CULTIVATION, COLLECTION, CONSERVATION AND ELABORATION OF MEDICINAL PLANTS PRODUCTS

Workbook

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Cultivation, collection, conservation and elaboration of medicinal plants products

Introduction
This handbook includes class notes and exercises to learn everything about medicinal plants production

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Primary or post-harvest processing

Medicinal plant raw materials harvested or collected must be discharged and rapidly unpackaged upon receipt at the processing plant. Before processing, they should be protected from rain, moisture and other circumstances that could cause their deterioration.

During the primary processing stage all medicinal plant material must be inspected. Products with inferior quality or foreign matter must be removed mechanically or by hand.

Subsequently, the transformation is performed according to the raw material to be obtained:

- Fresh herb: REFRIGERATION
- Frozen herb: FREEZING
- Dry herb: DRYING
- Essential oil: DISTILLATION
- Vegetable extract: EXTRACTION

Finally, the raw material must be packaged, labelled, stored and documented to ensure its quality.

Suggested reading:
Document GACP – 4.1. Post-harvest processing:
http://apps.who.int/medicinedocs/es/d/Js4928e/
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Refrigeration

Refrigeration consists in keeping a fresh aromatic plant at a low temperature (2-7 °C). An indispensable requirement is to comply with the cold chain.

We would be talking about foods known as fourth range, sometimes packaged under vacuum or modified atmosphere, in order to extend the expiration date, maximum 3-4 weeks.

Usually it is made with aromatic plants, spices and condiments for use in food, fresh, clean, chopped and packaged for immediate consumption.

It consists of cutting the fresh part, usually leaves and flowers, cleaning, packaging, labeling and cooling. It is usually cleaned with water and chlorine. The usual container is usually plastic or porexpan. With this conservation method, the organoleptic characteristics and the texture of the plant can be maintained.

Should be refrigerated:

- **Fresh herbs**: basil, dill, chives, cilantro, tarragon, fennel, parsley, marjoram, mint, oregano, rosemary, savory, sage, etc.
- **Edible flowers**: capuchin, heartsease, borage, calendula, zucchini, etc.


Fresh herb producers (Gran Aroma in Colombia): [https://www.youtube.com/watch?v=1Zz3LSCzidQ](https://www.youtube.com/watch?v=1Zz3LSCzidQ)
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Freezing

Freezing consists in keeping a fresh aromatic plant at a temperature below 0 ºC. An indispensable requirement is to comply with the cold chain.

The expiration date is extended and can be stored up to 1 or 2 years.

It consists of cutting the fresh part, usually leaves and flowers, cleaning, packaging, labelling and cooling. The packaging is usually plastic.

With freezing the texture of the vegetable is not maintained, although it respects the organoleptic characteristics of the plant.

It can be frozen: basil, garlic, dill, chives, coriander, tarragon, parsley, mint.

See:

Domestic freezing:
https://youtu.be/FkBvDwlpvw
http://www.wikihow.com/Freeze-Herbs

Industrial freezing (Daregal company in France):
https://www.youtube.com/watch?v=X0AH78ibp0A
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Drying

Drying consists of reducing the water content of fresh produce, usually up to a moisture content ranging from 5-13%, or below a water activity of 0.60. The goal is to conserve, and depending on the aromatic and medicinal plant can reach more than 3 years in good condition.

Depending on how the drying process is performed, there may be a decrease in essential oils, and therefore a reduction in aroma. Thus, this is a method that is usually used for medicinal plants and some aromatic (rosemary, sage, thyme, ...). The content of other active ingredients can also be reduced depending on the method.

Methods for dehydration at household level:
- Natural drying,
- in the shadow,
- solar.

Industrial techniques that require powerful infrastructure:
- Drying forced by convection,
- Lyophilisation,
- Osmotic dehydration,
- Microwave irradiation

See:
http://www.wikihow.com/Dry-Herbs
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Factors involved in drying are:

- Drying temperature. Between 35-40°C.
- Drying time. Natural and in favourable conditions it takes 1 week. By convection it can take around 3 days.
- Relative humidity of the drying air. The lower the relative humidity of the air, the faster the drying.
- Water content of the material to be dried. The initial humidity depends on the species, but especially on the part of the plant to be dried and on the pre-harvest weather conditions. In general, initial moisture values range from 60 to 80%, but some flowers may contain 95% water.
- The active principles of plants.
- The part of the plant.

In order to preserve the quality of the product, it is generally better to dry it in a thin layer than in a thick layer, since the circulation of air through the layer of material is easier and the drying is more homogeneous and faster. However, in many species, especially small or woody leaves, it is feasible to use a thick layer without losing quality, if there are spaces where air can circulate.

Videos:
Natural drying: https://www.youtube.com/watch?v=JAKpdzIOkHE
Forced drying: https://www.youtube.com/watch?v=pRO4u0pQuBs
Moringa drying: https://www.youtube.com/watch?v=BjzXUCvokY8
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In the natural drying at room temperature, the harvested plant is distributed in a protected place of the entrance of animals, never in direct contact with the ground, clean, and, if possible, well ventilated. According to the type of plant, the part and the amount of material to be dried, it is deposited in drawers, trays, nets or hanging in branches.

At the professional level and for large quantities, drying is done by the circulation of hot air or by convection.

A forced air dryer can be purchased from specialized manufacturers or can be manufactured by yourself. It consists of the following elements:

- Fan.
- Air distributors.
- Source of heat: solar energy or fossil fuel burners.
- Temperature control systems to set and maintain constant temperature and automatisms to control the drying time, in addition to a hygrometer to know the indoor and outdoor humidity of the dryer.
- Structure. The drying facilities can be:
  - *Static*: rooms or chambers, with trays, nets or drawers, if possible closed and with an extractor that eliminates indoor humidity.
  - *Dynamics*: Tunnels or conveyor belts (high investment).

See:
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Post-drying

Often, after drying, a series of activities to improve the quality of the dry plant are needed.

Among these operations we distinguish the following:

- Separate a part of the plant (e.g., from the lemon verbena you have to separate the leaves from the stem). This activity can be done manually, although there are machines that perform it mechanically, but the dry leaves are very crushed.
- Remove remains of ground or stones, through sieves or air columns that separate by weight.
- Homogenize the size (granulometry).
- Cut or pulverize.
- Mix different cut or powdered plants.

LEARNING ACTIVITY

Consult this publication:
http://pam.ctfc.es/docs/ficha%20TRANSFORMACION%20PAM.pdf

And argue which method is most suitable for drying lemon verbena (*Aloysia triphylla*, sin. *Lippia citriodora*) under your area conditions and for a crop of 2000 m².
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Distillation

Distillation is the process by which a specific group of active ingredients is obtained, called essential oils, which due to their physical and chemical characteristics are volatile, and easily removable thanks to water vapor. These components are not only obtained by distillation, but can be extracted thanks to the pressure in cold (citrus), enfleurage (rose, jasmine), etc.

Although there are various techniques of distillation, the most used is steam distillation. Plants are never in contact with water, but above, and through them only steam passes.

Essential oils are found in any part of a plant, although for each species it is a specific part that contain them. The distillation can be carried out immediately after collection or from dry plant. Although the time of harvest is fundamental to obtain the best yield.

The distillate process must also take into account the plant species, the part used, the size of the product, temperature, refrigeration, time, etc.

Consult:
Transformation of aromatic and medicinal plants (distillation)
http://pam.ctfc.es/docs/ficha%20TRANSFORMACION%20PAM.pdf
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**Steam distillation**

A distiller is composed of:

- Boiler (steam generator),
- Distillation vessel,
- Cooling coil,
- Separation vessel (Florentine vessel).

The quantities of essences (essential oils) obtained vary according to the species, the environmental conditions that it has lived and the moment of the productive cycle in which the plant is.

The size of the distiller depends on the quantity to be distilled at the time of maximum production and collection.

It is preferable stainless steel for the equipment material. Copper stills for the production of spirits are not suitable since the essential oils are corrosive.

Videos:
Lavandin distillation (Guadalajara, España):
[https://www.youtube.com/watch?v=AolkGhVH0Gw](https://www.youtube.com/watch?v=AolkGhVH0Gw)
Esencias Lozano (Murcia, España):
[https://www.youtube.com/watch?v=ULS2hJOQw2I](https://www.youtube.com/watch?v=ULS2hJOQw2I)
Small scale distiller: [https://www.youtube.com/watch?v=SjpqeAwsunc](https://www.youtube.com/watch?v=SjpqeAwsunc)
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Extraction

Extraction is the process in which the active ingredients of a plant are obtained. Several techniques for obtaining the active substances of plants are distinguished. It will depend on the type of active ingredients and their solubility (essential oils, tannins, flavonoids, ...), end use (for food, medicines, cosmetics, ...), the part of the plant, ...

The European Pharmacopoeia defines the extracts as preparations of liquid, semi-solid (soft extracts) or solid (dry extracts) consistency, obtained from plant drugs normally in dry state.

Different types of extracts can be distinguished:

- The *standard extracts* are adjusted using an acceptable tolerance to a content of constituents with known therapeutic activity; standardization is achieved by adjusting the extract with inert material or mixing the lots of extracts.
- The *quantized extracts* are adjusted to a defined range of constituents; adjustments are performed by mixing batches of extracts.
- Other extracts are generally defined by their production process (state of the drug to be extracted, solvent, extraction conditions) and their specifications.
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The extracts are prepared by suitable methods using appropriate solvents. Prior to the extraction different batches of vegetable drug can be mixed. The plant drug to be extracted may require pretreatment, such as, for example, enzyme inactivation or trituration. In addition, unwanted substances can be removed after extraction.

For soft and dry extracts in which the organic solvent is removed by evaporation, a recovered or recycled solvent can be used, provided it meets the appropriate specifications. Where applicable, the concentration to obtain the desired consistency is performed using suitable methods, generally under reduced pressure and at a temperature at which the degradation of the constituents is minimal.

Essential oils that have been separated during the process can be returned to the extracts at an appropriate stage of the manufacturing process.

Suitable excipients may be added to the various steps of the manufacturing process to improve technological qualities such as homogeneity or regularity. Suitable stabilizers and antimicrobial preservatives may also be added.

Extraction with a solvent leads to typical proportions of the constituents characterized in the extractable matter. During the production of standardized and quantified extracts, purification processes may be applied which increase these proportions in relation to the expected values. Such extracts are called 'refined'.
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Types of extracts:

**Fluid extracts**

Fluid extracts are liquid preparations in which, in general, 1 part by mass or volume is equivalent to 1 part by mass of the vegetable drug. If necessary, these preparations are adjusted to meet the solvent and constituent content requirements.

Fluid extracts may be prepared using ethanol of suitable concentration, with water to extract the drug or by dissolving a dry or soft extract (produced using the same extraction solvent concentration as that used in the preparation of the fluid extract by direct extraction) of the plant drug in ethanol of any suitable concentration or in water. If necessary, the fluid extracts are filtered. At rest, they may form a slight sediment, which is acceptable as long as their composition does not vary significantly.

**Soft extracts**

The soft extracts are semi-solid preparations obtained by evaporation or partial evaporation of the solvent used for extraction.

**Dried extracts**

The dry extracts are solid preparations, obtained by evaporation of the solvent used for their production. In general, the dry extracts have a drying loss or a water content of not more than 5 percent m/m.
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Types of extracts

Tinctures

The tinctures are liquid preparations generally obtained using 1 part vegetable drug and 10 parts extraction solvent or 1 part vegetable drug and 5 parts extraction solvent.

The dyes are prepared by maceration or by percolation using only ethanol of suitable concentration for the extraction of the vegetable drug, or by dissolving a soft or dry extract in ethanol of adequate concentration. If necessary, the dyes are filtered.

• *Production by maceration*: reduce the plant in fragments of adequate size, mix uniformly with the required extraction solvent and leave to rest in a closed container for an appropriate time. The residue is separated from the extraction solvent and, if necessary, pressed. In this case, the 2 liquids obtained are collected.

• *Production per percolation*: reduce the plant in fragments of adequate size. Mix uniformly with a portion of the prescribed extraction solvent and allow it to stand for a suitable time. Transfer to a percolator and allow the percolate to flow slowly to room temperature ensuring that the vegetable drug to be extracted is always covered by the remainder of the extraction solvent. The residue can be pressed and the squeezed liquid can be collected with the percolate.

Video:
How to make herbal tinctures:
https://youtu.be/4dloPF1QDuw

Copyright photo: CTFC
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LEARNING ACTIVITY

**Preparation of a rosemary leaves extract**

Add 100 g of dried leaves in 1 liter of alcohol of 70°, macerate for 14 days, shake every 3 days, filter. Make the relation plant:extract of form mass:mass and mass:volume.

If it is recommended to take a daily dose of 2-6 g (EMEA monograph), (2 g in 150 ml of hot water in infusion and take 2-3 times a day), calculate the ml of extract equivalent to 2-6 g of dry leaves.

**Commercial extracts**

Look for extractor companies in your country, find out which extracts from what plants they make, for which use, with which equipment and extraction methodology. See the quality specifications for an extract.

In case you do not find information, we suggest that you consult these European companies:

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Packaging

Packaging is the process of introducing a raw material, semi-finished product or final product into a container that protects or isolates from the outside, from light, moisture, or contamination.

Machinery, equipment, premises and containers must be clean before packaging. Balances shall be calibrated or verified. Be very clear about the batch concept, make sure that the label and manufacturing information matches the material to be packed and each unit contains the specified quantity.

The type of packaging, material, shape, volume, etc., is, of course, fundamental since it will have been expressly selected for each product and concrete use. This packaging guarantees the integrity of the packaged products, properly sealed and properly labeled and the labels contain sufficient information.

See videos:
Packing fresh herbs: https://www.youtube.com/watch?v=87wbslOOpMaM
Packaging in trays: https://www.youtube.com/watch?v=t3vUsgmI50s
Infusion Packing Machine: https://www.youtube.com/watch?v=MzLabOsfr78
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Labelling

Labelling is the action of placing a label on a container of a raw material, semi-finished product or final product. It contains information that defines, describes, and incorporates the mentions, indications, marks, drawings or signs related to a specific product.

It must be guaranteed that there are no errors or mistakes in packaging, and that the information on the label matches in terms of description, batch, net weight, etc. with the material.

Each type of product (food, cosmetic, medicine, ...) or raw material has different regulatory requirements as regards the information that the label must contain.

Labels should contain:

- Latin name.
- Popular name (optional, since it depends on each origin country and the synonyms number).
- Part used.
- Presentation.
- Batch Number.
- Zone and date (month and year) of collection.
- Expiration date.
- Supplier's name.
- Net weight.
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The delivery note is the documentation that accompanies a product, identifies and defines it and allows confirming the delivery of the product to the customer. It must have the following information:

- Supplier's name.
- Address.
- Product name.
- Batch.
- Total weight of the batch.
- Number of containers.
- Order number.
- Delivery note number.
- Date

More información in the GACP- 4.2. Bulk packaging and labelling:
http://apps.who.int/medicinedocs/es/d/Js4928e/
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Storage

Consists of storing the raw materials, semi-finished products and final products in a suitable environmental conditions, in a orderly and cleanly way, with reduced possibilities of degradation, so that they can be used or dispatched when convenient.

Factors affecting the quality of a raw material or herbal product during storage are as follows:

- Conservation measures,
- Protection against light,
- Low temperature,
- Low humidity,
- Suitable packaging type,
- Correct tag
- The size of the crushed.

More information in GACP- 4.3. Storage and transportation: http://apps.who.int/medicinedocs/es/d/Js4928e/
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Warehouse

A warehouse has some fundamental aspects:

- Optimum environmental conditions through temperature and humidity control.
- Correct sorting of materials to find them quickly.
- Products correctly labeled with lot number and closed container.
- Adequate place, walls, ceilings, floors and lighting.
- Clean, lightly ventilated, of sufficient capacity and easy access.
- Closed and protected from the entrance of animals.
- Controlled with regard to insect growth.
- With a rational management of pest control treatments, carried out by properly trained personnel with license, using only authorized substances.
- A management and separation of raw materials, semi‐finished products, finished product and conditioning material.
- Correct identification of the reception, identification, warehouse and dispatch zones.
- With a quarantine management control, rejections, returns, incidents and withdrawals.
- It has to ensure the rotation of the materials so that the oldest lots are always used or marketed.

In short, in a warehouse the materials must be well packaged and labeled in well‐identified areas and in suitable environmental conditions.
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Documentation

It is essential to prepare documentation of our processes, often to record errors that allow us to control and correct and other times because they are required at marketing time.

A supplier must supply a raw material according to the manufacturer's quality specifications and to the Pharmacopeia. The performance of quality control tests specified in the analysis bulletin will ensure the efficacy and safety of the plant drug.

The bulletin should contain organoleptic, macroscopic and microscopic characteristics, tests (loss of mass by drying, ashes, foreign elements, inflation index, bitterness, stomata, saponification, etc.), identification by thin layer chromatography, titration, microbiology, heavy metals and pesticides.

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Recommended documentation

- **Specifications of the raw material**: Name and code, reference to monograph pharmacopoeia, approved suppliers, standards for sampling or testing or reference to procedures, qualitative and quantitative requirements with acceptance limits, storage conditions and precautions, storage conditions prior to analysis, etc.

- **Complete monograph**: for the manufacturer: all of the above, pharmacology, activity, indications, toxicology, etc.

- **Control Guide**: Latin and common name, used part, origin, description, tests, identification, treatments, contaminations, adulterations/falsifications, previous), etc.

- **Procedures and instructions** (form of realization): cleaning, sampling, testing, control of the raw material, equipment, manufacturing, packaging, returns, claims, etc.

- **Protocols** (batch history).

- Plans of disinfection, deratization, traceability, cleaning, hygiene, sampling, training, control, hazard analysis and critical control points, manufacturing, calibration, validation, etc.

More information in GACP-Annex 5. Sample record for cultivated medicinal plants [here](http://apps.who.int/medicinedocs/es/d/Js4928e/13.html)
LEARNING ACTIVITY

Collect by cutting (without tearing) the same type of leaf or flower, in a sufficient amount (approximately 1 kg). Divide the kg into six equal parts and do the following:

- Dry one part in the sun in a thin layer (three or five centimeters) for a week.
- Dry one part in the shade in a thin layer (three or five centimeters) for a week.
- Dry one part in the shade in a thick pile (fifty centimeters) for a week.
- Dry one part in the sun in a thick pile (fifty centimeters) for a week.
- Refrigerate one portion for a week and remove from the refrigerator at the time of observation and comparison.
- Freeze one part for six days and remove from the freezer one day before the observation.

Observe the resulting material of the six cases and note the observed differences (organoleptic characteristics: color, smell, taste, texture, macro, etc.).