Table 44.4 Extraction procedures

Technique	Advantage	Disadvantage	Description
Removal of acellular products (unorganized drugs)	Simple	High risk of microbial and extraneous contamination	Traditional plant products, e.g. opium (incision), certain essential oils such as citrus (applying pressure)
Distillation	Suitable for volatile oils		Water or steam diffusion at 100 °C causing volatilization and condensation
Maceration	Simple	Time consuming, incomplete extraction	Prolonged infusion
Percolation	More concentrated extract	Time consuming, expensive	Maceration followed by flow of fresh solvent
Countercurrent extraction	Can be used in large scale. Wide array of extractives possible	Often complex operating procedures need to be devised. Costly to run	Separation by bi-directional flow of two immiscible solvents
Supercritical fluid extraction	Main solvent is CO_2, no toxic residue	Costly industrial plant	Supercritical CO_2 plus co-solvent/ modifier is forced through plant matrix

Extraction procedures

Table 44.4 lists the types of extraction procedures that are widely used.

Removal of acellular products. This techniques is really a collection method specific to a few plant products, but is also classed by some as a method of 'extraction'. As shown in Table 44.4, this is only used for a few specific examples of materials obtained by simple traditional techniques. Although crude in design, the products are the commercially available material, and often need highly specialized treatment before incorporation into formulated products.

Distillation. If the active constituent is a volatile oil it is most often removed by the process of distillation. Whist this 'extracts' the active constituents it is not, in a chemical engineering sense (as described above), a true extraction process. Three different types of distillation processes are employed for the removal of volatile oils from plant material:

Water distillation – the raw material and water are heated to boiling and oil is collected. This technique is slow, produces poor quality oil and is labour intensive

Water and steam distillation – this involves direct contact between steam and raw material. Plant material is held above, not in, the water present for steam generation.

Steam distillation – this involves direct contact between the steam and raw material. Here the steam is generated externally as opposed to in the still. It is rapid and the rate of distillation is controlled.

Maceration. Maceration involves the steeping of raw material in a solvent, which is later strained out. It is widely used for the preparation of tinctures, but is very inefficient for the collection of solutes.

Percolation. Percolation involves the subjection of raw material to continuous flow of fresh solvent. This produces stronger extracts, but at increased solvent cost. Repeated percolation using a number of extractors with solution percolates (solvent already containing extracted components), partially decreases the problem.

Countercurrent extraction. Countercurrent extraction is effected by continuous distribution of solutes from raw material between moving tubes of immiscible upper and lower phases (basically a series of interconnected separating funnels). This gives improved extraction yields, but the equipment is expensive and needs lengthy extraction times for best results.