PRACTICAL ACTION
Technology challenging poverty

technical brief

ESSENTIAL OILS

SMALL-SCALE PRODUCTION

Essential oils are steam volatile oils distilled from plant materials and represent the typical flavour and aroma of a particular plant. They are found in flowers, leaves, roots, seeds and barks and find use principally in perfumery and flavourings. The essential oil content of plant material is low, typically 1 to 3% of the plant weight. They are thus low-volume, very high value products. This makes them attractive crops for remote smallholders where high transport costs prevent the transport of lower value cash crops.

Essential oils contain a complex mix of components and it is this mix that gives the " note" that experts recognise. Table 1 shows the important constituents of some 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	Cineale 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	

Table 1 - Essential oils

The quality of the oil obtained from a particular species will be influenced by where it is grown and how it has been processed. New producers are likely to meet with resistance from buyers as this is a very conservative market depending to a great extent on trust regarding supply and quality. Producers and buyers also closely guard information and "secrets". Once established trading relationships are made, however, reliable markets can be gained.

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Essential oils can be divided into two broad categories:

- Large volume oils which are usually distilled from leafy material such as lemon grass, citronella and cinnamon leaves. Lemon, lime and orange oils are also produced in very large amounts.
- Small volume oils which are usually distilled from fruits, seed, buds and, to a lesser extent, flowers, e.g. cloves, nutmeg ,coriander, vetiver and flower oils.

Harvesting

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

Essential oils are usually contained in oil glands, or veins that are fragile. Poor handling will break these structures and release the oils resulting in losses. This is the reason a strong smell is given off when these plants are handled. Some examples of harvesting of common oils are:

- 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 bark is harvested during the wet season since the rains facilitate the peeling of the bark. Harvesting involves the removal of bark from stems measuring 1.2-5 cm in diameter. This takes place early in the morning.
- Spices should be harvested correctly and at the correct stage of maturity. 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.
- **Flowers** such as ylang-ylang, should be picked very carefully and processed as soon as possible.

The preparation of the material for distillation varies. Some materials, and in particular flowers, should be distilled as quickly as possible. Many herbs are left to wilt, or are dried before distillation while barks, seeds and roots can be dried and stored for several months prior to distillation. Information on small scale drying systems can be found in the Practical Action Technical Briefs on drying.

As oil is lost during drying care needs to be taken and low temperatures used. Allowing leaves to dry in the shade or partial shade will result in less loss than direct sun drying. It is vital that the material is dried to a moisture content that is low enough to prevent the growth of moulds and typical moisture levels are shown in Table 2. The dried product should be stored in a cool place and protected from any pick-up of moisture.

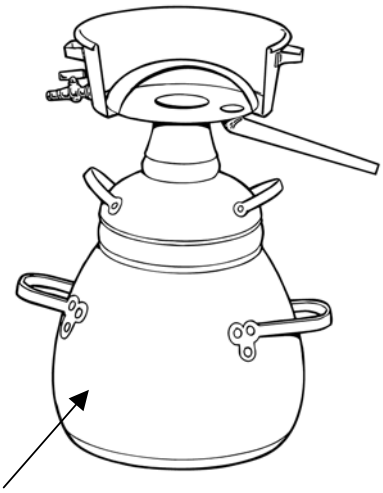
Spice	*Maximum final moisture content % (wet basis)*
Mace	6.0
Nutmeg, cloves	8.0
Turmeric, coriander	9.0
Cinnamon	11.0
Pepper, pimento, chillies, ginger	12.0
Cardamom	13.0

Table 2: moisture contents for various spices

Distillation

This section examines the three common methods of distilling essential oils first examining the stills used and then condensers and oil separation methods.

- **Water distillation** is the simplest and cheapest distillation method. Two stills are shown in Figure 1 below.



This small still has a combined condenser on the top of it, shown in section. Cold water is put into the open pan and condensation collects in the dome.

The plant material is totally immersed in water and boiled. The steam and oil vapour is condensed and the oil is separated from the water using the system described below. The stills used are simple and find wide use amongst smallholder

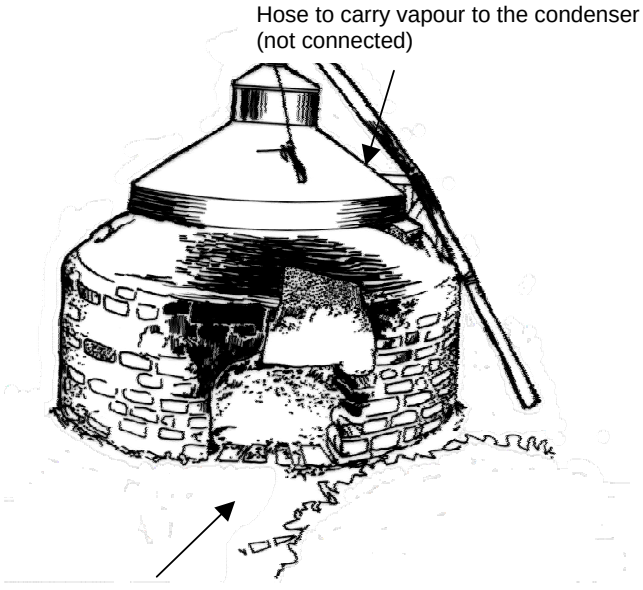
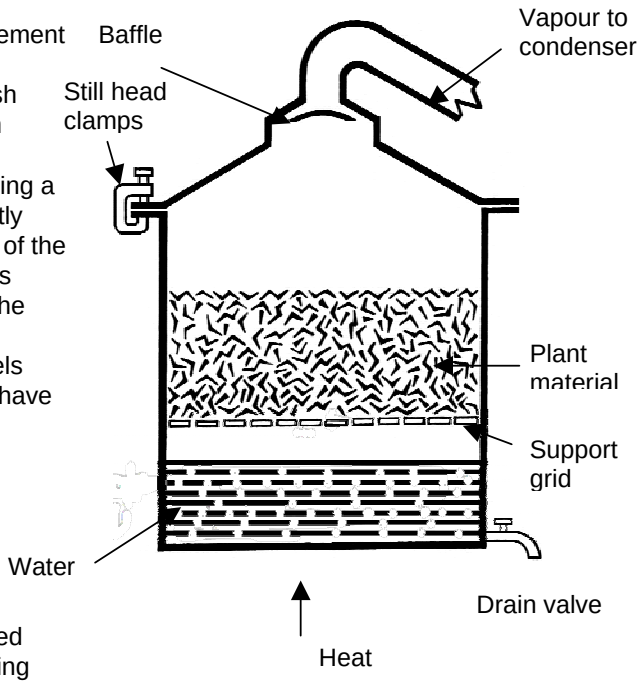


Figure 1: Simple water stills

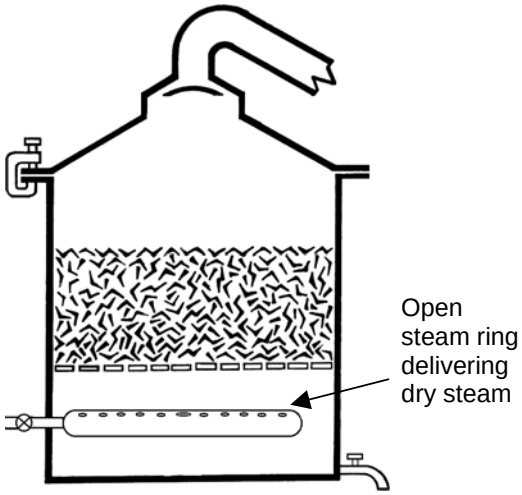
farmers, They are often heated over an open fire, which if not carefully controlled, may result in local overheating and burning of the charge. The quality of the oils produced in such traditional stills can be improved if they are heated by steam generated in a separate boiler. This, however, requires more expenditure in capital equipment. Water distillation remains the recommended method for barks, such as cinnamon and sandlewood, and certain flowers.

- **Water-steam distillation** is an improvement of simple water distillation. The charge of plant material is supported on a mesh or grill above boiling water as shown in Figure 2. The water is boiled, either over a fire or by steam from a boiler using a steam coil or jacket. This system greatly reduces local overheating and burning of the charge. It is important that the charge is packed evenly and not too tightly into the still. Over-packing will result in back-pressure and the steam finding channels through the charge leaving zones that have not been extracted.



- **Steam distillation** is the most advanced method and depends on live steam being supplied from an external boiler. The charge is again supported on a mesh above the base of the still and above a steam coil as shown in Figure 3.

The principle advantage of this method is that “dry steam” is used which results in reduced distillation times and hence greater outputs.



All still bodies should be insulated to reduce heat losses and fuel consumption. In some cases they are mounted on frames that allow them to be inverted in order to rapidly remove the hot charge after distillation. This reduces “turn round times” and increases daily outputs.

Modern still bodies are usually made from stainless steel while traditional systems use mild steel. For the reasons described below, in many cases, the use of expensive stainless steel is not necessary.

Condensers

Steam containing the essential oil vapour leaves the still via a head, known as a gooseneck, and passes to a condenser as shown in Figure 4. Simple condensers consist of a metal coil in a tank of flowing cold water. Ideally the coil of the condenser should be constructed from an inert material such as stainless steel in order to prevent the oil chemically reacting with mild steel. In many traditional stills the gooseneck and condenser coil were constructed from

copper or brass that had been internally tinned to provide a reasonably inert surface. It is very important that the condensed steam (water) leaving the condenser is thoroughly cooled. If it is still warm there will be a loss of essential oil.

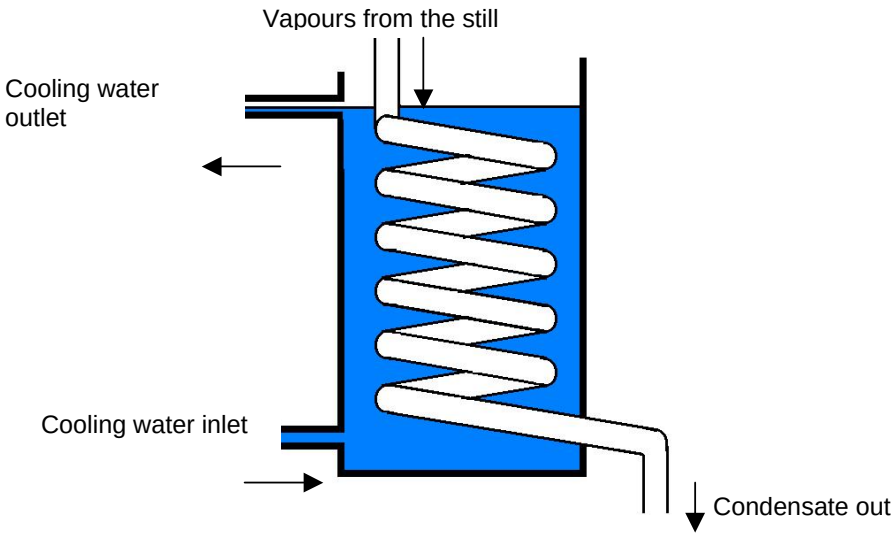


Figure 4: A simple condenser

Oil separation

The final step in the distillation of essential oils is the separation from the water flowing from the condenser using a special flask called a Florentine. This is a very important stage as small quantities of oils of very high value are being handled and maximum efficiency is the key to profitability.

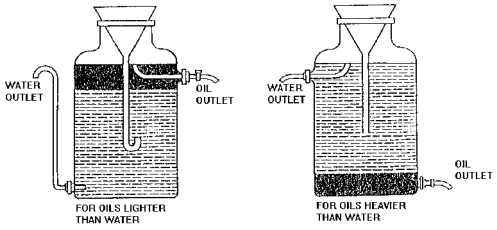
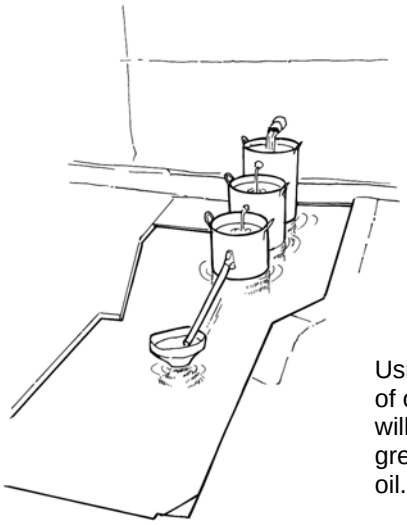


Figure 5: Florentines used for oil separation

Most essential oils are lighter than water and float to the surface of the Florentine. Some oils, however, are denser than water and sink to the bottom. For this reason two types of Florentine are used as shown in Figure 5. It is common practice to link several Florentines together. Most of the oil will separate in the first flask but some will pass over with the water to the second, third etc. separates the oil from the water. 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.



Using a sequence of oil separators will extract a greater amount of oil.

If the water is cloudy after separation, it should be returned to the distillation unit and redistilled. This is called 'cohabitation'.

At the end of the distillation the oil and water in the Florentines is placed in a large laboratory separating funnel (Figure 6) and

technical brief

allowed stand for several hours after which the water can be run off. At is stage a small plug of cotton wool is often placed in the outlet of the funnel. As the oil runs through the plug any final traces of water are removed.

The oil should be stored in brown glass bottles or drums, tightly closed and with the minimum possible headspace as oxygen in the air reacts with many oils.

References and further reading

Minor Oil Crops FAO Agricultural Services Bulletin 94, B. Axtell, FAO,1992
Essential oil distillation Food chain No 24, ITDG, 1999
Quality Control of Essential Oils: Series on Aromatic Plants of Sri Lanka Booklet No 4, Ceylon Institute of Scientific & Industrial Research (CISIR), 1981

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