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A critical analysis of extraction techniques used for botanicals: Trends, priorities, industrial uses and optimization strategies

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ABSTRACT

Plant extracts have been long used by the traditional healers for providing health benefits and are nowadays suitable ingredient for the production of formulated health products and nutraceuticals. Traditional methods of extraction such as maceration, percolation, digestion, and preparation of decoctions and infusions are now been replaced by advanced extraction methods for increased extraction efficiency and selectivity of bioactive compounds to meet up the increasing market demand. Advanced techniques use different ways for extraction such as microwaves, ultrasound waves, supercritical fluids, enzymes, pressurized liquids, electric field, etc. These innovative extraction techniques, afford final extracts selectively rich in compounds of interest without formation of artifacts, and are often simple, fast, environment friendly and fully automated compared to existing extraction method. The present review is focused on the recent trends on the extraction of different bioactive chemical constituents depending on the nature of sample matrices and their chemical classes including anthocyanins, flavonoids, polyphenols, alkaloids, oils, etc. In addition, we review the strategies for designing extraction, selection of most suitable extraction methods, and trends of extraction methods for botanicals. Recent progress on the research based on these advanced methods of extractions and their industrial importance are also discussed in detail.

1. Introduction

Extraction is a fundamental process for separation and recovery of bioactive compounds from plants. It converts real matrix into a sample suitable for subsequent analytical procedure. From ancient times, sample preparations have been conducted by various ethnic

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groups worldwide, using decoction, maceration, infusion, digestion and percolation methods for making extract and thus utilize plants for their therapeutic effect (Fig. 1a). These extraction techniques have come into light during the 11thcentury and have been reported to be the oldest techniques used so far which also form the basic principles of advanced extraction techniques. Continuing to the modernization and industrial growth era, during the 18th century an improved extraction technique "Soxhlet Extraction" was introduced, which is an advanced form of the digestion and decoction methods. However, these conventional extraction techniques including Soxhlet, have the disadvantages of using larger volume of solvent and also take longer time for extraction of compounds with lower yield. The exponentially increasing demand of herbal products and/or extracts for wider and safer applications, timely availability of high quality products with low cost of processing and higher yield are the needs of the growing herbal/nutraceutical medicine based industries. To meet these challenges, there is an increased demand for alternative and non-conventional extraction techniques (Fig. 1b), which have been introduced in various time span. These include, microwave assisted extraction (MAE),

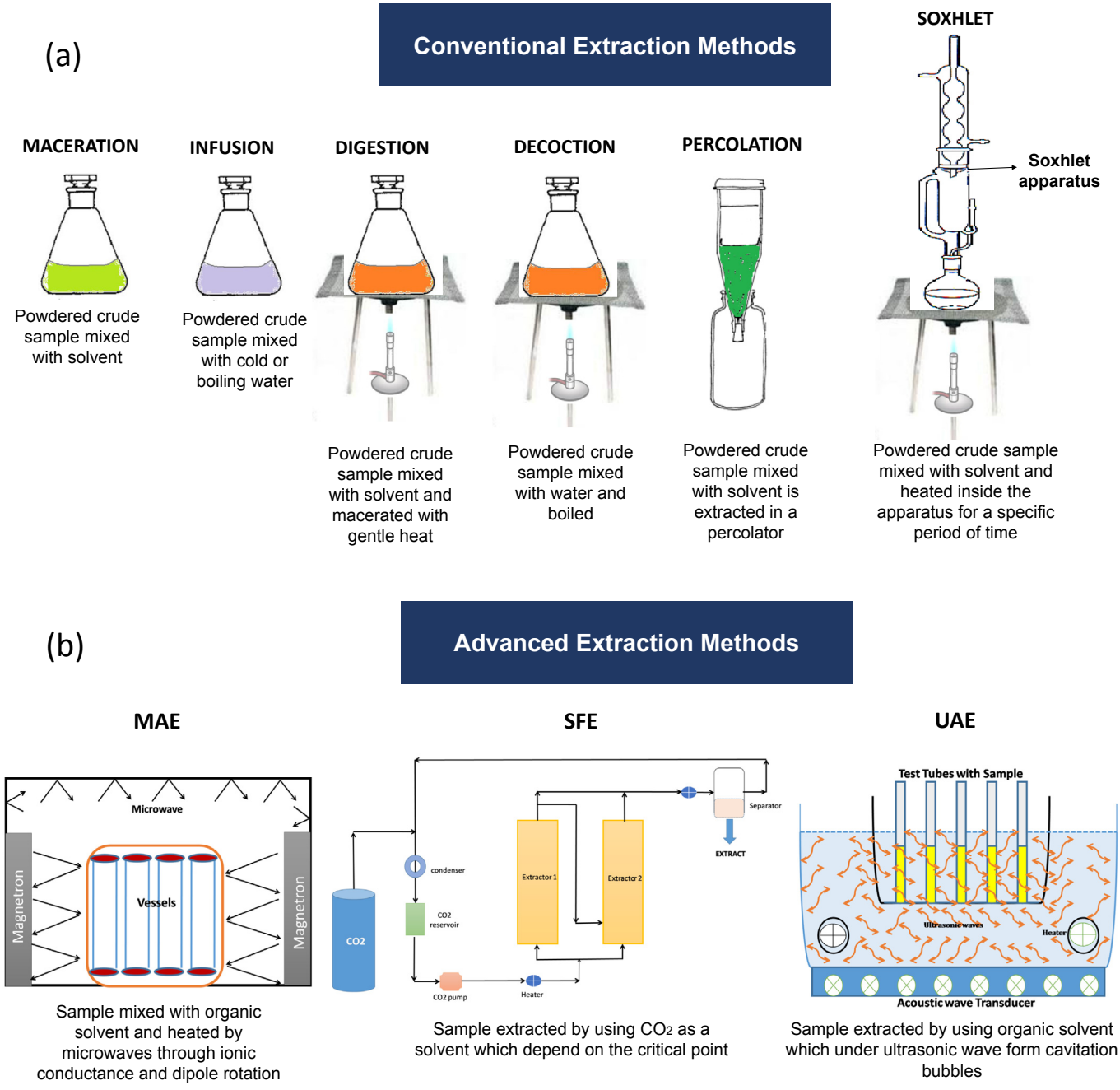

Fig. 1. Some of the (a) conventional and (b) advanced extraction techniques with their mechanism of extraction.