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African Traditional Medicine – Procedures for Processing Medicinal Plants

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Foreword

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This African Standard was prepared by ARSO *Technical Committee African Traditional Medicine* (ARSO/TC 82)

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Introduction

Medicinal plants are extracted and processed for direct consumption as herbal or traditional medicine or prepared for experimental purposes. The concept of preparation of medicinal plant involves the proper and timely collection of the plant, authentication by experts, and adequate drying and grinding. The processing procedure of medicinal plant can be basic, involving simply crushing the fresh whole plant or desired parts and using directly as medicine, while others are complex, involving solvent extraction purification and drying using highly sophisticated equipment.

It is important that the moisture content of processed medicinal plants is reduced to discourage microbial growth which could lead to the destruction of the active principles and the deterioration of the plant medicine, with the goal of assuring herbal medicines quality, safety and efficacy.

All processing methods considered shall ensure no negative impact on the quantity of the active ingredient, as well as the quality and safety of the finished product. Collection of medicinal plants can be from cultivated or wild plants for preserved quality and quantity of the active ingredients desired enabling easier standardization of the finished product.

African Traditional Medicine – Procedures for Processing Medicinal Plants

1 Scope

The scope of this document is limited to procedures for processing of Medicinal Plants for direct consumption; either internally or externally. It is by no way meant for processing for experimental or research purposes.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ARS 951, *African Traditional Medicine – Good Manufacturing Practices (GMP) for Herbal Medicines*

ARS 953, *African Traditional Medicine – Guidelines on Good Agricultural and Collection Practices (GACP)*

ARS 955, *African Traditional Medicine – Technical Guidelines for Safety, Efficacy and Quality of Raw materials and Herbal Medicines*

WHO Guidelines on Good Herbal Processing Practices for Herbal Medicines – Annex 1
Revised Draft: WHO Guidelines on Good Herbal Processing Practices (GHPP) for Herbal Medicines

3 Terms and definitions

For the purpose of this standard the following definitions apply.

3.1 Active ingredient:

Any component of a drug product intended to furnish pharmacological activity or other effect in the diagnosis, cure or to affect the structure or any function of the body of humans or other animals. OR Part of a substance or compound that produces chemical or biological effect

3.2 Essential oils:

are the volatile liquids that are isolated from plants when introduced to solvents.

3.3 Ghee:

clarified butter, made from the milk of a buffalo or cow, used in South Asian cooking.

3.4 Harvesting:

collection of the desired parts of the plant to be processed.

3.5 Herbal medicine:

are medicinal preparations containing active ingredients obtained from ~~the~~ herbal plant. The product can be made from the whole plant or any part. Preparations from acellular plant parts such as oils, gums, and other secretions are also included.

3.6 Medicinal plant:

refers to a plant comprising active ingredients or secondary metabolites that possess biological activity

3.7 Menstruum:

a liquid that dissolves a solid, a solvent especially one used to extract a drug from a plant

3.8 Procedure:
an established or official way of doing something

3.9 Processing method:
Is any method used to turn freshly harvested medicinal plants into finished products.

3.10 Singeing:
Burn something superficially or lightly

3.11 Trimming:
cutting small pieces off something

3.12 Levigation:
grinding or pulverizing of a solid substance in the presence of a liquid, typically water or a suitable solvent.

4 Factors that influence quality, safety and efficacy of processed medicinal plants.

a) Quality of source material, manufacturing and processing factors, among others.
b) Correct identification of source plant species
c) selection of appropriate parts for use in herbal medicines are basic and essential steps for ensuring safety, quality and efficacy of herbal medicines.
d) The time and method of harvesting medicinal plants for processing.

5. Processing of Medicinal Plants:

Collection of medicinal plants can be from cultivated or wild plants for preserved quality and quantity of the active ingredients desired enabling easier standardization of the finished product. There are many different methods of processing medicinal plants for therapeutic uses. Some are extremely basic, simply involving the crushing of the fresh whole plant or parts of the plant and using it directly as medicine. Others are extremely complex, involving solvent extraction, purification and drying using highly sophisticated equipment. (explained in clause 6)

5.1. Primary processing:

The primary processing step after harvesting, includes but not limited to drying, cutting, grinding, sifting and storing freshly harvested medicinal plants. 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. The primary herb processing steps include drying, size reduction, grinding and sieving.

i. Washing: Raw herbs, especially roots, rhizomes and tubers, are usually washed with clean water and dried soon after harvest or collection. During the washing process, scraping and brushing may be necessary. It is generally recommended not to soak the herbs in water for an unnecessarily long period. Water should be changed as frequently as required. The use of water containing a low concentration of chlorine (for example, sodium hypochlorite, bleach) to prevent microbial fermentation is recommended where and when possible or practical.

ii. Leaching: Some impurities can be removed by the action of running water over the raw herbs by a process called leaching. The duration of leaching has to be controlled in order to prevent excessive loss of active ingredients.

iii. Primary cutting: Bulky raw herbs that have been harvested or collected may require primary cutting to reduce their size before transportation to the processing or manufacturing facility. Primary cutting is

usually performed at or near the harvest or collection site.

iv. Ageing: The ageing process refers to storing the herbal materials for a period of time after harvesting or collection from the field prior to use. Herbs are generally aged in the sun or in the shade, depending on the specific herbal material. During the process of ageing, excessive water is evaporated and enzymatic reactions (such as hydrolysis of the glycone portion of glycosides) or oxidation may occur to alter the chemical composition of the herbal material. For example, in cascara (Frangula purshiana Cooper) bark, after proper ageing (at least one year, or having been artificially heated to speed up the process), the reduced forms of the emodin glycosides in the fresh bark are converted to monomeric oxidized emodin glycosides. The latter form of glycosides are milder cathartic agents, with reduced irritating effects that may cause vomiting and stomach upsets, and hence, are more suitable as a therapeutic agent.

v. Sweating: A similar process known as sweating (for example, fermentation) involves keeping the herbal materials at a temperature of 45–65 °C in conditions of high humidity for an extended period, from one week to two months, depending on the plant species. The sweating process is considered a hydrolytic and oxidative process in which some of the chemical ingredients within the herbal materials are hydrolysed and/or oxidized. The herbal materials are usually densely stacked between woollen blankets or other kinds of cloth. For example, vanilla beans (Vanilla planifolia Jacks. ex Andrews) are well known to undergo repeated sweating between woollen blankets in the sun during the day and packed in wool-covered boxes at night for about two months. During this process, the vanilla pods lose up to 80% of their weight and take on the characteristic colour and odour of vanilla.

vi. Parboiling (blanching): After washing, certain herbal materials may undergo a parboiling or blanching process in which they are put into boiling water for a brief period without being fully cooked. Such a heating procedure may serve several purposes, such as improving storage life of the processed materials by gelatinizing the starch, preventing mould or insect contamination, easily drying, destroying enzyme activity to prevent the alteration of certain chemical constituents, and facilitating further processing such as removal of the seed coat of almonds.

vii. Boiling or steaming: The boiling process involves cooking the herbal materials in water or another liquid such as vinegar, wine, milk or other vehicle. In the steaming process, herbal materials are kept separate from the boiling water but have direct contact with the steam, resulting in a moist texture of the herbal materials. Often, the herbal materials are placed in a steamer or in a special utensil equipped with a flat frame suspended over boiling water. In some cases, the herbal materials are pre-mixed with excipient substances such as wine, brine or vinegar before being steamed. The boiling or steaming process serves to soften plant tissues, to denature enzymes present in the herbal materials, and/ or to thermally degrade selected chemical constituents. At the same time, the excipient, if used, is absorbed into the plant tissues to become an integral part of the processed herbal materials. For example, Reynoutria multiflora Thunb. Moldenke (synonym Polygonum multiflorum Thunb.) root is often steamed in the presence of a black bean (Phaseolus vulgaris L.) decoction in order to enhance its tonic effects. Boiling the raw herbs such as Croton tiglium, Abrus precatorius, Nerium oleander and Gloriosa superba L., in cow's milk is practised in some traditional medicine contexts to reduce the levels of their toxic ingredients and thus diminish the toxicity of the herbal materials.

viii. Baking or roasting: The baking or roasting process is a dry-heating using indirect, diffused heat, where the herbal materials are put in a heating device. The herbal materials are often embedded in bran or magnesium silicate (talc) powder to ensure even heating over the entire surface at an elevated temperature for a specified period of time. Some herbal materials are wrapped in moistened papers during the roasting process. The exact temperature used and duration of baking or roasting vary from one herbal material to another. Some are baked or roasted until the surface colour turns yellowish brown; some may be further heated until charred. For example, nutmeg (Myristica fragrans Houtt.) and kudzu (Pueraria montana var. lobata (Willd.) Sanjappa & Pradeep) root require roasting before they are used for medicinal purposes.

ix. Stir-frying: Stir-frying is a process in which the herbal materials are put in a pot or frying pan, continuously stirred or tossed for a period of time under heating until the external colour changes, charred or even carbonized. Depending on the plant species, the stir-frying process may require the addition of adjuvants such as wine, vinegar, honey, saline and ginger juice, which would be infused into the herbal matrix to become an integral part of the processed herbal material. In order to ensure even heating over the surface of the herbal materials, sand, rice, bran, talc or clay can be admixed with the herbal material

during stir-frying. For example, liquorice (Glycyrrhiza glabra L. and G. uralensis Fisch.) root and rhizome and Astragalus roots (Astragalus mongholicus Bunge or A. membranaceus (Fisch.) Bunge) are often stir-fried with honey for the preparation of decoction slices, whereas the Salvia miltiorrhiza Bunge root is stir-fried with wine. Fresh ginger is often stir-fried with sand until the surface colour turns brown. In other instances, ginger can be further stir-fried over intense fire to a carbonized state for use as decoction pieces.

x. Fumigation: Fumigation with sulfur dioxide has been employed in post-harvest handling of some herbs for the purpose of preserving colour, improving fresh-looking appearance, bleaching, preventing the growth of insects and inhibiting decay caused by moulds. Thus, the process has been frequently applied to herbal materials of light and bright colours to avoid “browning”. Due to concerns about the undesirable residues, this process should be avoided as much as possible. When a real need is identified, treatment should be carried out at the earliest possible stage and exclusively by adequately trained and qualified personnel, according to the specific recommendations for use. All relevant regulations (for example, limits on sulfite residue) should be complied with.

xi. Irradiation: In some cases, irradiation or ultraviolet light can be used to eliminate or reduce microbial load of the herbal materials. The use of these procedures **shall** comply with the national and/or regional regulations.

xii. Advanced cutting, sectioning and comminution: When thoroughly dried, the herbal materials are processed by cutting and sectioning into convenient or specific sizes and shapes or forms for storage, direct use as decoction slices or pieces, and/or for further processing for the manufacture of herbal preparations or herbal dosage forms.

xiii. Drying:

Proper drying and storage of medicinal plants for future use are important since moisture encourages microbial growth, leading to the destruction of the active principle and the deterioration of the plant drug. Air – drying and sun – drying are the methods employed in the absence of temperature - controlled ovens. Properly dried leaves crumble easily. Small quantity of material may be dried in a large transparent container in a sunny window, such as an uncapped large jar. Large quantity may be hung in bundles, baskets, mesh bags, outdoors or spread on a clean mat in warm, dry place indoors.

Avoid drying on top of concrete pavements or roof – tops; extreme heat could destroy some of the plant constituents. The growth of molds and other microorganisms, infestation by insects and rodents can be prevented by keeping the dried drugs inside air –tight containers in a cool, dry place away from direct light. Stored medicinal plant must be labeled inside and outside the container; include the date of collection on the label.

Heat – Drying: Medicinal plants may be dried with hot air in an oven or drying room. The air warmed by the heater rises by thermal convection, comes into contact with the plants, extracts moisture from them and gradually dries them out.

Generally, 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.

*If heaters or other sources of artificially generated heat are used in the drying operation, provide adequate ventilation of the heating equipment, and use only fuels that will not result in hazardous combustion emissions coming into contact with the plant material thereby contaminating the material

xiv. Size Reduction: Also known as Comminution, Diminution or Pulverization is one of the most extensively used and vital unit operations. It is a process of reducing large solid unit masses into small unit masses, coarse particles or fine particles. There are many types of size reduction equipment, which are often developed empirically to handle specific materials and then are applied in other situations.

Knowing the properties of the material to be processed is essential. Probably the most important characteristic governing size reduction is hardness; because almost all size –reduction techniques involve somehow creating new surface area and this requires adding energy proportional to the bonds holding the feed particles together. Size reduction is an important operation in many pharmaceutical applications. The important reasons for size reduction are easy handling, increase in surface area per unit volume and separation of entrapped components.

xv. Grinding: The primary purpose of grinding is to reduce the particle size and increase the surface area that contributes to oil diffusion during the extraction process. A simple first step can be grinding a Medicinal Plant in a mortar, adding a liquid and filtering to separate the soluble from the insoluble.

xvi. Sieving: The process by which fine particles are separated from bigger particles by using a sieve.

xvii. Sifting: A preparation procedure of passing dry ingredient through a mesh bottom sieve.

5. 2. Secondary herb processing Steps

Secondary Processing: They are those processes that are carried out after the initial manufacturing processes. They are not the same as finished processes, which include things like polishing, packaging, labelling and final inspection before shipping off to the customers.

The secondary processing is when the primary product is changed to another product. The secondary processing steps involve extraction with the aid of suitable solvents, concentration and drying.

Traditional methods for extracting herbs involve slicing, pressing, pounding in a mortar, add cold or hot water (which yields an infusion e.g. in the preparation of teas and dyes), boiling (to produce a decoction) or soaking in alcohol, oil (ghee is widely used in Ayurveda), grease or wax. Such secondary processing methods include:

i. Extraction:

Extraction of medicinal plants is a process of separating active plant materials or secondary metabolites such as alkaloids, flavonoids, terpenes, saponins, steroids, and glycosides from inert or inactive material using an appropriate solvent and standard extraction procedure.

Several methods can be used in the extraction of medicinal plants such as maceration, infusion, decoction, percolation, digestion and Soxhlet extraction, superficial extraction, ultrasound-assisted, and microwave-assisted extraction. In addition, thin-layer chromatography (TLC), high-performance liquid chromatography (HPLC), paper chromatography (PC), and gas chromatography (GC) are used in the separation and purification of the secondary metabolites.

The choice of an appropriate extraction method depends on the nature of the plant material, solvent used, pH of the solvent, temperature, and solvent to sample ratio. It also depends on the intended use of the final products.

Ethanol has been known as a good solvent for medicinal plant extraction and it is safe for human consumption. The five (5) factors that affect extraction are:
- the ratio of solutes to solvent
-the size of the solutes
-the temperature of the solvent
- the duration of time the two substances are mixed
- how much the solution is agitated before extraction
Commonly used methods in the extraction of medicinal plants are:

i. Maceration: This is an extraction procedure in which coarsely powdered drug material, either leaves or stem bark or root bark, is placed inside a container; the menstruum is poured on top, until it completely covers the drug material. The container is then closed and kept for at least three days. The content is stirred periodically, and if placed inside bottle it should be shaken time to time to ensure complete extraction. At the end of extraction, the micelle is separated from marc by filtration or decantation. Subsequently, the micelle is then separated from the menstruum by evaporation in an oven or on top of water bath. This method is convenient and very suitable for thermolabile plant material.

ii. Infusion: This is done by pouring boiling water over the plant material in a container, covered and allowed to stand for 15 minutes, strained and used immediately upon cooling. Brown sugar or honey may be added for pleasant taste as optional ingredient.

iii. Digestion: This is an extraction method that involves the use of moderate heat during extraction process. The solvent of extraction is poured into a clean container followed by powdered drug material. The mixture is placed over water bath or in an oven at a temperature about 50o C. Heat will be applied throughout the extraction process to decrease the viscosity of extraction solvent and enhance the removal of secondary metabolites. This method is suitable for plant materials that are readily soluble in solvent of extraction.

iv. Decoction: This is obtained when the medicinal plant parts are boiled in water for 15 - 20 minutes or until the water is reduced to half its original volume. Allow to cool, strain and drink as recommended.

v. Percolation: The apparatus used in this process is called percolator. It is a narrow-cone-shaped glass vessel with opening at both ends. A dried, grinded, and finely powdered plant material is moistened with the solvent of extraction in a clean container. More quantity of solvent is added, and the mixture is kept for a period of 4hours. Subsequently, the content is then transferred into percolator with the lower end closed and allow to stand for a period of 24hours. The solvent of extraction is then poured from the top until the drug material is completely saturated. The lower part of the percolator is then opened, and the liquid allowed to drip slowly. Some quantity of solvent will be added continuously, and the extraction will take place by gravitational force, pushing the solvent through the drug material downward. The addition of solvent stops when the volume of solvent added reached 75% of the intended quantity of the entire preparations. The extract is separated by filtration followed by decantation. The marc is then expressed and final amount of solvent added to get required volume.

vi. Soxhlet Extraction: This process is otherwise known as continuous hot extraction. The apparatus is called Soxhlet extractor made up of glass. It consists of a round bottom flask, extraction chamber, siphon tube, and condenser at the top. A dried, grinded, and finely powdered plant material is placed inside porous bag (thimble) made up of a clean cloth or strong filter paper and tightly closed. The extraction solvent is poured into the round bottom flask, followed by the thimble into the extraction chamber. The solvent is then heated from the round bottom flask, evaporates, and passes through the condenser where it condenses and flow down to the extraction chamber and extracts the drug by coming in contact.

Consequently, when the level of solvent in the extraction chamber reaches the top of the siphon, the solvent and the extracted plant material flow back to the flask. The entire process continues repeatedly until the drug is completely extracted, a point when a solvent flowing from extraction chamber does not leave any residue behind. This method is suitable for plant material that is partially soluble in the chosen solvent and for plant materials with insoluble impurities. However, it is not a suitable method for thermolabile plant materials.

Advantages. Large amount of drug can be extracted with smaller amount of solvent. It is also applicable to plant materials that are heat stable. No filtration is required, and high amount of heat could be applied.
Disadvantages. Regular shaking is not possible, and the method is not suitable for thermolabile materials.

vii. Microwave – assisted extraction: This is one of the advanced extraction procedures in the preparation of medicinal plants. The technique uses mechanism of dipole rotation and ionic transfer by displacement of charged ions present in the solvent and drug material. This method is suitable for extraction of flavonoids. It involves the application of electromagnetic radiation in frequencies between 300 MHz and 300 GHz and wavelength between 1cm and 1 m. The microwaves applied at frequency of 2450 Hz yielded energy between 600 and 700 W. The technique uses microwave radiation to bombard an object, which can absorb electromagnetic energy and convert it into heat. Subsequently, the heat produced facilitates movement of solvent into the drug matrix. When polar solvent is used, dipole rotation and migration of ions occur, increase solvent penetration, and assist extraction process. However, when non-polar solvent is used, the microwave radiation released will produce only small heat; hence, this method does not favor use of non-polar solvents.
Advantages. Microwave-assisted extraction has special advantages such as minimizing solvent and time of extraction as well as increase in the outcome.

Disadvantages. This method is suitable only for phenolic compounds and flavonoids. Compounds such as tannins and anthocyanins may be degraded because of high temperature involved.

viii. Ultra sound- assisted Extraction: This process involves application of sound energy at a very high frequency greater than 20 KHz to disrupt all plant cell and increase the drug surface area for solvent penetration. Consequently, secondary metabolites will be released. In this method, plant material should dry first, grinded into fine power, and sieved properly. The prepared sample is then mixed with appropriate solvent of extraction and packed into the ultrasonic extractor. The high sound energy applies hasten the extraction process by reducing the heat requirements.

Advantages. Ultrasound-assisted extraction is applicable to small sample; it reduces the time of extraction and amount of solvent used, and maximizes the yield.

Disadvantages. This method is difficult to be reproduced; also, high amount of energy applied may degrade the phytochemical by producing free radical.

6. Procedures for processing of medicinal plants

6.1 Harvesting

a) Harvested or collected raw medicinal plant materials shall 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.
b) Medicinal plant materials shall 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 shall be harvested/collected and delivered as quickly as possible to the processing facility to prevent microbial fermentation and thermal degradation.
c) 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.
d) 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.

6.2 Reconditioning - Specific processing

a) 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.

b) 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.

c) Antimicrobial treatments of medicinal plant materials (raw or processed) by various methods, including irradiation, shall be declared and the materials shall be labelled as required. Only suitably trained staff using approved equipment should carry out such 6 applications, and they shall 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.

d) Suitable processing techniques shall be employed to maintain the quality of the medicinal plant products. The primary herb processing steps include drying, size reduction, grinding, and sieving. The secondary processing involves extraction with the aid of suitable solvents, concentration and drying. The extracts shall then be standardized based on a recognized herbal Standard. Further purification to obtain pure phytochemicals requires elaborate separation and purification steps such as solvent - solvent extraction, solid – phase extraction and liquid chromatography.

6.3. Medicinal Plant Products and Methods of preparation

The medicinal plant materials can be processed into the following preparations, as indicated in Table 1 below:

Table 1: Medicinal Plant Products and Methods of Preparation

Product	Method of Preparation
Decoction	Obtained when the medicinal plant parts are boiled in water for 15 - 20 minutes or until the water is reduced to half its original volume. Allow to cool, strain and drink as recommended.
Infusion	This is done by pouring boiling water over the plant material in a container, covered and allowed to stand for 15 minutes, strained and used immediately upon cooling. Brown sugar or honey may be added for pleasant taste. *Note: In processing medicinal plant, use containers made of inert materials, such as clay pots, enamel – lined, pyrex and so on and non- metallic utensils. Infusions and decoctions should be freshly – prepared; a day's dose may be prepared and kept fresh in a thermos bottle or in a refrigerator, if available.*
Syrups	The plant material is processed first as a decoction and, after straining, honey or syrup made by boiling brown sugar in water (1:1) is added. Allow to simmer further until syrup is of the desired consistency. Syrups keep longer than decoctions and infusions.
Juices	These are extracted from fresh plant part, taken internally or applied locally on the affected parts of the body, as the case may be.

Product	Method of Preparation
Poultice	This is softened, pounded or crushed fresh plant material. Mixed with a little warm oil, can be applied externally and held in place with a piece of clean cloth. Sometimes, mashed boiled rice or gewgaw is mixed with the plant material instead of oil. This dressing should be changed daily.
Liniments	Plant material is crushed and macerated in *alcoholic or oil (Arachis oil) solution or emulsion* strained and used internally or externally.
Ointments	An herbal ointment will be made by using the levigation method to combine precisely weighed neem and garlic extract with the ointment base. Making a smooth paste with a base that weighs two or three times as much as the base, gradually adding more base until the ointment is uniform, and then transferring it into an appropriate container.
Essential or Volatile oil	As discussed later
Powdered extracts	Solid preparations having a powdery consistency obtained by evaporation of solvent used for extraction. They may contain suitable suitable added substances such as excipients, stabilizers and preservatives
Soft extract or Semisolid extract	Preparations having consistencies between fluidextracts and those of powdered extracts and are obtained by partial evaporation of the solvent , hydroalcoholic mixtures being used as extracting solvents
Fluid extracts	Preparations of plant matter, containing alcohol as a solvent or as a preservative or both and are so made that each ml contains the extracted constituents of 1 g of the crude material that it represents unless otherwise specified in the individual monograph

7. Pre - requisites for Processing of Medicinal plants

7.1 Basic Components of Good Agricultural Practices for medicinal plants

a) Hygiene and Cleanliness

Medicinal plant material shall be tested for bacterial and fungal residues before being bought by the medicine manufacturers; if the product contains levels greater than permitted, they are rejected. Medicinal plant materials are susceptible to microbes contamination therefore a central theme needed throughout the Good Agricultural and Collection Practices (GACPs) guidelines to prevent microbial contamination by means of improved hygiene and cleanliness

b) Prevention of Contamination

Controls shall be put in place to ensure prevention of contamination

c) Identification

Adverse health consequences have been reported in a number of cases pertaining to consumers The herbal medicine practitioners shall comply with the requirements of the on GACPs for starting materials of herbal origin place to ensure medicinal plants are correctly identified to provide herbal medicine users/buyers with the vital assurance that they are buying the intended species material

d) Efficacy

If herbal/medicinal plants are not cultivated in a suitable environment, not harvested at the right time of the calendar year, or if not processed correctly, the consequences are obvious; the active ingredient content of the medicinal plant material is likely to be lesser in amount, leading to the manufacture of partially effective/ineffective herbal medicines. GACP guidelines for starting materials of herbal origin have explicitly laid down the main principles that should be followed by farmers and collectors to ensure that medicinal plant materials are produced with optimum/maximum levels of active ingredients.

e) Production and Income

“Casual” agricultural and collection practices not only reduce the end quality of the herbal medicines but also affect the production and income of the farmers and collectors. Knowlegde on the optimization of both quality and extent of production of medicinal plant material vis-à-vis maximization of farmers' income has been provided by GACP guidelines for starting materials of herbal origin.

f) Sustainability

Sustainable collection methods in the wild should be encouraged and taken up as an increasing number of medicinal plant species are on the verge of being endangered or have become endangered in recent times. Medicinal plants collected in a manner allows the plants to regenerate perennially represents one of the pivotal themes presented or laid out in GACP guidelines for starting materials of herbal origin. Sustainable availability of the plant species may be ensured if this path is followed. In addition, the benefactors of the talisman are not singular in nature as it is not only the medicinal plant collectors who shall have a regular source of income but also the herbal medicine industry.

g) Documentation and Traceability

Proper and scientific documentation of activities of the medicinal plant growers as well as collectors is required to trace the medicinal plant material back to its origin. Traceability is a key factor of GACP guidelines; it ensures that problems can be traced back to the root place of occurrence so that timely measures may be taken in response to any recurrence. Traceability is possible only through documentation, which is why documentation is a recurring theme throughout the GACP guidelines for starting materials of herbal origin.

7.2 Good Agriculture and Collection Practice (GACP):

Good Agricultural and Collection Practices (GACP) for Medicinal Plants are a set of guidelines aimed at advising medicinal plant producers on how to improve the safety, efficacy and quality standards of raw materials used in the preparation of herbal medicines. The GACP guidelines provide a basis for homogenized national or regional standards for the cultivation and collection of medicinal plants and should therefore be viewed as an effective working tool whose benefits are to reduce waste, ensure quality of raw materials and gain market credibility. The implementation of GACP will ensure processing of good quality medicinal products.

7.3 Good Manufacturing Practice (GMP)

The implementation of this Practice will also ensure processing of good quality, efficacious and safe herbal products. The Practice makes specifications that includes the following, good storage for example, the herbal raw materials should be kept in a dry and cool area protected from moisture and processed following the principle of “first in. first out” (FIFO). GMP helps to ensure the consistent quality and safety of products by focusing attention on five (5) key elements (the 5Ps), namely – people, premises, processes, products and procedures (or paper work – documentation).
The practices are minimum technical requirements for the manufacturing of goods and are intended to reduce risks and damage to health, to provide manufacturers and marketing of pharmaceuticals with quality, efficacy and safety.
GMP is an important tool that ensures that the manufacturing process meets prescribed standards, quality control and complete harmonization of the GMP regulations and for successful globalization of the herbal products. The manufacturers have to meet the local GMP regulations and demonstrate satisfactory pre – and post market assessment before sales.

8. Processing Steps

Post-harvest processing is often specific to the herb and may involve unique procedures. The particular processing method may be a practice based on a tradition as old as the use of medicinal plants, and/or it may be based on proprietary procedures. In either case, herbal processing procedures should be

subjected to good practice standards. Herbs obtained from field collection or cultivation should be subjected to a series of good practice post-harvest processing procedures set out in the GACP Guidelines. In general, post-harvest processing of herbs includes inspection and sorting, primary processing and drying. The exact herbal processing procedures may vary from one herb to another. Thus, some procedures consist of only a few simple steps of primary processing such as cleaning, primary cutting and sectioning, before being dried.

Sometimes, the processing procedures can be extremely basic; simply involving the crushing of the fresh whole plant or parts of the plant and using it directly as a medicine. Others are extremely complex, involving solvent extraction, purification and drying using highly sophisticated equipment
The time and method of harvesting medicinal plants for processing are very important. Plants contain numerous active constituents, chemical compounds responsible for the therapeutic activity, which are affected by environmental factors such as temperature, humidity, light and manner of handling during harvest. Different plant parts require different methods of collection. As much as possible, leaves and flowering tops should be hand – picked. If the plant part to be used is the seed, the fruit must be fully ripe before harvest. If the whole fruit is to be used, it must be harvested before maturity. Underground parts are collected before the flowering stage. In processing medicinal plants, only the recommended parts are to be used; this is because the relative distribution of constituents within the plant body varies. Sometimes, for example, the roots or seeds may contain more of the active constituents than the leaves and stem or vice versa. The processing of medicinal plants involves two steps, the primary and secondary processing.

8.1 Primary Processing of Medicinal Plants

8.1.1 Purposes and functions of primary processing

Simple post-harvest processing (such as sorting, washing and leaching) serves to remove dirt and other unwanted materials from the herbs after they have been harvested or collected from the growing site. Unless intended for use in its fresh form, the herb is subjected to a drying procedure, immediately or shortly after harvesting, in order to minimize damage from mould and other microbial infestation. Over time through experience, knowledge has been acquired for the development of various primary processing procedures for maximizing the quality and therapeutic value of herbal medicines. The final form of a herbal material depends upon the nature of the herb and its intended use. In general, primary processing of herbs serves several purposes, such as concentrating the ingredients; removing undesirable substances; modifying the therapeutic properties; reducing toxicity; facilitating dispensing, compounding and storage. The major objectives of primary processing of herbal materials are summarized below:

i. Neutralization of toxicity and diminishing side-effects: Herbal materials that possess significant toxicity, highly potent pharmacological activity or are known to cause severe side-effects, should be pretreated in specific manners in order to neutralize the toxicity or to reduce the side-effects prior to use. Such a detoxifying process is particularly important for those herbs that are known to contain toxic or undesirable chemical components; they must be properly processed to remove those unwanted substances. Through the primary processing methods such as steaming and frying, heat-sensitive toxic components will be degraded. In other cases, processing methods such as sweating (for example, fermentation) and ageing result in enzymatic degradation of the toxic ingredients. For example, raw aconite (Aconitum carmichaelii Debeaux)root, containing significant amounts of toxic alkaloids such as aconitine, must be boiled or steamed for hours to hydrolyse aconitine into less toxic derivatives. In the case of cascara (Frangula purshiana Cooper), the bark that has been collected or harvested should be kept (aged) for at least one year before use. This is to allow oxidation to occur, by which the strongly purgative hydroxyanthracene glycosides are converted to oxidized compounds with lower laxative potencies.

ii. Modification of therapeutic properties: Some herbal materials require primary processing to alter their therapeutic properties. For example, rhubarb (rhizome of Rheum spp.) in its raw form possesses purgative action and is useful as a cathartic. After being steamed with wine, however, the purgative action is attenuated and the processed rhubarb can be used for other purposes such as reducing inflammation. The specific medicinal property of some herbal materials may be changed through primary processing. For example, the unprocessed raw rehmannia (Rehmannia glutinosa (Gaertn.) DC.) root is used to treat fever, hypertension and skin eruptions. After being cooked in wine, however, the processed rehmannia is often used for tonic and anti-ageing purposes in some traditional medicine contexts. In the case of ginseng (Panax ginseng C.A. Mey.) roots, different primary processing procedures give rise to several processed

products, such as white ginseng and red ginseng. White ginseng is the herbal material dried in the sun or by heat, whereas red ginseng is prepared through a series of steaming and cooking steps. These two types of ginseng products have different therapeutic uses in some traditional medicine contexts, red ginseng being more potent than white ginseng in its warming or energizing effects.

iii. Enhancing efficacy and reinforcing therapeutic effects: The therapeutic efficacy of certain herbal materials can be augmented through primary processing in some traditional medicine contexts. For instance, the pain-relieving property of corydalis (Corydalis yanhusuo W.T. Wang) rhizomes is believed to increase when they are stir-fried with rice vinegar.

8.2 Post-harvest processing procedures: Raw herbs should be inspected and sorted immediately following harvest or collection. They are then subjected to a series of on-site primary processes, and in most cases, subjected to further processes at a processing facility. The exact processing methods may differ from one herb to another, and the guidelines therefore may need to be adjusted on a case-by-case basis. An example of a model format for a GHPP monograph/SOP protocol is given in Appendix 1.

8.2.1 Sorting (garbling): The sorting process serves as the first step to ensuring the purity and cleanliness of the herbs. After the bulk amount of the desired plant part has been harvested or collected, all extraneous and unwanted matter including dirt (for example, soil, dust, mud and stones), impurities (for example, insects, rotten tissues, untargeted/ extraneous medicinal plant(s) and/or plant part(s)), and residual non-medicinal as well as toxic part(s) must be removed from the medicinal part(s). Depending on the herb, the process may involve procedures such as: – removing dirt and foreign substances; – discarding damaged parts; – peeling (to separate unwanted plant part(s) from the medicinal plant part(s) such as removing unwanted root bark from the roots or collecting stem bark from the stem); – sieving, trimming, singeing (to remove hairs or rootlets); – removal of residues of unwanted plant part(s) (for example, removing unwanted seeds from fruits and stripping leaves from stems). Although in some cases, sorting may be done by mechanical means, it is usually done by hand. Only staff who are suitably trained and equipped (for example, wearing gloves and a dust mask, etc. as appropriate) should carry out this work.

Bibliography

Identify and acknowledge useful literature used in the preparation of this standard.