Newer extraction techniques. A number of alternative techniques can be employed in laboratory conditions. These include:

- Supercritical fluid extraction
- Subcritical water extraction can be used from 100–374 °C under pressure
- Sonication-assisted extraction
- Microwave-assisted extraction is used for fast, selective heating of raw material in solvent, and removes the need for prior drying of material
- Phytol/florasol extraction using hydrofluoroalkane (HFA) 134a is carried out at −26 °C, and is useful for thermolabile materials (Oztekin and Martinov, 2007).

The supercritical fluid extraction technique involves elevating the temperature and pressure of the solvent above its critical value. It is now widely used in industrial scale procedures. Supercritical CO_2 is a good solvent for non-polar compounds, but not for most plant compounds with biological activity (notably alkaloids, glycosides and phenolics) which are polar in nature. For these, a co-solvent or modifier must be added to the CO_2. Industrial processes have been reported for naringin, colchicine and oleoresins (Wang and Weller, 2006).

Choice of extraction technique

Usually the method of choice is determined by the size of the batch of plant material to be extracted. Solvent extraction may include risks of toxicity when using particular solvents.

The solubility of plant entities determines the choice of the best medium, but this is usually fixed by formulation constraints resulting in either partial or complete lack of solubility. This problem is confounded by extracts containing ranges of chemicals of differing solubilities (Bonati, 1980). Alternative solvents may result in lower solute recoveries; therefore co-solvents may be added to polar solvents to increase recovery.

Concentration, purification and drying of extracts

Concentration of extracts

Liquid extracts typically contain 2–5% of the plant constituents, and further concentration by evaporation is required. The Roberts concentrator was once commonly used but it is slow and inefficient. It is being replaced by either the descending film concentrator or the plate concentrator, both of which are fast acting and thus reduce the risk of degradation. If water is the solvent, no solvent recovery is required, although some degree of clean-up may be necessary before disposal. With other solvents, evaporated solvent must be collected by condensation under cooled conditions and the collection vessel enclosed to avoid evaporative losses.

Purification of extracts

Following concentration of the original extracts, further purification is often required. A number of procedures are available to remove extraneous plant material or undesirable material formed during extraction. These include decantation, pressure filtration, vacuum filtration, centrifugation and drying.

Many extracts are sticky due to their hygroscopic nature, and this causes processing problems. A number of crude plant drugs may need to undergo preliminary treatment such as defatting to avoid high fat levels in the extract, or enzyme inactivation to avoid degradation of active constituents (Bonati, 1991).

Drying of extracts

After purification, extracts may be dried, and several types of equipment are available to carry out this procedure. The range of dryer types available is outlined in Table 44.5 (see Chapter 29 for further details).

Dry extracts have a superior stability profile over time and are likely to have lower levels of microbiological contamination. In addition to this, gamma irradiation can easily be used, if necessary, to eradicate any remaining microbiological contamination.

Formulation and manufacture of plant-based medicines

Active-constituent considerations

Purity of active constituent(s)

Production and formulation of plant-based medicines involves technology and stability problems far greater than those for single natural isolated chemicals or synthetic compounds. One major cause of the problem is inclusion of compounds which are