

SMALL-SCALE PRODUCTION OF ESSENTIAL OILS

Essential oils are the volatile oils distilled from aromatic plant materials. The odour and flavour of these oils is usually dependent upon these oxygenated compounds. Many oils are terpenoids, a few oils are benzene derivatives. Table 1 shows the important constituents of the more common essential oils.

Name	Part of plant used	Botanical name	Important constituents	Uses
Lemongrass and citronella	Leaf	Cymbopogon spp	Citral Citronella Terpenes	Perfumery Disinfectant
Eucalyptus	Leaf	Eucalyptus globulus Eucalyptus citriodora Eucalyptus dives	Cineole Citronella Terpenes	
Cinnamon leaf	Leaf	Cinnamomum zeylanicum	Eugenol	Used to make artificial vanilla
Clove	Bud	Eugenia caryophyllus	Eugenol	Dentistry flavouring
Turpentine		Pinus spp	Terpenes	Paints
Lavender	Flower	Lavendula intermedia	Linalol	Perfumery
Sandalwood	Wood	Santalum album	Sanatols	Perfumery
Nutmeg	Nut	Myristica fragrans	Myristicin	
Almond	Nut	Prunis communis	Benzaldehyde	
Coriander	Seed	Coriandrum sativum	Linalol Terpenes	
Ginger	Root/ tuber			
Turmeric	Root/ tuber			

Table 1: Essential oils

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Essential oils can be divided into two broad categories:

- Large volume oils which are usually distilled from leafy material, eg lemon grass, citronella and cinnamon leaves.
- Small volume oils which are usually distilled from fruits, seed, buds and, to a lesser extent, flowers, e.g. cloves, nutmeg and coriander.

Harvesting

Correct harvesting is very important. The essential oil content varies considerably during the development of the plant. If the plant is harvested at the wrong time, the oil yield can be severely reduced.

The oil is usually contained in oil glands, veins or hairs which are often very fragile. Handling will break these structures and release the oils. This is the reason a strong smell is given off when these plants are handled, so these plants have to be handled very carefully to prevent valuable oils being lost.

Citronella and lemongrass

The first harvest can take place 6-9 months after planting. Then the grass can then be harvested up to four times a year. If harvested too often, the productivity of the plant will be reduced and the plant may even die. If the plant is allowed to grow too large, the oil yield is reduced. For lemongrass it should be 1.2m high with 4-5 leaves. The grass should be harvested early in the morning as long as it is not raining. Harvesting can be done with machetes or simple knives.

Cinnamon leaves

Cinnamon leaves are harvested during the wet season since the rains facilitate the peeling of the bark. Harvesting involves the removal of the stems measuring 1.2-5 cm in diameter. This takes place early in the morning.

Spices

It is essential that the spice is harvested correctly. The main obstacle to correct harvesting is the crop being picked immature. This is usually due to fear of theft or the farmer requiring money urgently. However, every effort should be made to wait until the spice is fully mature.

Flowers

These should be picked very carefully and processed as soon as possible.

Drying

Drying the material increases the yield obtained considerably. However, oil is lost during drying so care needs to be taken. Drying the leaves in the shade or partial shade will reduce the amount of oil lost; 50% of the oil can be lost if it is dried in the sun. The dried product should be distilled as quickly as possible. If it does have to be stored, it should be stored in the shade and should not be allowed to get wet. Before the leaves are placed in the distillation unit they can be cut up. This increases the percentage of oil collected. However, oil is lost prior to distillation. The balance of these two factors has to be investigated for each individual case.

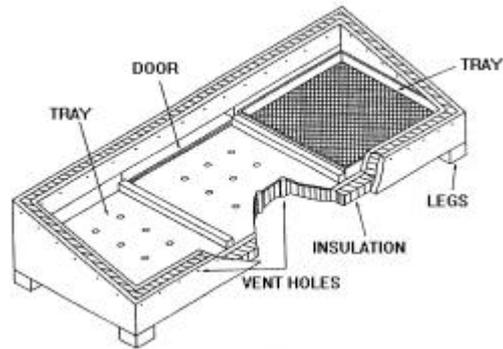


Figure 1: Solar Dryer

During the dry season, sun drying is usually adequate to dry the produce. The simplest and cheapest method is to lay the produce on mats in the sun. However, there are problems associated with this method. Dust and dirt are blown onto the crop and unexpected rain storms can re-wet the crop.

A solar dryer avoids these problems. The simplest type is the cabinet solar dryer, see Figure 1, which can be constructed out of locally available materials (e.g. bamboo, coir fibre or nylon weave).

For larger units (over 30kg/day an 'Exell Solar Dryer' could be used, see Figure 2. However, the construction costs are greater and a full financial evaluation should therefore be made to ensure that a higher income from better quality spices can justify the additional expense.

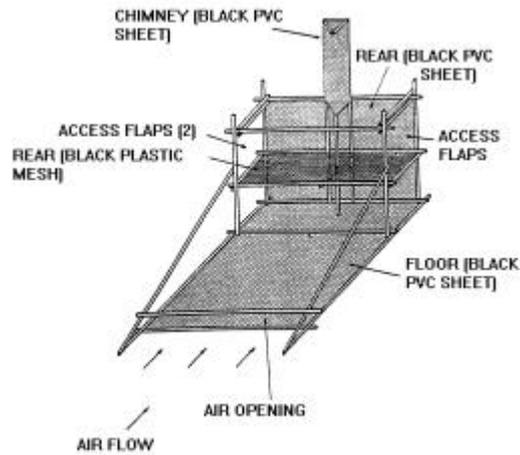


Figure 2: Exell Solar Dryer

During the wet season or times of high humidity, which often coincides with the harvest of the spices, a solar dryer or sun drying can not be used effectively. An artificial dryer, which uses a cheap energy source is necessary. This may be a wood or husk burning dryer or a combined wood burning and solar dryer. Figures 3-6 show a combined wood burning and solar dryer which is based on the McDowell Dryer and has been used in Sri Lanka.

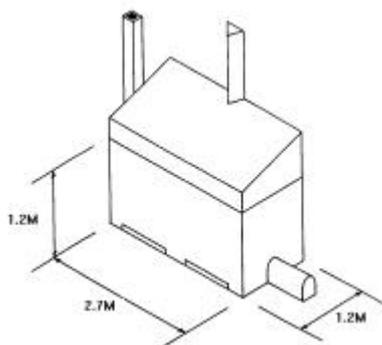


Figure 3

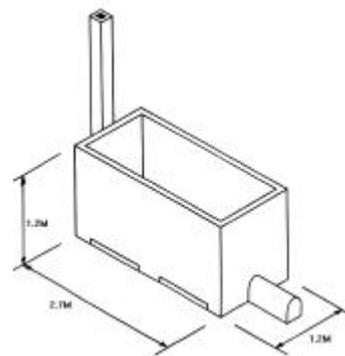


Figure 4

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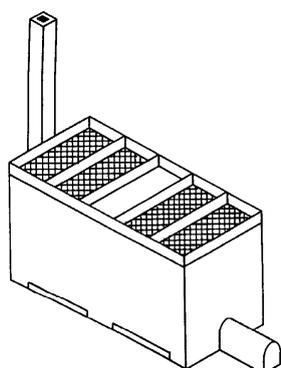


Figure 5

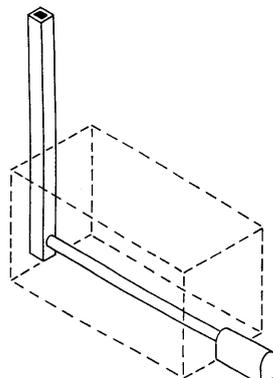


Figure 6

The crop should not be overheated (e.g. the maximum air temperature for drying pepper and cardamom is 50°C). Neither should it be over dried (the final moisture contents for various spices are shown in Table 2 below).

<i>Spice</i>	<i>Maximum final moisture content % (wet basis)</i>
Mace	6.0
Nutmeg, cloves	8.0
Turmeric, coriander	9.0
Cinnamon	11.0
Pepper, pimento, chillies, ginger	12.0
Cardamom	13.0

Table 2: moisture contents for various spices

The drying of certain spices requires special conditions. For example cardamom has to be dried in the dark so that the green colour is retained.

Flowers

These should be distilled as quickly as possible after harvest.

Distillation

There are three methods of distilling essential oils:

Water distillation

This is the simplest and usually cheapest distillation method. The plant material is immersed in water and boiled. The steam and oil vapour is condensed and the oil is separated from the water. This method is suitable for flower blossoms and finely powdered plant material.

The distillation temperature should be about 100°C. Care needs to be taken to prevent the plant material being damaged by contacting the overheated still walls. The pressure in the still should be atmospheric. The distillation time depends on the plant material being processed, but is

usually three hours. Prolonged distillation produces only a small amount of extra oil, but does add unwanted high boiling compounds and oxidation products.

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The rate of distillation and yield of oil are low, as water soluble oils are retained by the water remaining in the distillation unit. The quality of the oil can be poor due to ester hydrolysis and possible damage from the plant material coming into contact with the wall of an overheated tank.

The distillation unit consists of three parts:

Retort or tank

This is the container or tank B in Figure 7. The plant material is placed in the tank and covered with water. A direct heat source or steam jacket will heat up the chamber and boil the water. The plant material needs to be kept covered with water and vaporised water replaced. A removable cover is needed so that the plant material can be placed in the chamber and spent material removed.

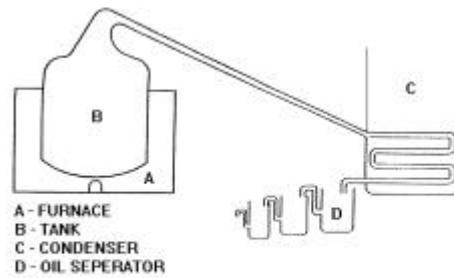


Figure 7: Distillation Equipment

A pipe should lead from the top of the tank to the condenser. The size of the tank depends on the size of the operation. The diameter of the tank should be slightly less than the height.

Iron and copper react with essential oils and therefore should not be used for the construction of the tank. Aluminium reacts with phenol-containing oils, so should be avoided in those cases. Stainless steel and glass are the best materials to use. A cheap alternative that can be used is heavily tinned copper.

Condenser

The condenser, part C in Figure 7, converts the steam and oil vapour to liquid. This is very important and the rate of distillation depends on it. If the condenser is too small, the distillation rate will be reduced.

The condenser is usually a cooled pipe in a large water tank. The water should be kept cool by changing it regularly.

As with the tank, the condenser should be made from stainless steel, glass or, in some cases, aluminium. All joints should be soldered, as even a small hole will result in large oil losses.

Separator

This separates the oil from the water. See part D of Figure 7. This is usually done by letting the mixture settle in a large container made of glass. If the oil is heavier than water, the oil is collected from the bottom of the container, and if lighter from the top, see Figure 8.

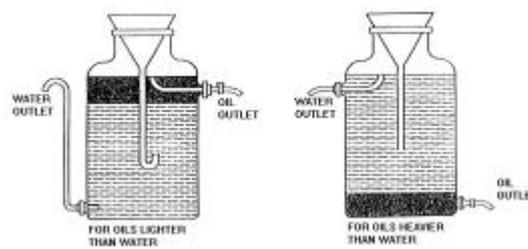


Figure 8: Methods of oil collection

If the water is cloudy after separation, it should be used in the distillation unit with the next load of plant material. This is called 'cohabitation'.

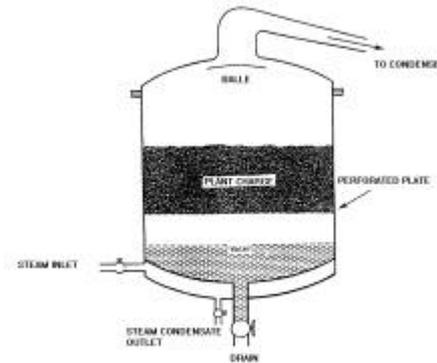
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Water and steam distillation

This is the same as the water distillation, except that the plant material is not immersed in water but held above the boiling water on a grid, see Figure 9. This is slightly more expensive than water distillation but better for herb and leaf material.

The plant material does not need to be finely chopped or powdered. The distillation temperature should be about 100°C and at atmospheric pressure.



Steam distillation

In this process the steam is prepared in a separate chamber and piped into the tank, see Figure 10. This is more expensive than the other methods. This is especially good for plant materials with high boiling point oils.

In this method the temperature and pressure can be increased for certain oils.

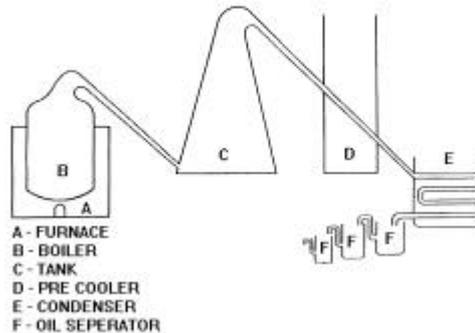
The rate of distillation and yield of oil are high and the quality of the oil is good.

Solvent extraction

Essential oils can be extracted using solvents. Hydro-distillation is not suitable for various products like delicately odoured oils. There are three main ways that this can be performed.

Enfleurage

This was popularised in France to extract jasmine and other oils from flowers. The flowers are laid on cold fat, which absorbs the 'perfume' given off by the flowers. This is extremely difficult in that the oil has to be made extremely pure and to be of just the right consistency.



Maceration

This method involves putting the flowers in hot fat and the oils being extracted. This is very rare nowadays.

Volatile solvent extraction

The flower are put into the extractor and the solvent penetrates the flowers and dissolves the oils. This is pumped into an evaporator and concentrated at low temperatures. The solvent is driven off by a vacuum. This is expensive and dangerous due to the quantities of solvents used.

Filtration

After the oil is collected, it should be filtered. This can be done through dry cotton wool. Water can be removed by saturating with sodium chloride and filtering.

Storage

The oils should be stored in darkened glass bottles, galvanized iron or stainless steel containers. The head space in the containers should be minimal.

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Grading/Quality

The criteria for essential oil quality are:

- Colour - most oils should be clear, colourless and clean. A murky oil is a sign of water being present.
- Odour - often the odours are specific to the areas in which the plant is grown. This makes it very difficult for new producers to enter the market.
- Relative density
- Refractive density
- Optical rotation
- Solubility in ethanol
- Content of specific chemicals

Market

The market is very uncertain. The prices for citronella and lemongrass oils varied by over 300% in the early 1980s. This makes it very difficult for the small producer.

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