Natural Product Evaluation in Papua New Guinea

M. J. PRICE, Natural Products Chemist

A variety of plants producing essences, spices or perfumes have been introduced into Papua New Guinea to check the possibilities of new industries. Most of the early investigations were concerned with how the plants would grow but more emphasis is now being placed on combined field and laboratory studies to aid the early evaluation of an introduction. It is easy to see whether a plant is growing well or not, but this is not the only important factor. A plant may be growing very well, but if it is not producing the right amounts of the right kind of spice or oil, it is useless. So the laboratory studies are a vital part of assessing the value of these newly-introduced crops. This article explains the chemist's role in natural product evaluation. It outlines the types of apparatus used to study the major crops at present under consideration and gives descriptions of the use of the chemical and electronic equipment in a natural products laboratory.

THE terms "essential oil" and "oleo-resin" may be defined as follows:—

"Essential oil"—any group of volatile oils which give to plants their characteristic odours and are used in making perfumes and flavours. An essential oil is usually a very complex mixture of chemical compounds.

"Oleo-resin"—a natural mixture of an essential oil and a non-volatile resin. The non-volatile resin may contain important taste principles.

Examination of Plants Producing Essential Oil

Gum trees (*Eucalyptus* sp.), Ti trees (*Melaleuca* sp.), Japanese mint (*Mentha arvensis* var. *piperascens*) and Sweet Basil (*Ocimum basilicum*) are all examples of essential oil producing plants. In the first two examples the oil is produced in the leaves while in the latter examples, it is present in both leaves and flowers.

It is convenient to use Japanese mint as an example of essential oil plants as some studies have been made of this species in Papua New Guinea. With essential oil producing plants it is generally necessary to harvest at a particular stage of growth, usually related to floral development to obtain the maximum oil yield and optimum oil quality.

In the case of the mint, the most important component of the oil is menthol. The chemist must therefore analyse the plant to determine—

1. How much oil is there in the leaves of the mint plant?

2. How much menthol is there in the oil?

The percentage of essential oil in the leaves may be determined in the laboratory by a process known as steam distillation. In the apparatus used, the finely divided plant material is boiled with water and the steam produced carries the essential oil over into the cooling condenser. Here the steam is condensed to water and, as water and oil do not mix, the lighter oil floats on the surface of the water in the measuring section of the apparatus. After a certain time the distillation is stopped and the oil cooled and measured.

By distilling the plant material at various stages of growth, the chemist can construct a graph of the development of the oil in the plant with time.

The samples of oil obtained by the above process at different stages of plant growth can then be analysed to answer the second question, "How much menthol (and other components) is there in the oil?" The Gas Liquid Chromatograph is an instrument used extensively in essential oil research to obtain information about the composition of the oils. The information obtained from the apparatus is in the form of a graph which can be analysed to give information as to the type and concentration of the compounds present in the essential oil.

By analysing oils produced at different stages of plant growth, the chemist can construct a graph of menthol percentage in *Mentha arvensis* oil with time. Both the percentage oil and menthol in oil percentage may be put onto the one graph and the optimum harvest time is then readily ascertained. Such a graph construction is shown in *Figure* 1.

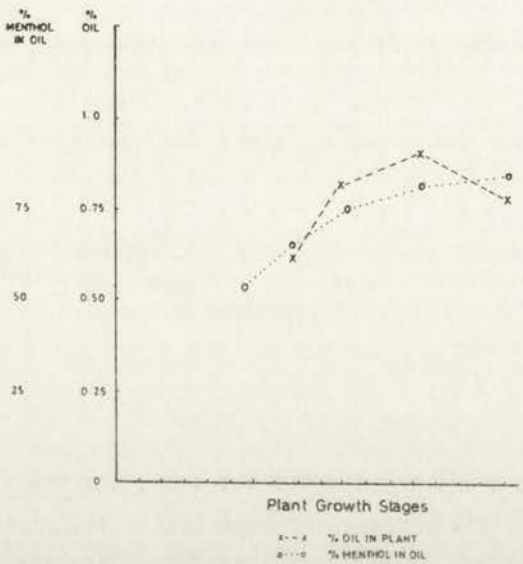

Figure 1.—Graph showing the variation of the percentage of menthol in the oil and the percentage of oil in the plant as the plant grows

In the field, essential oils are distilled from the plant on a much larger scale. A typical apparatus is shown in outline in *Figure* 2. The actual distillation time may vary considerably depending on the material being processed.

The chemical work done so far has indicated that a high quality mint oil may be obtained from the mint plants growing at the Lowlands Agricultural Experiment Station, Keravat. The amount of oil in the plants, and the amount of menthol in the oil, are both satisfactory. Agronomic trials to check on the yields per acre are now proceeding at Keravat.

Examination of Oleo-resin Producing Plants

Ginger (*Zingiber officinale*), Pepper (*Piper nigrum*), Nutmeg (*Myristica fragrans*) and Vanilla (*Vanilla tahitensis*) are species that are usually extracted by solvents. The residue remaining after the removal of the extracting solvent, by gentle heating under reduced pressure, is termed the oleo-resin. The oleo-resin is not soluble in water. Pepper, a commonly used household spice, is extracted commercially for its oleo-resin, both the quantity and composition of this extract being very important.

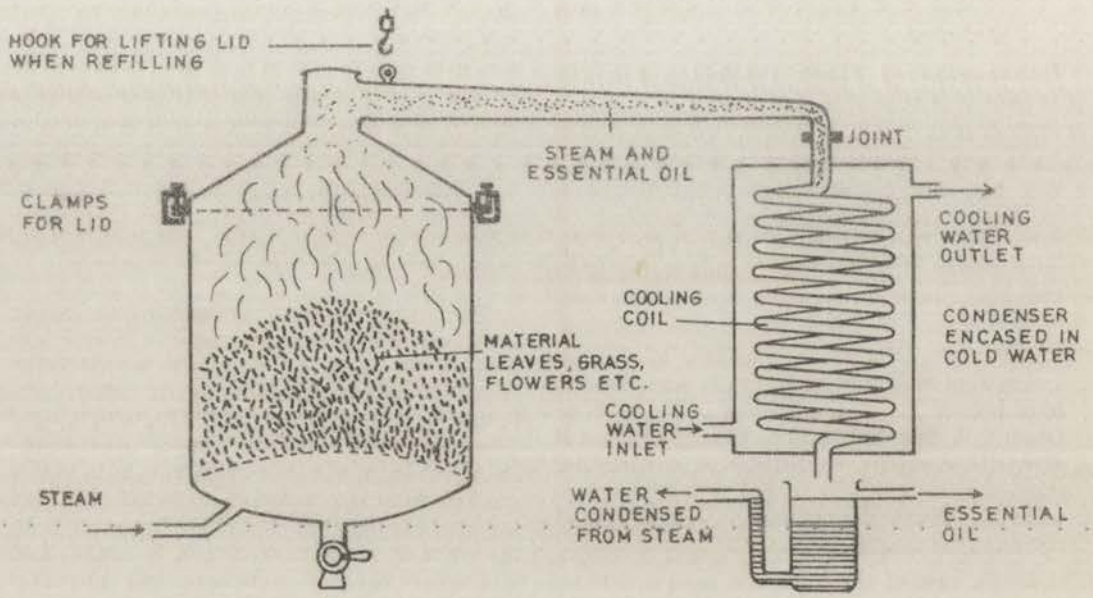

Figure 2.—Steam distillation apparatus

The laboratory apparatus used for solvent extraction studies is illustrated in *Figure* 3. The material to be extracted is finely divided and placed in compartment A, the solvent to be used for extraction is placed into the boiling flask B. On heating, solvent vapours rise through the bypass tube C and are condensed to liquid in the condenser D. The liquid percolates through the material, in the extraction compartment, removing the solvent soluble oleo-resin. The solvent oleo-resin solution automatically siphons back into the boiling flask B via siphon tube E. Only the solvent is vaporized by boiling so that the process is one of removal of oleo-resin from the material in compartment A and concentration in the boiling flask. It is then a relatively easy procedure to remove the solvent completely from the boiling flask leaving behind only the oleo-resin which can be weighed and its percentage in the original pepper calculated.

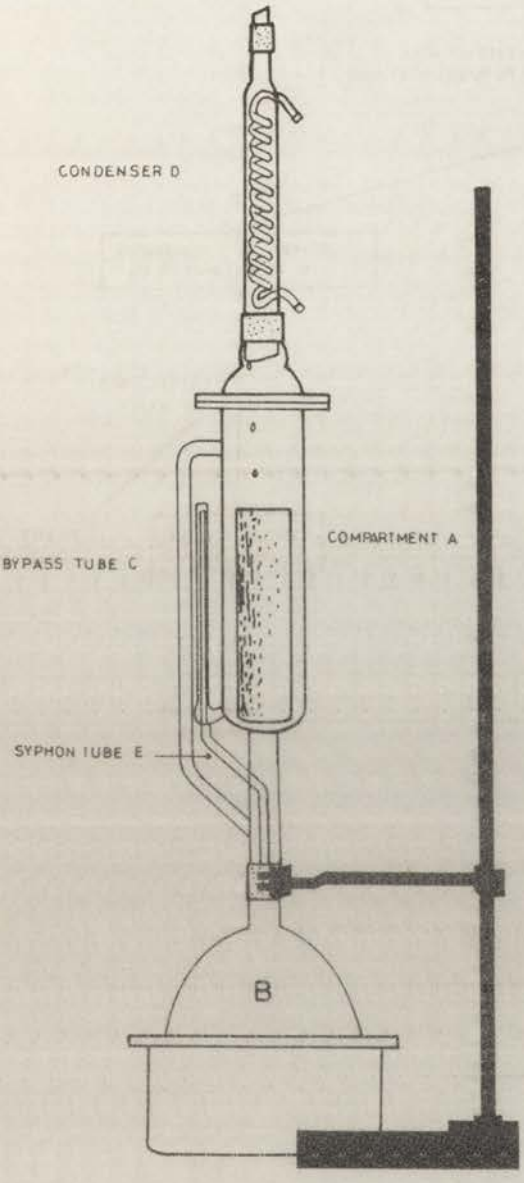

Figure 3.—The laboratory apparatus for extracting oleo-resins from plant material

An important constituent in pepper oleo-resin is piperine. This compound is responsible for the pungency or sharp flavour of pepper. The chemist analyses the oleo-resin for piperine percentage and may thus compare different varieties and different processing techniques used for pepper production.

Industrial extractions are carried out on a large scale. Despite the size of industrial extraction processes, extremely careful control of the operation is exercised to ensure the oleo-resin is not affected by excessive temperature.

Examination of Miscellaneous Samples

The procedures discussed above are all very clear cut since we are examining a known plant species.

Investigation of the usefulness of a plant species that has not been previously examined is a more complicated matter.

The number of compounds that occur in plant materials is of course very large but the compound categories which have been found to be commercially useful are fortunately much smaller.

By a procedure of extraction and examination of the extracts recovered under different conditions the chemist can fairly quickly confirm the presence or absence of certain classes of compounds in the particular plant he is confronted with. Such a scheme is illustrated by *Figure* 4. It can be seen from this diagram that a few reasonably simple extraction procedures followed by the use of chemical spot tests and colour reactions can indicate the presence of some very important classes of plant compounds. Steroids, saponins and alkaloids are important groups of drugs used in

medicine. Terpenes are present in essential oils and tannins are a group of compounds used in the leather industry.

The chemist engaged in natural product research has a challenging and interesting role to play in the evaluation of many plant species. The challenge arises when new species are investigated. The interest comes when the laboratory results are applied in the agronomic handling of the crop.

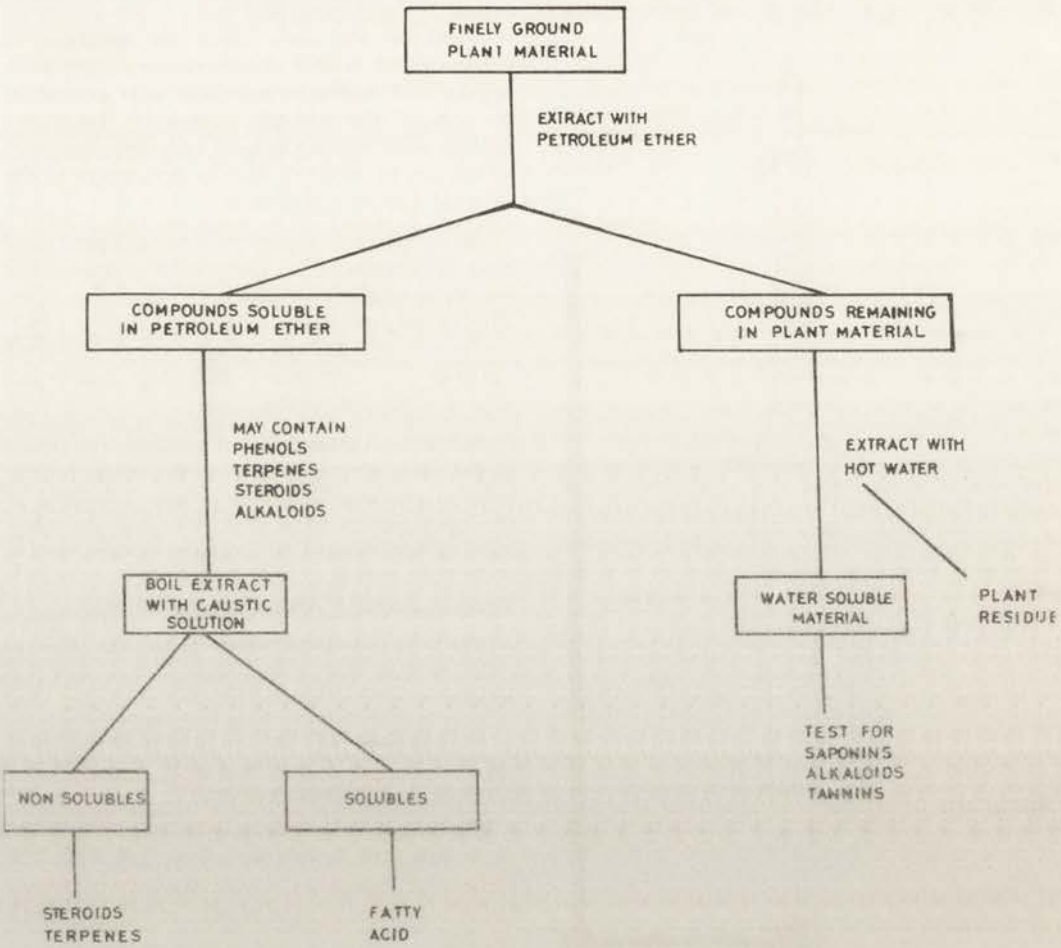

Figure 4.—Scheme for analyzing natural products in plants