for cultivated medicinal plants

Identification of cultivated medicinal plant

Scientific name (genus, species, author, family): _____

_____

Local name: _____

English common name (if known): _____

Plant part for harvest: _____

Crop code no.: _____

Identification of cultivation site

Field location: _____

Province/state/country: _____

Identification of cultivator

Name of cultivator: _____

Contact address: _____

Date(dd/mm/yyyy) cultivation begins: _____

Date (dd/mm/yyyy) cultivation ends: _____

Seeds and propagation materials

Source of the planted material: _____

Physical description of the planted material: _____

Commercially available (circle): yes / no

If yes, name of cultivar:_____ name of supplier: _____

Cultivation

Method of propagation materials establishment (circle): direct seed sowing / transplants

Date of first sowing/planting: _____ Percentage emergence: _____

Date of re-sowing/replanting: _____ Percentage stand establishment: _____

Distance between rows (cm): _____ Distance between plants (cm): _____

Size of planted area (m^2): _____ Number of plants per unit area: _____

Crop rotation: _____

Type of soil: % Clay _____ % Sand _____ % Silt _____

% Organic matter _____ % Others (describe) _____

Soil pH _____ Soil fertility (circle): good / poor

Soil moisture retention (circle): good / poor Soil drainage (circle): good / poor

Irrigation (circle): yes / no Land (circle): even / sloping

Type of irrigation (circle): flood / furrow / sprinkler / drip

Source of water (circle): municipal piped supply/lake/ river/ well / other

If Other, please specify:_____

Quality of water: good / bad

Description: _____

Salt content in water (circle): low / high

Name of adjacent plants: _____

Insects on adjacent plants (circle): Aphids/scale/caterpillars/locust/other

If Other, please specify: _____

Agrochemicals

Fertilizer applied before planting (circle): organic (composted animal manure) / chemical

Name: _____ Method_____

Time/date (d/m/y):_____ Rate_____

Herbicides applied before planting:

Name: _____ Method_____

Time/date (d/m/y): _____ Rate_____

Herbicides applied after planting

Name: _____ Method_____

Time/date (d/m/y): _____ Rate_____

Pesticides applied:

Name: _____ Method _____

Time/date (d/m/y): _____ Rate _____

Harvest/Collection

Date of harvest: _____ Time of day: _____

Conditions: _____ Method: _____

Yield: _____

Unusual circumstances that may influence quality
(extreme weather conditions, exposure to hazardous substances, pest outbreaks, etc.):

_____

_____

Summary of plant growth conditions Year_____

	Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sept	Oct	Nov	Dec
Duration of sunlight (hours)												
Average day temperature (°C)												
Average night temperature (°C)												
Average rainfall (mm)												
Plant height (cm.)												
Plant diameter (cm)												
Flower buds												
Calyx formation												
Insect damage												
Diseases												
Herbicide applied												
Pesticide applied												
Branching												
Tillage												
Irrigation												
Frost/chilling												
Wind												
Drought												
Yield per plant (part).												

Other observations and recommendations: _____

_____

If needed, write additional information or details of the work or observations on a separate sheet.

Annex 6. Participants in the WHO Consultation on Good Agricultural and Field Collection Practices for Medicinal Plants

World Health Organization, Geneva, Switzerland, 7–9 July 2003

Mr Emmanuel **Agyarko**, Chief Executive, Food and Drugs Board, Accra, Ghana

Dr Dora N. **Akunyili**, Director General, National Agency for Food and Drug Administration and Control, Garki Abuja, Nigeria [Chairperson]

Professor Ahmad S. **Alkofahi**, Dean, Faculty of Pharmacy, Jordan University of Science and Technology, Irbid, Jordan

Dr Linda **Anderson**, Pharmaceutical Assessor, Medicines and Healthcare Products Agency, Department of Health, London, England

Mr U. **Aung** Myat Kyaw, Director, Department of Traditional Medicine, Ministry of Health, Yangon, Myanmar

Dr Kamel **Boukef**, Centre National de Transfusion Sanguine, Ministère de la Santé Publique, Tunis, Tunisia

Dr Anchalee **Chuthaputti**, Senior Pharmacist, Institute of Thai Traditional Medicine, Department for Development of Thai Traditional and Alternative Medicine, Ministry of Public Health, Nonthaburi, Thailand

Professor Peter **Eagles**, Chairperson, South African Medicines Control Council, Pretoria, Republic of South Africa

Mrs Öznur Sevim **Evranosoglu**, General Directorate of Pharmaceuticals, Ministry of Health, Sihhiye Ankara, Turkey

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Professor Chlodwig M. **Franz**, Head, Institute of Applied Botany, University of Veterinary Medicine, Vienna, Austria

Dr Benjamin **Gilbert**, Ministry of Health, Oswaldo Cruz Foundation, FarManguinhos-Fiocruz, Rio de Janeiro, Brazil

Dr Eiman Hassan Abdel Rahman **El Hassan**, Director, Directorate of Medicinal Plants and Traditional Medicine, Federal Ministry of Health, Khartoum, Sudan

Dr Konstantin **Keller**, Director and Professor, Federal Institute for Drugs and Medical Devices, Bonn, Germany (WHO Temporary Adviser)

Ms Lucie **Larose**, Deputy Director, Special Crops, Horticulture and Special Crops Division, Market and Industry Services Branch, Agriculture and Agri-Food Canada, Ottawa, Canada

Mr Jaafar **Lassa**, Head, Traditional Medicine Laboratory, National Pharmaceutical Control Bureau, Ministry of Health, Selangor, Malaysia

Dr **Lin** Rui Chao, Director, Division of Traditional Chinese Medicine, National Institute for the Control of Pharmaceutical & Biological Products, State Food and Drug Administration, Beijing, People's Republic of China

Dr Farnaz Rathore **Malik**, Chief, National Program Manager, Drugs Control and Traditional Medicine Division, National Institute of Health, Islamabad, Pakistan

Mr **Ng** Wai-kit Grant, Pharmacist, Chinese Medicine Division, Department of Health, Hong Kong, Hong Kong Special Administrative Region, People's Republic of China [Rapporteur]

Dr Efraim **Njau**, Pharmaceutical Consultant, Arusha, Tanzania

Mr Bala **Prasad**, Director, Department of Indian Systems of Medicine and Homoeopathy, Ministry of Health and Family Welfare, New Delhi, India [Vice Chairperson]

Dr **Ren** Dequan, Deputy Director-General, State Food and Drug Administration, Beijing, People's Republic of China (WHO Temporary Adviser)

Professor Motoyoshi **Satake**, Life Science Center, Ochanomizu University, Tokyo, Japan (WHO Temporary Adviser)

Professor Kamilia Fouly Taha **El-Sayed**, Head Manager, Applied Research Centre for Medicinal Plants, National Organization for Drug Control and Research, Giza, Egypt

Dr Uwe **Schippmann**, Federal Agency for Nature Conservation, Bonn, Germany

Dr Setsuko **Sekita**, Director, Tsukuba Medicinal Plants Research Station, National Institute of Health Sciences, Ministry of Health, Labour and Welfare, Tsukuba-shi, Japan

Professor Azimova **Shakhnoz**, Deputy Director, Main Department of Drug and Medical Equipment Quality Control, Ministry of Health, Tashkent, Uzbekistan

Dr Michael J. **Smith**, Senior Advisor to the Director General, Natural Health Products Directorate, Health Canada, Ottawa, Canada [Rapporteur]

Dr Sergei **Sur**, Deputy Chief Inspector, State Inspection for Quality Control of Medicines, Ministry of Health, Kiev, Ukraine

Dr (Mrs) Suryowinoto **Sutarni**, Head, Sub-Directorate for Ethno-pharmacology and Cultivation, National Agency for Drug and Food Control, Ministry of Health and Social Welfare, Jakarta, Indonesia

Mr Hashim Ubale **Yusufu**, Deputy Director, Technical Services, National Agency for Food and Drug Administration and Control (NAFDAC), Garki-Abuja, Nigeria

Representatives of other organizations

FAO (Food and Agriculture Organization of the United Nations)

Mr Peter Griffee, Senior Officer, Crop and Grassland Service (AGPC), Plant Production and Protection Division, FAO, Rome, Italy

FIP (International Pharmaceutical Federation)

Professor Éva Németh-Zàmbori, Secretary, MAP Section, Faculty of Horticultural Sciences, Department of Medicinal and Aromatic Plants, Szent István University, Budapest, Hungary

IUCN (The World Conservation Union)

Ms Mandy Haywood, IUCN/Species Survival Commission (SSC) Wildlife Trade Programme Assistant, Cambridge, England

TRAFFIC International (Trade Record Analysis of Fauna and Flora in Commerce)

Mr Wolfgang Kathe, Research Officer, TRAFFIC Europe – Regional Office, Brussels, Belgium

UPOV (International Union for the Protection of New Varieties of Plants)

Mr Makoto Tabata, Senior Counsellor, UPOV, Geneva, Switzerland

WSMI (World Self-Medication Industry)

Dr Barbara Steinhoff, German Medicines Manufacturers' Association (BAH), Bonn, Germany

Dr David E. Webber, Director-General, Ferney-Voltaire, France

WWF (World Wide Fund for Nature)

Dr Susanne Schmitt, International Plants Conservation Officer, WWF-UK, Godalming, Surrey, England

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Dr Gerald **Moy,** GEMS/Food Manager, Department of Food Safety, WHO, Geneva, Switzerland

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