Technical guide

2021 | Kosovo | No. 1233

Harvest and post-harvest handling of herbs

FiBL

CARITAS Schweiz Suisse Svizzera Svizra

Austrian Development Cooperation

Imprint

Published by

Research Institute of Organic Agriculture FiBL
Ackerstrasse 113, Postfach 219, CH-5070 Frick, Switzerland
Tel. +41 62 865 72 72
info.suisse@fibl.org
www.fibl.org

Caritas Switzerland
Adligenswilerstrasse 15, P.O. Box, CH-6002 Lucerne, Switzerland
Tel. +41 41 419 22 22
info@caritas.ch
www.caritas.ch

Authors

Birgitt Boor (BIOHERB), Nicolas Lefebvre (FiBL)

Contributor

Basri Pulaj (Initiative for Agricultural Development of Kosovo IADK)

Editing

Gilles Weidmann and Toralf Richter (FiBL)

Layout

Sandra Walti (FiBL)

Illustrations

Sandra Walti (FiBL)

Photo credits
Brigitt Boor (BIOHERB), Basri Pulaj (IADK), Association Organika, Nicolas Lefebvre (FiBL)

FiBL ordering no. 1233

ISBN PDF 978-3-03736-419-2 Print version 978-3-03736-418-5

1st edition 2021 © FiBL

Disclaimer

All information contained in this guide was produced by the authors to the best of their knowledge, and checked by them and other experts with the utmost care. However, errors cannot be completely excluded. Therefore, all involved people and FiBL do not accept liability for any loss or damage that may be incurred to/by any person, private, government or non-government organisation based on the information provided in this manual, and will not be responsible for any detrimental effects, financial, intrinsic or material losses.

Recommended citation

Boor, B., Lefebre, N. (2021). Harvest and post-harvest handling of herbs – a technical guide. Research Institute of Organic Agriculture FiBL and Caritas Switzerland.

Acknowledgements

The technical guide was developed in the scope of the SIRED project, implemented by Caritas Switzerland and supported by the Austrian Development Agency ADA.

With funding from

Austrian Development Cooperation

Content

00

Introduction

In the last decade, the international demand for medicinal and aromatic plants (MAPs) has continuously increased. This development offers a significant marketing opportunity to Kosovo. Of particular interest is the development of the demand in Europe.

Most products are sold in a dried form. This gives them a high value per weight unit. The market prices for MAPs vary strongly depending on the quality of the products and their state of processing. Proper handling of the different MAP species during harvest and post-harvest is therefore essential to achieve good market prices.

In 2019, 855 farmers cultivated MAPs in Kosovo according to the Assessment Report for NWFP and MAPs, whereas in 2017 only 355 farmers were counted. Within a few years, the sector has grown strongly. In 2021, the supply chain of MAPs includes over 30 collection points and primary processing companies.

Good to excellent product quality is essential to achieve good prices.

Many growers are lacking knowledge on proper post-harvest handling and its influence on product quality. Due to lack of instruction, many farmers have adopted individual post-harvest management practices. During production and processing, MAPs are exposed to a large number of microbiological and other contaminants which can decisively deteriorate the quality of the herbs.

Many mistakes in handling of MAPs are made at the beginning of the supply chain and cannot be corrected later on. Or, in some cases, a correction would be very expensive. It is therefore important to produce clean, high quality products right from the beginning at farmer's level.

Harvesting and post-harvest handling including drying, preparation, sorting, packaging, storage, and transport have an enormous influence on the quality of MAPs. Knowledge of the issues and the implementation of the correct measures are a prerequisite for a successful high-quality production of MAPs.

Herbs produced in Kosovo for export to the European Union

This manual provides recommendations and guidelines for producers to reduce the contamination of MAPs to a minimum and to obtain high quality products.

Products that are marketed in the EU must meet the minimal legal requirements. Products that fail to meet these requirements cannot be marketed in the EU. Depending on the market segment (food, pharma industry or cosmetics), specific regulations apply e. g. the EU Food safety regulation (Regulation (EC) No 178/2002 of the European Parliament) and the pharmacopoeia in case of pharma industry.

Many importers in the EU demand compliance with additional requirements that go beyond the legal regulations. Exporters from countries outside the EU and importers to the EU agree on such extra requirements. Exporters to the EU often provide detailed product specifications to the importer to the EU, including a clear product description.

Most relevant parameters such as the quantity and quality of active ingredients or contaminations cannot be checked by eyes and therefore must be determined with laboratory analyses.

00

In the challenging but promising situation of Kosovo MAP production, Caritas decided to support the production of a practical guide for extension workers and small-scale producers to provide them the basic information on post-harvest handling of MAPs and ensure a high quality and good marketability of the products.

The elaborated guide offers a broad introduction to generic post-harvest operations, which have often proved to be the limiting factors for achieving profitability in MAP production

The market for herbs in Kosovo has a significant growth potential.

01

Quality requirements in the EU

General information

MAPs produce and store active ingredients in different plant parts like in leaves, flowers, the root or the bark. These ingredients are demanded by the market as they can have a positive effect on human health.

The quality of organic MAPs is defined according to the requirements of the EU Food safety regulation (Regulation (EC) No 178/2002 of the European Parliament) and of pharmacopoeia for the 'outer' and 'inner' quality (quantity and quality of active ingredients) of herbs.

General points to note

- The obtained prices for MAPs are always based on the quality of the products. Proper handling of the different MAP species duri g harvest and post-harvest have a great influence on the quality of the product and thus also on their price. Product quality is not only defined by the stage of the plants at har est and the conditions during harvesting, but also by primary processing including drying, cutting, sifting and storing of freshly harvested medicinal plants.
- Herbs that do not satisfy the quality requirements are refused and sent back to Kosovo.
- Inner quality is not visible to the naked eye, but must be determined by laboratory analysis.

Quality criteria

The quality of MAPs is assessed according to the following parameters:

Outer quality

The outer quality is assessed organoleptically with the eyes and the nose by assessing the appearance of the product. Common critiera are colour, particle size, smell, cleanliness, damages, etc.

Examples of Peppermint and Melissa: The leaves should be nicely green without brown spots and black cutting surfaces, among other criteria.

High content of active ingredients

MAPs produce active ingredients, which are mixtures of different chemical compounds. Peppermint that is harvested too early, has a low menthol content. If the herbs are dried above 45 °C, the essential oils evaporate and the quality decreases.

The content of active ingredients is analytically assessed in a laboratory.

01

Example of Peppermint: The essential oil content should be at least 1.5 % in whole leaves and at least 0.9 % in cut leaves with a proportion of menthol of at least 35 % of the total essential oil content, depending on the market segment.

High grade of purity

The MAPs should be practically free of any visible foreign matter such as dust, stones, hairs, excrements from mice, birds, etc., and the marketed material should only contain the desired plant parts of the same species. This parameter is mainly assessed by grading and sorting by hand a representative sample of the final raw product. Impurities are then weighed to determine their proportion.

Example of Peppermint: The marketed material should consist of leaves only. Peppermint stems shall not amount to more than 5 % of the total product, and have a maximum diameter of 1.5 mm. Other external elements etc. shall not amount to more than 2 % of the total weight. The product must be free from living pests whatever their stage of development is (eggs, larva or insect, etc.).

Low microbiological contamination

As MAPs are used in the food and pharma industry, the microbial contamination (contamination with pathogenic germs) must be low from a public health viewpoint, and must meet the legal requirements of the Commission Regulation (EC) No 2073/2005.

In the case of a high microbial load, products need to be steam sterilised to reduce the pathogens to a tolerated level. The extra costs for the buyer reduce the acquisition price or can even result in the refusal of the material in the worst case, which means that the material is sent back to the producer.

Example: Bacteria or microbes can occur on herbs. Salmonella, for example, easily grow on moist and non-aerated products.

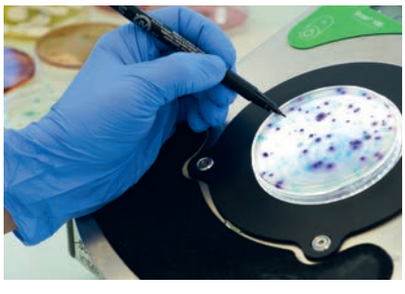
Free of residues

MAPs are regarded as products for human health and should therefore not contain any kind of chemical residues, including pesticide residues. Organic standards do not allow any application of pesticides. High requirements also apply to conventional goods. Typically, a multi-residue screening analysis is performed on a representative sample, capable of identifying and quantifying over 00 different substances.

Example: If an organic plot is situated next to a conventionally managed field, there is a risk of pesticide drift resulting in a contamination of the organic product.

The essential oil content of MAPs is determined analytically in the laboratory.

Pesticide residues due to drift, uptake from the soil or any other way of contamination are also analytically determined in the laboratory.



Microbial contamination is determined on culture plates in a laboratory.

Free of contaminants

Food contaminants are substances that may be present in certain foodstuffs due to environmental contamination, cultivation practices or production processes. These substances, that have not been added intentionally, include mycotoxins, heavy metals, nitrates, etc.

The EU Commission has set maximum contaminant levels to avoid any toxic impact of the product.

Contaminant levels are monitored with special laboratory equipment.

How are the quality standards achieved?

Quality standards serve to ensure a uniformly high quality of the products.

Suitable conditions and proper handling during cultivation, harvesting, post-harvest handling, drying, storage and transport have an enormous influence on the quality of MAPs.

The **European Medicines Agency (EMA)** has developed guidelines with the aim to ensure consumer safety by establishing appropriate quality standards. Therein is of particular importance that medicinal plants / herbal substances:

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

For more information on the EMA guidelines see at: https://www.ema.europa.eu/en/documents/scientific-guideline/guideline-good-agricultural-collection-practice-gacp-starting-materials-herbal-origin_en.pdf

The **World Health Organization (WHO)** has developed Good Agricultural & Collection Practices (GA & CP) Guidelines with the same purpose and which shall help formulation of national or regional GA & CP guidelines. GA & CP guidelines are mandatory for all MAP farmers and processors in Europe since 2006.

Importers in the EU demand that the suppliers of products from outside the EU also implement GA & CP.

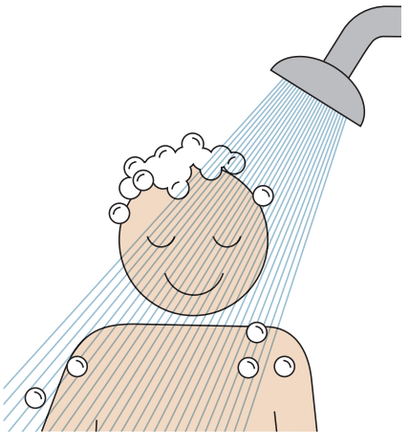
The GA & CP guidelines must be implemented by collectors, farmers and primary processors of MAPs.

02

Hygiene

General information

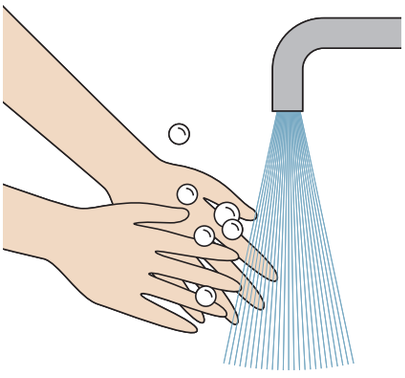
Good hygiene along the entire production process, from cultivation through harvesting, drying to primary processing is essential to obtain a high-quality product.



Personal hygiene starts at home.

- ✔ Provide an adequate training on hygiene rules to all the persons who are in contact with the plant material, including the persons working in the fields. Explain them their responsibility to ens re hygienic end products.
- ✔ Ensure that all primary processing procedures comply with regional and/or national guidelines on food hygiene.
- ✔ Ensure that all the persons who are in contact with the plant material, including the persons working in the fields, maintain a high level of personal hygiene.

Pathogen germs are especially dangerous as we cannot see, smell, taste, feel and hear them! Thorough washing of hands with soap is the most effective measure to control pathogens that are transmitted through contact!



For hygienic hands they must be rubbed with soap for 30 seconds.

General rules

- ✔ Ensure that the personnel involved in harvesting and post-harvest handling cleanes the hands after:
  - Each pause
  - Working in storage and transport
  - Waste disposal
  - Cleaning and disinfection of equipment
  - Each use of toilet
- ✔ Ensure that means of hygiene, such as clean water, soap, and towels are available wherever MAPs are handled, including on the field at har est time.
- ✔ Ensure that farmers or workers who suffer of a disease th t can be transmitted by food (including diarrhoea) are excluded from all activities with plant material.
- ✔ Ensure that staff with open wounds, infections and skin iseases are not involved in activities dealing with plants until they have fully recovered.

03

Harvest

General information

Harvesting equipment

Common harvesting machines can only be used in very few cases without modification by the farmer. Which machines can be used depends on the plant part that is required for the market.

Mechanical harvest of a leaf crop

Equipment for harvesting leaves

- Leaf crops are usually harvested with a sickle bar mower with a catching device, a green crop loader or a self-driving cutter loader.
- These devices cut the complete herbs, which requires later separation of the leaves and stems before or after drying.
- Some farmers use an adjusted cereal combine harvester for harvesting leaf crops. For this purpose, they remove the threshing drum, among other measures. The crop is cut by a hydraulically moved double knife-cutting unit and then transported to an open tank without touching the soil.
- With any equipment, squeezing and compression of the harvested material must be avoided. Squeezed and compressed leaves easily turn brown and the essential oil content decreases, and microbial contamination increases due to beginning fermentation of the material.
- For a smooth harvest, the knifes must be sharp.

Windrowing of an organic seed crop to dry out weeds and obtain a cleaner product.

Equipment for harvesting roots

- For harvesting root crops, first the lea es and stems of the crop are chipped off with a flail forage ha ester.
- Uprooting of the roots is commonly done with a shaking sieve digger or a potato elevator-digger. Basically, all types of machines which are used for harvesting potatoes, carrots or beetroot can be used after having made lile modifications.

Equipment for harvesting seeds

- Seed crops are harvested with combine harvesters which may be retrofitted with an extension of the cutting table or side-cutting devices.
- All seed crops should be threshed by leaving high stubbles to relieve the cleaning elements of the combine harvester. Less (often still green) leaf parts accrue which are easier to separate from the seeds and fruits.
- As the seeds of some species tend to drop off or shaer, seed cr ops are sometimes cut and left on windrows for a period of 5 to 10 days (swathing). Then, they are lifted and threshed by using a combine

harvester. However, this system is only recommended when a longer period of sunshine is expected.
- For threshing coriander, a low drum speed is used to avoid splitting of the seeds.
- In contrast, caraway is threshed sharply to separate the little stems from the fruitlets. For more detailed information, the respective crop manual should be studied.
- Swathing of weed infested crops results in a significantly cleaner final product after threshing

Equipment for harvesting flowers
- Flower crops can be harvested by using special machines, as for chamomile, but can also be harvested manually, as for calendula (see annex).
- However, flo ers are still often harvested manually today.
- Harvested chamomile flo ers need to be processed within 2 hours after harvest to avoid fermentation.

Optimum harvesting time

The active ingredients of the MAPs change in the course of the plants' development in the season and even in the course of the day. It is therefore important to know, at which stage of plant development, also based on the plant species, and at what time of the day the harvest is best carried out in order to achieve a high quality product.

Determining the optimum harvesting time requires much experience and know-how. However, there are some «thumb rules» to define the ideal harvesting time:

Leaves and aerial parts:
- ✓ hortly before flow ering

Flowers:
- ✓ At full bloom
- ✓ On sunny days
- ✓ In the morning, when the dew has dried off

Fruits and seeds:
- ✓ In general, at full maturity. However, the seeds of some species tend to drop off or shaer (e.g. caraw ay, coriander) which needs to be considered to avoid losses.

Roots and rhizomes:
- ✓ At the beginning of senescence of the crop when the aerial parts are dead
- ✓ Usually in late autumn (October / November) or in early spring (end of February / beginning of March, before sprouting) when there is no frost and on dry days

Flower crops are often harvested by hand.

A peppermint crop at the optimum stage for harvesting, shortly before flowering.

Harvesting stages of flowers: top left: too early; top right: too late; bottom: ideal

Use well-aerated containers such as baskets for collecting flowers. Do not use plastic containers or buckets.

When harvesting whole plants, the cutting height should be high enough, so that no soiled crop material is harvested (left: good, right: too low).

Ensure that wheelbarrows are properly cleaned, or lay out a clean cotton cloth in them.

Harvest MAPs under dry conditions only, **not during**:

- X Rain (minimum 1 day after rain)
- X Dew
- X High soil moisture
- X Extreme humidity

Check list for the harvest	
Equipment and work force	✓ Ensure clean harvesting tools and machines in good condition. ✓ Adapt the labour force for harvest according to the drying capacity. ✓ Use airy baskets for harvesting. Do not use plastic bags or plastic containers, as they may cause condensation and heating up of the harvest material. ✓ Never use bags that were used for non-plant material before, such as tools or chemicals. ✓ Cut the stems of the plants with appropriate tools. Do not tear out the plants.
Harvesting process	✓ Avoid oil leaks in the field or exhaust outputs too close to green material. ✓ Avoid the contamination of the herbs with weeds. ✓ Avoid picking up soil when cutting the herbs. ✓ Sort out and destroy damaged and rotten material. ✓ In case of wild collection: Avoid collection areas that are too close to circulated roads.
Handling of the harvesting material	✓ Do not overfill bags and baskets. Avoid compression and mechanical damage of the harvested material. ✓ Do not lay the harvested material onto the ground for wilting. The material must not get into contact with soil. Instead, put the material directly into baskets, bags, or picking containers.

After harvest / collection

- ✓ Ensure that the harvested material is loosely layered. Avoid compression due to piling up of bags.
- ✓ Protect the harvested material from rain, heat and direct sun.
- ✓ Protect the harvested material from pests and domestic animals.
- ✓ Organise the transport before harvest in order to minimise the time between harvest and drying / distillation. The harvested material should be delivered to the drying point within less than 4 hours after collection.
- ✓ Make sure that the harvested material will be processed quickly once delivered, as agreed with the buyer.

03

Crop specific aspects

Peppermint (*Mentha x piperita*)

Timing

- ✓ The plants are ready for harvest, when the flo er buds are visible.
- ✓ The latest stage for harvesting is at the beginning of flo ering.
- ✓ If the leaves start to turn yellowish, the harvest can be advanced.
- ✓ The ideal conditions for harvesting are sunny days with mild temperatures and no wind. Extreme heat and strong winds will favour the evaporation of essential oil. Rainfall within the last 2 to 3 days before harvest will decrease the quality of the final product.
- ✓ The best time of the day is in the late morning, when the leaves are dry.

Equipment

- ✓ Harvesting can be done with special green crop loaders or modified combine har esters without a threshing drum. Common hay mowers that leave the cut plants on the ground are not permitted.
- ✓ Peppermint can also be harvested by hand. For manual harvest, the same rules apply as for mechanical harvest.

Procedure

- ✓ Cut the whole plants about 10 cm above ground.
- ✓ Avoid any contact of the harvested material with the soil.
- ✓ Transport the material directly to the loading space and store it away from direct sun or rain. Then quickly deliver it to the drying station.

White Oregano (*Origanum heracleoticum*)

Timing

- ✓ Harvesting is done at the beginning of flo ering but before full blossom.

Equipment

- ✓ Harvesting can be done manually with a sickle.
- ✓ As for peppermint, a green crop loader can be used.

Procedure

- ✓ In the first ear after planting, one harvest is possible. From the second year onwards, 2 or even 3 harvests are feasible.
- ✓ Cut the plants quite close to the soil above the yellow leaves, but pay attention not to pick up any soil.
- ✓ Avoid any contact of the harvested material with the ground by putting it directly into the harvesting container or basket.

Peppermint plants ready for harvest. In this stage, peppermint plants have the highest content and the right composition of essential oils.

In its first year of growth, oregano must be harvested manually, because of its small size.

Mechanical harvest of oregano

Rigoni i prerë i freskët, pa njolla të verdha të gjetheve ose mbetje të dheut.

Chamomile (*Matricaria chamomilla*)

Timing

- ✔ Timing of harvest is a matter of judgement, as chamomile plants flo er sequentially over a period of 2 months or more. The plants produce new flo ers as older flo ers mature. The essential oil content in the flo ers increases constantly from budding to full blossom. After flo ering, the essential oil content and quality decrease continuously. Therefore, the aim is to harvest the flo ers when the white petals of the maority of the flow ers stand in horizontal direction.
- ✔ A practical way to determine the ideal moment for harvesting is to look at the colour of the field the ideal moment is, when th e chamomile field has as a homogeneous white colour, and is neit er greenish and nor yellowish.
- ✔ Late harvest may also result in disintegration of the flo ers.
- ✔ The best time of the day for harvesting is at noon on sunny days. In cool, cloudy weather the essential oil content is lower.

Chamomile flowers at the optimal harvesting stage

Equipment

- ✔ Today, chamomile is mostly harvested mechanically with specially developed or modified machines. ince a few y ears, special chamomile harvesters are produced in Eastern Europe, but also in Italy and Argentina. Some farmers modify cereal combine harvesters to harvest chamomile flo ers.
- ✔ Manual harvesting with special combs is possible, too. It results in a very high product quality, as only few and short stems are collected with the flo ers. For average chamomile flo ers, the optimum distance between the teeth of the comb is 3.5 mm. For the large flo ered varieties, the distance between the teeth of the comb can be as large as 4.5 mm. Regular combs with a distance of 3.5 mm tend to pick too many buds when used for large flo ered varieties.
- ✔ The flo ers of older plants may slip through the teeth of the comb as they get smaller with the age of the plants. It may be handy to have two different combs for different flower sizes.
- ✔ The harvesting combs used in Kosovo for harvesting blueberries are not suitable as the collecting space cannot be cleaned thoroughly which may result in microbial contamination.

Mechanical harvest of chamomile

Procedure

- ✔ In general, 2 and sometimes 3 harvests are feasible per season.
- ✔ For the production of tea bag chamomile, the complete fl wering herb is cut with a green crop loader at the time of full blossom.
- ✔ The harvested flo ers should be transported at once to the drying unit.
- ✔ At the drying unit, the flo ers should be put into the drier immediately. If this is not possible, they can be spread out in the shade for some hours. The fresh flo ers should not be filled into bags, as they warm up quickly and turn brown within a few hours.

Time requirement per hectare for harvesting chamomile

- Manual harvesting with a comb: approx. 360 hrs
- Mechanical harvesting: approx. 3 hrs

Filling freshly harvested chamomile flowers into the dryer.

03

Hand-picking of cornflower

Freshly harvested cornflowers on shelves ready for drying

Common mallow flowers with calyx and short stem ready for drying

Cornflower (*Centaurea cyanus*)

Timing

- ✓ Harvesting starts at the beginning of flo ering; in case of autumn planting at the beginning of June, in case of spring planting at the end of June.

Equipment

- ✓ Cornflo ers are hand-picked.

Procedure

- ✓ Flower heads are broken off by hand 2 to times a w eek.
- ✓ In order to avoid fading of colour, the flo ers must be dried quickly after picking.

Note: Before starting with the harvest and after every work break, workers must wash their hands with soap. Therefore, a reasonable quantity of water, soap and a towel must be available in the field.

Common Mallow (*Malva sylvestris*)

Timing

- ✓ The flo ers are ideally harvested at full blossom.
- ✓ Manual harvesting of flo ers starts usually at the end of June with the main harvest in July and lasts until September. As the flo ers are open for one day only, before they roll in, the flo ers are ideally harvested daily.
- ✓ If the complete aerial part is demanded in the market, mechanical harvesting of the herbs takes place around mid of July. A second cut at the end of August is feasible.
- ✓ The best time for harvesting is in the morning after the dew has dried.
- ✓ It takes about 10 to 12 hours to harvest 1 kg of dried cornflo er with calyx.

Equipment

- ✓ For mechanical harvesting, a general green crop loader can be used.

Procedure

- ✓ For manual harvesting, the flo ers are broken off together with the sepal / calyx and a short stem.
- ✓ For mechanical harvesting, the plants should not be cut too low to avoid too high a proportion of stems.

04

Primary preparation before drying

General information

The time between harvest and drying must be short; best not more than 4 hours, even 2 hours for chamomile!

Avoid sorting goods on the floor. In addition to a very poor working comfort, the risk of contamination by dust or other residues is very high.

Reception of fresh material

- Unload product immediately after arrival.
- Lay the herbs onto clean surfaces only, not onto the bare soil!
- Unpack the bags or baskets one after the other on the sorting tables.
- Avoid exposure of the herbs to direct sun and rain. In the non-ideal case that the MAPs cannot be processed immediately, store them temporarily in the shade and under a roof.
- Avoid the access of wild and domestic animals to the fresh harvested raw material.

Sorting out of impurities and contaminations by hand

- Use a sorting table to sort out impurities from the fresh harvest material.
- Before using the sorting table on a new working day and prior to switching to a new species, clean the table thoroughly.
- Put the fresh harvest material onto the sorting table. Quickly sort the material by hand from impurities and contaminations.
- Move the sorted material through the outlet onto drying racks or into baskets and put them directly into the dryer.

A professional sorting table offers a higher working comfort and contributes to a better product quality.

Check list for cleaning and sorting	
Flowers	☑ Remove brown and discoloured flowers, remnant flowers, stems and leaves, and others
Leaves	☑ Remove brown and damaged leaves and remnants of stems
Whole herbs	☑ Remove undesired particles like fruits, leafless stems and other plant species
Fruits / seeds	☑ Remove unripe and damaged seeds and fruits, leaves and remnant stems
Barks	☑ Remove old and broken parts, and impurities
Roots	☑ Clean the roots in running water ☑ Cut-off the root collars ☑ Remove dry and damaged roots

04

Crop specific aspects

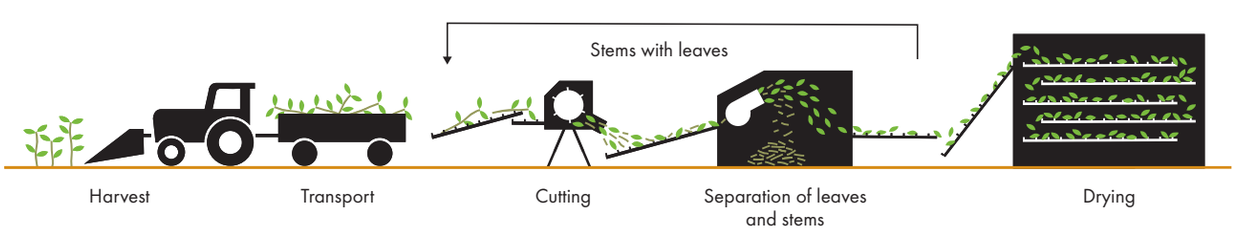
Peppermint

The leaves and stems of the herbs must be separated, as whole plants can be sold very rarely. Separation can be done before or after drying. Separation before drying results in a much higher product quality as the leaves are less fractured and therefore have a higher essential oil content compared to the separation of leaves from stems after drying with the Rebler.
The final product is called whole leaves or Kruell cut leaves.

The more the leaves are cut or broken, the more essential oils evaporate reducing the quality of the product.

- ✓ In order to gain whole leaves, cut the plants with a chopper, or better with a special cutting machine (see below), into 3–6 cm large pieces.
- ✓ Ensure that the knives are very sharp in order to avoid loss of essential oils, discolouring, and spreading of microorganisms, bruises, and heating up of the herbs.

Kruell cut process

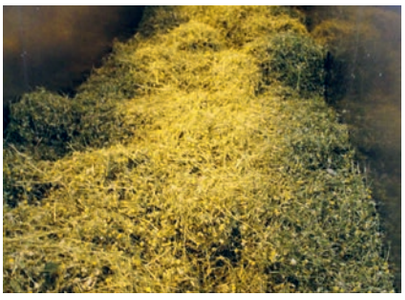


After having been cut in the cutter, an air separator separates leaves, stems and leaves with stems. The latter are led back again to the cutting machine. The stems are sorted out by the wind as they are heavier and have a smaller surface. The pure leaves are transported further to an artificial dryer.

Small producers:

- ✓ Sort out impurities by hand, then dry the whole plants.
- ✓ After drying of the material, separate the leaves from the stems with a Rebler.

Fresh chamomile flowers heat and go brown within a few hours. Therefore, they need to be dried rapidly.



Chamomile before separation in the drum separator

Chamomile after separation in the drum separator

Chamomile

Due to economic reasons, chamomile is nearly exclusively harvested by machines. The harvesting machines cut the herbs underneath the flower table, thus collecting the flowers together with a high percentage of stems and branches. This product does only meet the requirements for food-sector tea. For the use as pharmaceutical tea, the stems and branches need to be separated from the flower heads.

- ✔ Before harvest, organise continuous transportation of the harvested chamomile to the drying unit. This is an essential organisational task to ensure best product quality.
- ✔ After harvest, transport the flo ers best within 2 hours to the drying unit.
- ✔ Some growers aerate (or air) the flo ers in the loading space to maintain the quality.
- ✔ At the drying premises, screen the collected flo ers on riddling screens with a mesh size of 7 to 12 (7 to 12 mm sieves).
- ✔ Hand sort the material on the drying screens by removing coarse impurities, long stalks, weeds and other extraneous matter.
- ✔ Larger growers may use a drum separator to separate stems and other undesired matter (like stones or weeds) from flo ers before drying.

Functioning of the drum separator

- The drum separator has two sieve drums: the inner drum with a hole diameter of 25 mm, and the outer drum with a hole diameter of 20 mm.
- The separator divides the chamomile into 2 fractions: flowers with stems of up to 50 mm length, and stems with a length of more than 50 mm, some flowers and impurities.
- Flowers and small stems fall down onto a roller course with a roller clearance of 3–4 mm.
- Flowers are discharged in conveying direction, whereas small stems fall down to the waste.

Processing line for de-stemming and cleaning of chamomile

04

White Oregano

- ✓ Hand sort the fresh raw material quickly after arrival at the drying location.
- ✓ Put the sorted plants into the dryer.

Flower crops (e. g. Corn Flower, Common Malow)

- ✓ As these crops are picked by hand, there is usually no major impurity in the freshly harvested raw material. Therefore, the harvested material can directly be filled into the dr ers.
- ✓ Take care not to bruise the flo ers as bruised flo ers will turn brown.
- ✓ hile filling the flo ers into the dryer, a quick sorting may be carried out.

Manually harvested cornflower

05

Drying

Drying process

As the fresh herbs contain much moisture, proper drying is essential for good storage and quality.

Quick and effective drying is essential to produce storable and high-quality herbs.

General recommendations

- ✔ Do not dry the material on the bare ground and in direct sunlight. Use artificial dr ers or tunnel dryers for drying herbs.
- ✔ After sorting out of impurities, put the harvested material as quickly as possible into the dryer.
- ✔ Ensure thorough drying in order to maintain the material's natural colour and avoid later microbial contamination.
- ✔ As a general rule, a moisture content of 10 to 14 % is required. Seeds with a high oil content (e.g. fennel, linseed) require an even lower moisture content.
- ✔ In case the herbs are meant to be used for pharmaceutical purposes, check the monographies. Pharmacopoeias define specific fin moisture contents for some species.
- ✔ Drying below the required moisture contents not only causes higher drying costs, but may also negatively influence the taste and the fragrance of some MAPs.

Drying herbs on the bare ground is not recommended as it bears a high risk of contamination.

Maximum final moisture content for selected MAP species as defined by the European Pharmacopoeia

Species	Plant part	MC_f % w.b
Althaea officinaliis L.	Roots	10
Arnica montana L.	Flowers	10
Calendula officinalis L.	Flowers	12
Chamomilla recutita L. Rauschert	Flowers	12
Coriandrum sativum L.	Seed	10
Foeniculum vulgare Mill.	Seed	8
Hypericum perforatum L.	Herb	10
Levisticum officinale Koch	Leaves	12
Malva silvestris L.	Leaves	12
Melissa officinalis L.	Leaves	10
Mentha x piperita L.	Leaves	11
Plantago lanceolata L.	Herb	10
Valeriana officinalis L.	Roots	12
Verbascum phlomoides L.	Herb	12

05

Drying ratio

Along with the drying process goes a high weight reduction of the harvest material caused by the reduction of the water content of the fresh MAP. The weight reduction is characterised by the drying ratio. The drying ratio is used to estimate the amount of fresh material that is needed to produce a certain amount of dried MAPs.

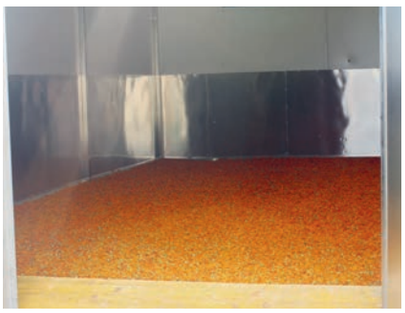
Drying ratios of selected MAPs		
Species	**Drying ratio**	**Water** (l per 100 kg FM)
Peppermint (leaves)	6 : 1	83
Peppermint (herb)	4 : 1	75
Cornflower	6–7 : 1	83 to 86
Chamomile	5 : 1	80
White Oregano	4 : 1	75

Example: . kilograms of fresh peppermint leaves give 1 kilogram of dried leaves, and 83 litres of water have to be removed from 100 kilograms of fresh leaves.

Conclusions from the drying ratio

During the drying process, the air in the drying room becomes increasingly humid, as it may absorb more than 80 litres of water per 100 kilograms of fresh herbs. For an efficient drying process, new dry air has to come into the drying room, and the moist, warm air has to go out.

- Good ventilation is essential for efficient drying and to avoid microbial and fungus infestation of the material.
- The inlets and outlets for air must be well dimensioned to ensure sufficient air flow and to keep the moisture level in the drying room low enough.
- The dry air must be conducted uniformly through the MAP material (for details see below).



A tidy drying room

Drying room management

Microorganisms prefer disorder, dirt and waste. Therefore, the drying room should always be kept clean.

Ensure that all the drying rooms, no matter of which kind, are:

- ✓ Clean
- ✓ Well aerated
- ✓ Never used for animal keeping
- ✓ Regularly serviced with clearly marked waste containers that are emptied daily

Avoid access to the drying room for:

- X Insects
- X Birds
- X Rodents
- X Domestic animals

Ideal arrangement in the drying room: The different species are dried beside each other, and not above each other. The mobile drying frames allow an individual handling of the material.

General recommendations

- ✓ Close the ventilation openings with fine wire nettings.
- ✓ Avoid simultaneous drying of different species in the same dryer.
- ✓ Never dry different species above each other.
- ✓ Maintain sufficient distance of the bottom drying shelf from the ground and between shelves to facilitate good aeration.
- ✓ Layer the material only so high that good air flow is still possible.

Drying temperature

The drying temperature has great influence on the product quality of MAPs. Too high temperatures cause the aromatic substances, such as the essential oils, to volatilise which results in quality losses. Other active ingredients are also influenced by the drying temperature.

MAP species have individual optimum drying temperatures. However, for practical reasons the following general drying temperatures may serve as thumb rule:

Flowers:	35 – 40 °C
Entire herbs / leaves:	40 – 45 °C
Seeds:	45 – 50 °C
Roots / rhizomes:	50 – 60 °C
Aromatic herbs:	38 – 42 °C

Essential oil-bearing crops have a narrow ideal drying temperature range.

General recommendations

- ✓ Place a thermometer in the centre of the dryer at the height of the highest shelf.
- ✓ Monitor the drying temperature regularly.
- ✓ When the temperature becomes too high, open the air inlets and outlets to increase ventilation.

05

Drying in tunnel dryers

Greenhouse tunnel dryer

In the greenhouse tunnel dryer, the sun warms-up the air creating an air-flow. The naturally warmed incoming air tends to rise while loading moisture.

- For efficient drying, greenhouse tunnel dryers must have large air inlets at ground level leading the dry air through the shelves. At the top of the tunnel, there must be an air outlet.
- The MAP material must be layered in a way that allows the air to flow through it.

Drying recommendations

- ✓ Place the harvested material in a thin layer onto the drying shelves to ensure an even air flow and quick drying.
- ✓ Maintain a distance of at least 50 cm between the ground and the bottom shelf to ensure good ventilation.
- ✓ Ensure a vertical distance of at least 40 cm between the shelves.
- ✓ Ideally, frames of 1–1.5 m^2 size are used that can be taken off the rack by one person.
- ✓ Ensure access to the shelves from all sides for easy handling.
- ✓ Ensure a good air flow from the bottom to the top running through the drying material.
- ✓ Carefully clean the drying shelves when changing to another crop species.

The openings in this tunnel dryer do not allow an optimal air flow. The air inlets at the bottom are placed too high, and the outlet at the top of the tunnel is missing. In this case, the air does not flow through the shelves and the drying material, and cannot carry out the humid air through the top.

Drying in artificial dryers

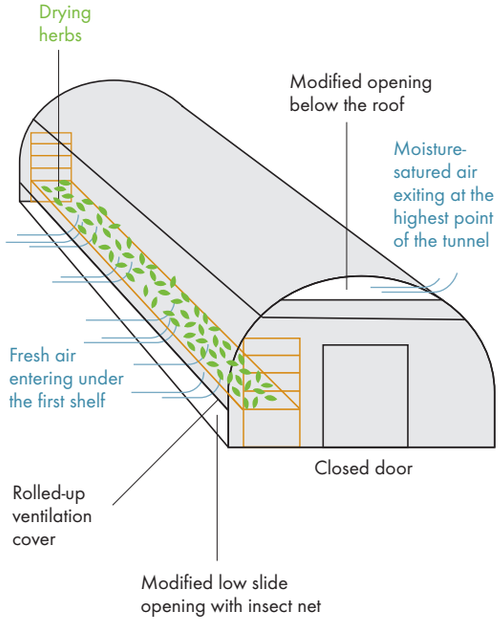
There are 5 types of artificial dryers that are used for drying MAPs: belt dryers, container or batch dryers, shelf dryers, dehumidifiers, and freeze dryers.

Belt dryers

- They result in a very high product quality.
- They are very expensive and, therefore, demand a high utilisation to be cost-covering.
- For large operations with a high mechanisation level 3- and 5-belts dryers should be used.

Batch or container dryers

- They are inexpensive and can easily be installed.
- The harvested material is spread on a large area which is aerated from underneath.
- Depending on the species, the material can be piled up to a filling height of 150 cm.
- The air can be heated with oil, gas or firewood.
- They are ideal for medium sized operations with MAPs where leaves and herbs are harvested.
- This type of dryer is used in Kosovo.



This illustration shows a tunnel dryer with an ideal design of the openings for an efficient air flow from the bottom to top.

Container dryer with open door

Empty container dryer with ventilated floor

Container dryer filled with fresh MAPs

Empty shelf dryers

Shelf dryers

- The harvested material is dried on shelves placed above each other in a cabinet.
- As in the batch dryer, heated air is blown through the raw material from below.

Dehumidifiers

- This type of drier ensures a very gentle drying.
- The system is cost-efficient and requires little energy.
- The harvested material is placed in boxes or shelves, which are put into a closed drying room or cabinet.
- The air is cooled down to the dew point and forced to emit the water. The heated (25 °C) dry air is lead through the fresh MAPs.
- It is well suited for drying small quantities of MAPs, especially of flowers, which are very sensitive to high temperature.

In Kosovo, artifical drying systems are mostly used by larger MAP growers. Container and shelf dryers prevail. Currently, dryers of three companies from Kosovo (Osa Termosistem), Kroacia (Herbas) and Serbia (Trmoplin) are used.

Recommendations for optimal drying efficiency

- ✓ Break up the harvested material and separation of stems as they require especial long drying time (in case of leaves)
- ✓ Loosen and mix the raw material.
- ✓ Consider individual filling height per species to allow good and even air flow.
- ✓ Ensure optimal drying temperature.
- ✓ Use optimal airflow rate and flow speed.
- ✓ Avoid too long drying.

05

Assessing the dryness of the material

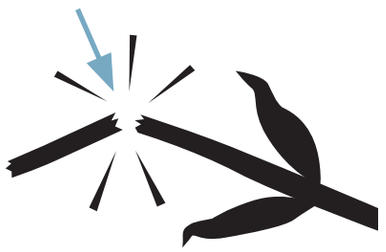
Leaves

- ✓ Move the fingers in the dried leaves. It should create a rustling sound.
- ✓ Rubb some leaves between the fingers. Dry leaves crumble.

Herbs (complete above ground plant parts)

The leaves dry first, whereas young tips, buds, flowers and fruiting bodies are often slower to dry. Stems take most time to dry.

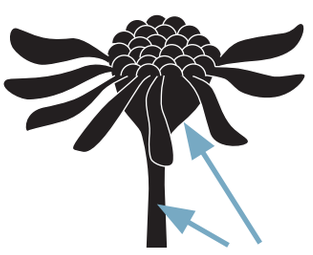
- ✓ Break some stems. They should snap when dry.



Stems should break sharply.

Flowers

- ✓ Check whether the base, stalk and central axis of species with larger flower heads, such as Calendula, are hard and brittle.
- ✓ Cut one large flower head axis with a knife and check with your thumbnail, whether it is hard.



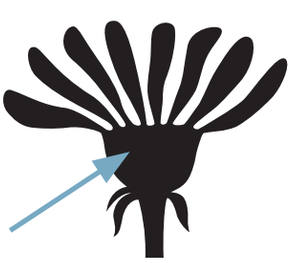
The base, stalk and central axis of larger flower heads should be hard and brittle.

Fruits

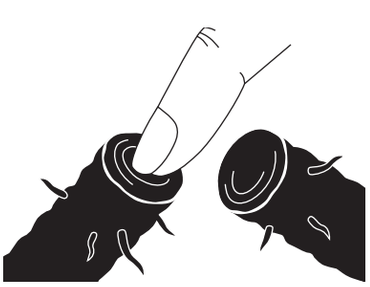
- ✓ Crush fruits between the thumb and the forefinger. Some should shatter when crushed.
- ✓ Check the hardness of fruits with the fingernail. The fruits should be difficult to dent.

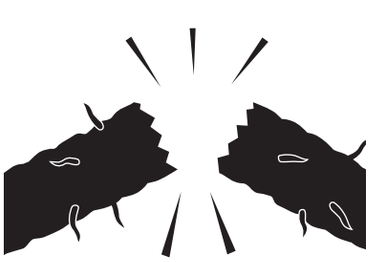
Roots

- ✓ Cut or break large roots in half and check with the fingernail whether the centre is hard. Roots with doughy center need to be dried further.
- ✓ Break thin roots. They snap when dry.
- ✓ Check inside the crown buds whether they are dry. Note that crown buds dry slowly.

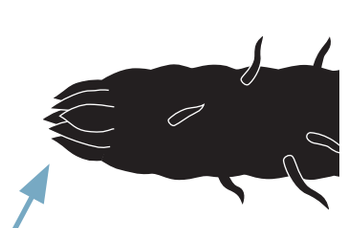


The flower heads should be hard inside.

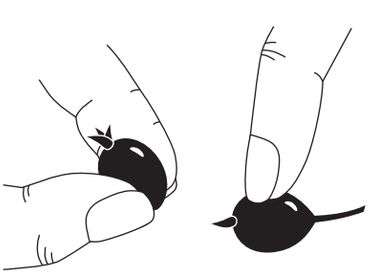




Top: Thick roots should be hard inside. Thin roots should snap when broken.



Left: Crown buds should be dry.



Crush a fruit between the thump and the fore-finger. Check the hardness with the fingernail.

Crop specific drying requirements

Peppermint

- ✔ Ensure a drying temperature between 38 and 42 °C. At higher temperatures, the essential oil content decreases (5 % at 45 °C, 37 % at 60 °C).

Chamomile

- ✔ Dry chamomile as quickly as possible after harvest, best within 2 hours.
- ✔ Ensure a drying temperature between 35 and 40 °C, and never above 45 °C!

White Oregano

- ✔ Ensure a drying temperature between 35 and 40 °C, as White Oregano is an essential oil crop.

Cornflower

- ✔ Avoid bleaching of colour with a very quick drying up to 60 °C.

Malva

- ✔ Lay out the flowers very loosely on the drying shelves as they stick together.
- ✔ Avoid a drying temperature above 40 °C.

Malva flowers laid out in a thin layer

Optimal primary processing requires a sorting table and proper light.

Primary processing and sorting after drying

General information

At the farm or collector level

After drying of MAPs, a final sorting must be carried out by hand on the sorting table. Dust, sand, non-desirable impurities, and too small plant parts are eliminated with a sieve.

Plant parts and impurities to be removed

- ✗ Discoulored plant parts
- ✗ Mouldy plant parts
- ✗ Damaged plant parts
- ✗ Stones
- ✗ Weeds
- ✗ Soil and other impurities

Procedure

- ✓ Use the outlet of the sorting table to directly fill the sorted material into clean bags.
- ✓ Bring the bags with the sorted material to the storage room.

Further preparation of dried MAPs is usually done at the collection points, or in processing and exporting companies, as this requires high investments and full capacity of machines.

Threshing line for dryed peppermint

At the collection point and in the processing company

The main step of processing consists of a final cleaning of the MAPs in order to remove all foreign material that lowers the quality and jeopardises the sale.

Procedure

- ✓ Remove all foreign material including plant parts of the same species, which are not desired in the final product (e.g. stems where leaves or flowers are wanted).
- ✓ Cut the harvested material into the requested size or pattern, if demanded by the buyer.
- ✓ De-stem marjoram, oregano, whole herb peppermint, Melissa and other MAP species which were dried as whole herb (all parts above ground), and where the leaves are the final product. Use a rebler or a treshing machine for de-stemming. Ensure that the desired plant parts remain as large as possible. Use sieves of the appropriate mesh size for the species.

Screen separator to remove fine particles and sort the dried product into different categories.

06

- ✔ Sieve the MAPs mechanically, screen, sort and remove stones and metal, if necessary.
- ✔ Use grain cleaning machines with sieves, winnower, trieur and table cantilever for seed crops like fennel, anise, etc.

Cutting of essential oil-bearing aromatic herbs (peppermint, melissa, white oregano, etc.) goes along with a loss of essential oils. The oils are stored in special cells in the leaves or other plant parts. When they are opened, the essential oils volatilise. Therefore, whole leaves or large pieces of leaves contain higher amounts of essential oils, and are of higher quality.

De-steming is usually done with a 'rebler' or threshing machine. Most companies who offer MAP harvesting machines also offer 'reblers' and special cutters. The photo shows dry peppermint stems after separation in the rebler.t

Processing lines

For mechanically harvested herbs, the large volumes of goods to be prepared require appropriate and specific processing lines. This equipment should only be used in large-scale units (at collection points and exporters) which will be able to make it profitable by maximising its use over time, on large volumes of dried products.

The Herbas company offers a processing line which separates dried chamomile into 5 fractions:

- High quality whole flowers
- Lower quality whole flowers
- Stems, leaves and white ray flower petals
- Yellow tubular flowers
- Dust

The different fractions can be sold to different market segments. The highest price is obtained for whole flowers with stems shorter than 2 cm.

High-quality peppermint leaves after threshing

Small pieces of peppermint leaves with a lower content of essential oil

Chamomile flowers during primary processing

07

Packaging

Unpacked dried MAPs easily take up moisture, lose odour and sometimes taste, and may gain a larger volume than packed material. The main purpose of packaging is to preserve the quality of the raw material during storage and transport.

Packaging of coarse raw materials

Coarser types of raw material like bark, roots, rootstocks and fruits that do not crush during transport, are usually packed into bags.

Open bags filled with coarse material

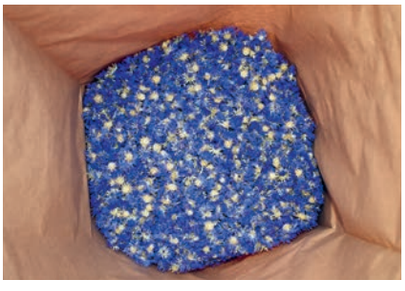
Bags are usually used for coarser types of raw material like bark, roots, rootstocks and fruits, that do not crush during transportation.

Check list for bag selection

- Not too heavy for stability and easy handling at transport
- Lightproof
- Air-permeable to allow a slight breathing of the MAPs
- Insect-safe
- Resistant to breaking, bruising and pressure
- Stackable
- Compatible with palletisation
- Labelled

Packaging of delicate and fragile raw materials

Flowers, but also **peppermint and Melissa leaves** that are especially delicate, are often packed in cardboard boxes or other rigid containers. Before packing, they are lined with wrapping and sack paper or imitation parchment.



These cornflowers are packed in a paper bag for transport.

Recommendations

- ✓ Ensure that the packing material is clean without extraneous odour, single-type for each batch of raw material and ensure its integrity during transport and storage.
- ✓ Packing material may be of different material, but should always be slightly permeable to air to allow a slight breathing of the MAPs. Plastic coating and inlays often do not prove themselves.
- ✓ Exporting companies shall consider instructions of the buyers.

07

Packaging of raw materials for extraction

Barks, roots, rootstocks, leaves and herbs which are intended for extraction are packed in bales.

The bales are made by pressing the raw material with a mechanical or hand-powered press. The bales are then covered with cloth to keep them free of dust.

Maximum weight of packaging units

- **Paper and plastic bags:** 15 kg
- **Paper packs:** 5 kg
- **Net:** 200 kg (to be handled with lifting equipment)

Paper bags filled with dry herbs ready for transport to the extraction location

Management of the packaging areas

A well-designed and well-operated packaging area contributes to the reduction of pathogen contamination. Mistakes in the facility or operation system may lead to cross-contamination.

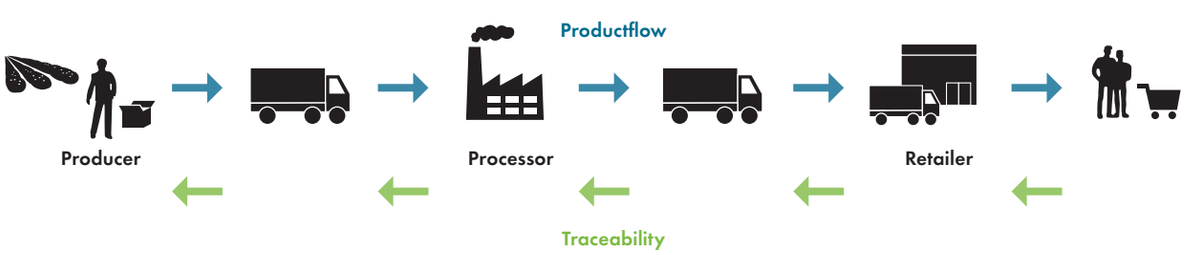
Following the safety rules is extremely important since the packaging area is the last step in post-harvest handling, and damages cannot be corrected in retrospect.

All the food safety standards must strictly be implemented and followed (see the chapter on hygiene).

Labelling for traceability

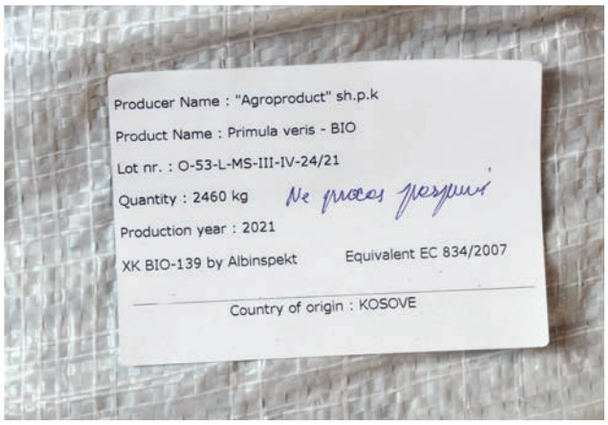
Proper labelling of the packaged products is essential to ensure full traceability of the procucts. Ensuring traceability is mandatory for organic products and a key requirement for establishing long-term relationships with the clients.

Traceability through the value chain

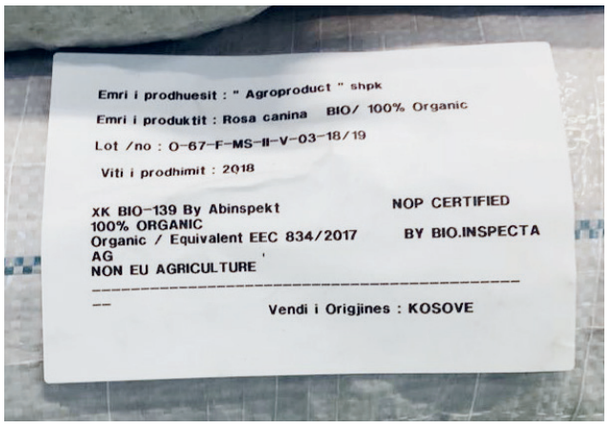


Traceability enables tracing the origin of the products if requested by the client or the certification body. (Source: IPD-Traceability in Supply Chain)

07



Label with batch number



Packaging labels of organic MAPs with all required information

Collection points who buy from collectors or farmers / growers need to be able to identify from which place / village or farmer a particular batch or raw material comes in order to trace possible problems to their source. This is more difficult for wild MAPs, where a day's raw material may come from many small collectors.

Recommendations

Information required in the traceability book

- ☑ Date of harvest
- ☑ Name of the harvested product
- ☑ Quantity (fresh and later dried)
- ☑ Harvesting location / zone or plot
- ☑ Batch number (particularly created for the harvested product)

- ✔ Create a batch number for the collection / harvest of each day in each defined zone or field.
- ✔ Attach the batch number first to the drying shelves and then to the bags in the store room.

Examples of batches

Example A:
Primula herb collected in zone A (e. g. village or collector's group) on the 20th of May 2019:

«Collection date_raw material name_collection zone»
190520_Primula_A

Example B:
Peppermint harvested on field plot no. 2 on the 5th of August 2018:

«Harvest date_product name_plot-No»
180805_peppermint_2

Mandatory information for the labelling of organic batches

- ☑ Name and address of owner or seller
- ☑ Name of product
- ☑ Product-related organic indication (e.g. Organic Chamomile)
- ☑ Code number of the certification body
- ☑ Lot / batch number for reasons of traceability

08

Storage

Dried herbs need to be kept dry and away from direct sunlight, to maintain their quality. Moisture is the biggest challenge in storage, as the dried herbs absorb moisture from the air. Moisture can promote the growth of yeast and mould, and encourage the development of microbes.

A well-managed small store room with bagged dry leaves.

Storage at the farm

The nature of the storage rooms and handling can have a decisive impact on the quality of MAPs. The duration of storage at the farm should be limited due to the continuous decrease of active ingredients in the herbs.

Recommendations

- ✔ Minimise the duration of storage of dried MAPs at the farm.
- ✔ Maintain cool temperatures in the storage room.
- ✔ Protect the herbs from vermin and insects.

Long-term storage

Long-term storage must be set at collection points and / or processing / exporting companies. The storage rooms must provide all preconditions to preserve the quality of the herbs.

A well-managed, air-conditioned store room at AGROPRODUKT

Requirements for proper storage conditions

- ☑ Controlled temperature of about 25 °C
- ☑ Less than 60 % moisture
- ☑ Concrete floor or similar easy to clean floor covering
- ☑ Openings closed with wire netting against pests and domestic animals
- ☑ Windows and walls painted in white colour
- ☑ Good air circulation with ventilator(s) or open (but rain-safe) windows
- ☑ Temperature and humidity measuring devices
- ☑ Metal shelves and racks (not wood to avoid insect infestation)

08

Management

- ✓ Clean the storage rooms properly before storing new herbs.
- ✓ Store the herbs in clean bags to maintain their quality.
- ✓ Place bags/sacks on pallets with at least 25 cm distance to the walls and the ground for proper air circulation.
- ✓ Keep different species and batches clearly separated and labelled, in order to avoid transmission of smell from one species to the other and eventual contamination from one batch to the other.
- ✓ Ensure a good circulation of the air.
- ✓ Frequently monitor the temperature and humidity in the storage room.
- ✓ Keep the storage room tidy, and empty the waste bins daily.
- ✓ Regularly check the storage room and the stored material for signs of storage pests. Collection points and companies should have insect controls (pheromone traps) inside the storage buildings for monitoring and rodent traps and baits outside the buildings.
- ✓ Once a week, monitor temperature and humidity in the bags.

Storage of the sacks on wooden pallets ensures sufficient distance of the crop from the ground.

These bags are stored too close to the wall. This can cause moisture to accumulate between the wall and the bags.

How to monitor temperature and humidity in the bags

Open a bag and put a clean hand into it:

- ☑ Does the material still feel cool?
- ☑ Does leafy material still rustle, when moving the fingers?

Take some material out of the bag and check it for dryness criteria (see chapter 5 Drying):

- ☑ Do stems and thin roots still snap?

Monitoring storage conditions in bags

Well-ventilated bags on a pallet

09

Transport

The quality and integrity of the herbs must also be guaranteed during transport.

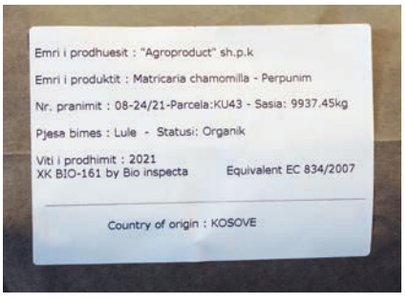
A clean, dedicated and elevated loading dock for final products

Conditions for transport

- Transport all fresh and dried MAPs in dry and clean vehicles only.
- Ensure that the loading space is free from extraneous odours and storage pests.
- Transport poisonous and essential oil-bearing herb species separately from other herb species.

Labelling for transport

For transport and delivery of MAPs (e. g. from the farm to the collection point), all bags must be labelled. If the bags are not labelled, each lot of raw material must be accompanied by documents (way bill) with the information listed below.



Correct labelling of the bags ensures clear identification of the contents at all times.

Obligatory data for organic labelling

- Name and address of the owner or seller
- Name of the product
- Product-related organic indication (e. g. 'Organic Chamomile')
- Code number of the certification body
- Lot / batch number (for reasons of traceability, if possible)
- Address of the recipient