

A REVIEW ON THE EXTRACTION METHODS USE IN MEDICINAL PLANTS

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Abstract

Medicinal plants are gaining much interest recently because their use in ethno medicine treating common disease such as cold, fever and other medicinal claims are now supported with sound scientific evidences. The study on medicinal plants started with extraction procedures that play a critical role to the extraction outcomes (e.g. yield and phytochemicals content) and also to the consequent assays performed. A wide range of technologies with different methods of extraction is available nowadays. Hence, this review aim to describe and compare the most commonly used methods based on their principle, strength and limitation to help evaluating the suitability and economic feasibility of the methods.

Introduction Medicinal plants are currently in considerable significance view due to their special attributes as a large source of therapeutic phytochemicals that may lead to the development of novel drugs. Most of the phytochemicals from plant sources such as phenolics and flavonoids have been reported to have positive impact on health and cancer prevention [1]. Modern Mediterranean and DASH (Dietary Approaches to Stop Hypertension) incorporate a phytochemicals rich diet from fruit and vegetable sources as the plant based diet has shown to extend life span in Okinawan people, that has the highest number of centenarians [2,3]. Interest in utilizing natural sources in the development and formulation of skin

products, as an alternative to conventional drugs and synthetic products, contribute to increase interest in research and industrial application of medicinal plants [4]. High content of phenolic and flavonoids in medicinal plants have been associated with their antioxidant activities that play a role in the prevention of the development of age-related disease, particularly cause by oxidative stress. With regards to the beneficial phytochemicals in medicinal plants and the shift towards natural products in pharmaceuticals and cosmeceuticals industry, the research on medicinal plants particularly are as important as the research on conventional drugs. The study of medicinal plants starts with the pre-extraction and the extraction procedures, which is an important step in the processing of the bioactive constituents from plant materials. Traditional methods such as maceration and Soxhlet extraction are commonly used at the small research setting or at Small Manufacturing Enterprise (SME) level. Significance advances have been made in the processing of medicinal plants such as the modern extraction methods; microwave-assisted (MAE), ultrasound-assisted extraction (UAE) and supercritical fluid extraction (SFE), in which these advances are aimed to increase yield at lower cost. Moreover, modifications on the methods are continuously developed. With such variety of methods present, selection of proper extraction method needs meticulous evaluation. This review describes the principle, strength and limitation of the commonly used methods with examples in recent years to help in the selection of proper methods.

Pre-extraction preparation of plant samples

The initial stage in studying medicinal plants is the preparation of plant samples to preserve the biomolecules in the plants prior to extraction. Plants samples such as leaves, barks, roots, fruits and flowers can be extracted from fresh or dried plants material. Other pre-preparation of plant materials such as grinding and drying also influences the preservation of phytochemicals in the final extracts.

Fresh vs. dried samples: Both fresh and dried sample is used in medicinal plants studies. In most cases, dried sample is preferred considering the time needed for experimental design. Sulaiman et al limit the interval between harvest and

experimental work at the maximum period of 3 hours to maintain freshness of samples, as fresh samples are fragile and tend to deteriorate faster than dried samples. Comparison between fresh and dried *Moringa oliefera* leaves showed no significant effect in total phenolics but with higher flavonoids content in dried sample [5].

Air-drying, microwave-drying, oven-drying and freeze-drying (lyophilisation) of plants samples:

Air-drying usually takes from 3-7 days to months and up to a year depending on the types of samples dried (eg. leaves or seed). Plant samples, usually plants leaves with stem were tied together and hang to expose the plant to air at ambient temperature. This drying method does not force dried plant materials using high temperature; hence, heat-labile compounds is preserved. However, air-drying take longer time in comparison to microwavedrying and freeze drying and may be subjected to contamination at unstable temperature condition. Microwave-drying uses electromagnetic radiation that possesses both electric and magnetic fields. The electric field causes simultaneous heating through dipolar rotation; alignment on the electric field of the molecules possessing a permanent or induced dipole moment (e.g. solvents or samples), and ionic induction, that produce oscillation of the molecules [8]. Oscillation causes collisions between molecules and resulted in fast heating of the samples simultaneously. This method can shorten drying time but sometimes causes degradation of phytochemicals. Oven-drying is another pre-extraction method that uses thermal energy to remove moisture from the samples. This sample preparation is considered as one of the easiest and rapid thermal processing that can preserved phytochemicals. Oven-drying at 44.5°C for 4 hours using 80% methanol resulted in highest antioxidants activities in *Cosmos caudatus* extracts and similar result were observed in optimized 80% methanol extracts at 44.12°C for 4.05 hours [9]. Shorter period of extraction time was obtained using this method. However, effect of drying on *Orthosiphon stamineus* showed no significant effect on the antioxidant activity but the bioactive phytochemicals; such as sinensetin and rosmarinic acid content were affected by the ovenand sunlight-

drying, suggesting the sensitivity of the compounds to temperature [10]. Freeze-drying is a method based on the principle of sublimation. Sublimation is a process when a solid is changed into gas phase without entering the liquid phase. Sample is frozen at -80°C to -20°C prior to lyophilisation to solidify any liquid (eg. solvent, moisture) in the samples. After an overnight (12 h) freezing, sample is immediately lyophilized to avoid the frozen liquid in the sample from melting. Mouth of the test tube or any container holding the sample is wrapped with needle-poked-parafilm to avoid loss of sample during the process. Most of the time, sample was lost by splattering out into the freeze-flask (Figure 1a and 1b). Freeze-drying yielded to higher level of phenolic contents compared to air-drying as most of the phytochemicals are preserved using this method. However, freeze-drying is a complex and expensive method of drying compared to regular air drying and microwave-drying. Thus, the use is restricted to delicate, heat-sensitive materials of high value.

Maceration, infusion, percolation and decoction: Maceration is a technique used in wine making and has been adopted and widely used in medicinal plants research. Maceration involved soaking plant materials (coarse or powdered) in a stoppered container with a solvent and allowed to stand at room temperature for a period of minimum 3 days with frequent agitation [11]. The process intended to soften and break the plant's cell wall to release the soluble phytochemicals. After 3 days, the mixture is pressed or strained by filtration. In this conventional method, heat is transferred through convection and conduction and the choice of solvents will determine the type of compound extracted from the samples. Infusion and decoction uses the same principle as maceration; both are soaked in cold or boiled water. However, the maceration period for infusion is shorter and the sample is boiled in specified volume of water (eg. 1:4 or 1:16) for a defined time for decoction [11]. Decoction is only suitable for extracting heat-stable compounds, hard plant materials (e.g. roots and barks) and usually resulted in more oil-soluble compounds compared to maceration and infusion. Unique equipment called percolator (Figure 1c and 1d) is used in percolation, another method that shares

similar fundamental principle. Dried powdered samples are packed in the percolator, added with boiling water and macerated for 2 hours. The percolation process is usually done at moderate rate (e.g. 6 drops /min) until the extraction is completed before evaporation to get a concentrated extracts [12].

Ultrasound-assisted extraction (UAE) or sonication extraction

UAE involves the use of ultrasound ranging from 20 kHz to 2000 kHz [11]. The mechanic effect of acoustic cavitation from the ultrasound increases the surface contact between solvents and samples and permeability of cell walls. Physical and chemical properties of the materials subjected to ultrasound are altered and disrupt the plant cell wall; facilitating release of compounds and enhancing mass transport of the solvents into the plant cells [26]. The procedure is simple and relatively low cost technology that can be used in both small and larger scale of phytochemical extraction.

Conclusion

All stages of extractions, from the pre-extraction and extraction are equally important in the study of medicinal plants. The sample preparation such as grinding and drying affected the efficiency and phytochemical constituents of the final extractions; that eventually have an effect on the final extracts. It can be concluded that, no universal extraction methods is the ideal method and each extraction procedures is unique to the plants. Previously optimized methods can be used to lead in the selection of suitable methods. However, evaluation and selection of pre-extraction preparation and extraction methods are depending on the study objectives, samples, and target compounds.

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