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Microwave-Assisted Extraction of Eucalyptus Citriodora Oil and Comparison with Conventional Hydro Distillation

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Abstract: Microwave-assisted hydro distillation MAHD of eucalyptus citriodora. oil was investigated and a comparison was made with conventional hydro distillation. For MAHD, three process parameters; Microwave power, Extraction time and duration of dryness of sample were selected for the extraction. MAHD resulted in a shorter extraction time and better quality of oil compared to that in conventional hydro distillation. Maximum yield of 1.2% (w/w) was obtained at higher power level and from HD; the yield was 0.91% (w/w) for 3 hours of extraction time. Longer extraction time was resulted in polymerization of oil in MAHD.

Key words: MAHD · Hydro distillation · Extraction · Essential oil · Eucalyptus oil

INTRODUCTION

Essential oils are volatile, natural base products, which are found in spices, aromatic and medicinal plants. The Extraction of essential oils is well known from old ages when pure essential oil and crude extract of essential oil bearing plants, herbs and grasses were in use for various medicinal and fragrances, flavors, preservatives and insect repellents purposes [1, 2].

Eucalyptus is a diverse genus of flowering tree and shrubs including a distinct group with a multiple-stem melee growth habit in myrtle family, myrtaceae. Botanical name eucalyptus citriodora, member of the genus dominate the tree flora of Australia. there are more than 700 species of eucalyptus, mostly native to Australia and a very small number are found in adjacent areas of new Guinea and Indonesia. Species of eucalyptus are cultivated throughout the tropics and subtropics including the Americas, Europe, Africa the Mediterranean basin, the middle east, China and the Indian subcontinent [3]. The essential oil have achieved high economic value [4]. Which are sweet and the primary source of cooling sensation. Essential oil is find main application as flavor in chewing gums, toothpastes, confectionary, tobacco and alcoholic beverage [5]. the eucalyptus citriodora also has many other compound include citronellal,citronellel,1-8cineole.E-citriodora can also be found application in shampoo and skin care product. E-citriodora commonly used to soothe or treat nausa, vomiting, abdominal pain, indigestion, irritable bowel and blotting. It is also used un aroma therapy [6-7]. essential oil extract from eucalyptus in India 30-40 tones of oil per year [8].

Steam distillation is the primary method to extract the eucalyptus essential oil for commercial product[9]; many other methods can be used for extraction of essential oils from eucalyptus, e.g. hydro-distillation (HD), Supercritical fluid extraction, solvent extraction, sox let, supercritical water extraction and direct thermal desorption[10, 11]. However these essential oil compounds are thermally sensitive and vulnerable to chemical changes. These extraction methods may result in losses of some volatile compounds, low extraction efficiency, long extraction time, degradation of unsaturated or ester compounds through thermal or hydrolytic effects and toxic solvent residue in the extract [12]. To overcome these problems some new "green" techniques in essential oil extraction have been developed by researchers. These techniques typically use less solvent and energy, such as ultrasound and microwave.

Microwave assisted process is a recent technique for essential oil extraction from plant materials, patented by federal department of environment, Canada [13]. Today, MAP is well known to selective and volumetric heating of target, less extraction time, high product quality. This technology finds application from analytical laboratory systems to industrial extractor [14].

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In this present work, extraction of eucalyptus essential oil is done by MAHD method (MAP with water as solvent) and extraction yield is compared with conventional hydro distillation. Experiments were conducted to study the influence of the MAHD process parameters viz, extraction time, power input of microwave, different drying duration on percentage yield of eucalyptus oil.

MATERIAL AND METHODS

Raw Materials: Plant material eucalyptus leaves were collected from the private farm at Gwalior. The family of the eucalyptus was myrtaceae and botanical name eucalyptus citriodora. The authenticity of variety was verified by department of botany, Jiwaji University. This variety has been commercialized in northern, south India. Plants were cleaned and dried in a dark room at 25°C.

Microwave-assisted hydro-distillation (MAHD): Microwave-assisted hydro-distillation (MAHD) was performed at atmospheric pressure with a microwave frequency of 2450 MHz using a household microwave oven; which was mechanically modified to perform the hydro distillation [15], as shown in fig. 1. This was a multimode microwave reactor with a maximum delivered output power of 800 W and input power of 1200W, having the voltage supply of 230 volt and dimensions of the oven cavity are 206mm (H) x 300mm (W) x 302mm (D), with total capacity.

Hydrodistilation: Eucalyptus oil was extracted by hydro distillation. Pretreated eucalyptus leave of different moisture levels was subjected to distillation as described in the European Pharmacopoeia [16]. Distillation equipment was made with the modified Clevenger type apparatus. Hydro distillation was carried out by submerged boiling of 500 g of leave sample in distilled water, using a heating source from below the 5 liter spherical flask at atmospheric pressure. Three repetition of each run was performed and average of three repeated run was recorded as final yield.

Extraction of Essential Oil: The eucalyptus leaves were properly cleaned and chopped in to 1-2 cm. long pieces. Before extraction of essential oil plant was stored in shade with limited air circulation and for three different drying durations. The moisture lost during 24 hour was 9-10%. A 100g of sample was placed in reactor with 1:2 (w/v) ratio of plant to water. The runs were taken at three different levels of time and microwave power. Light yellow colored oil, with a lemon like odor, was obtained which was separated and dried over the minimum amount of anhydrous sodium sulfate to remove traces of moisture. The percentage oil yield is expressed as follows;

Fig. 1: MAHD reactor setup

$$\text{oil yield}(\%) = \frac{\text{mass of extracted oil}}{\text{mass of sample}} \times 100\% \quad (1)$$

RESULT AND DISCUSSION

Effect of Extraction Time: Time needed to reach the extraction temperature or induction time is shown in fig. 2 for eucalyptus. For both methods; HD and MAHD, the extraction started at the boiling point of water at the atmospheric pressure. For MAHD (at 660 W), the extraction started much earlier than that in HD. With HD, induction time was 13 min. However, with MAHD at 660 W, the induction time was 5 min. Such results can be attributed to the more powerful effect of microwaves on water, a solvent with a high dielectric constant.

However, once the microwave power was reduced to 220 W, the induction time with MAHD was longer than that in HD (fig. 2). This is related to the low density of waves at this power level. Total times needed to fully recover the essential oils from the eucalyptus citriodora at different power levels are shown on fig. 3. MAHD needed shorter times than HD. Such effect is clearer when microwave power is increased to higher levels. Total extraction time needed for HD was 180 min. These results are in agreement with those available in literature, MAHD of essential oils from orange peels [17] and lavender [18].

It can also be concluded that by increasing microwave power from 220 to 660 W, the induction time for evaporation and total time for the extraction decrease (figs.2 and 3). According to Chen and Spiro [19] at higher power levels, the microwaves (i.e., the radiations) can be

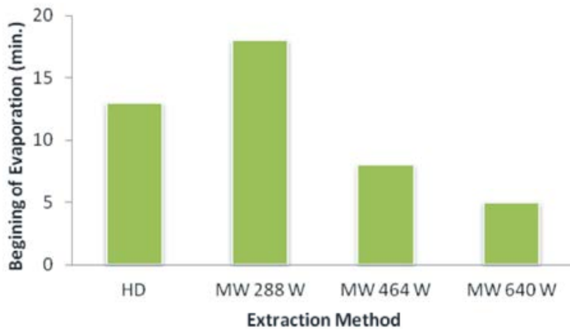

Fig. 2: Effect of extraction method on startup of evaporation.

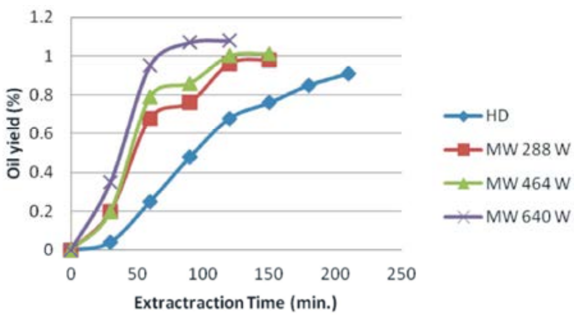

Fig. 3: Effect of extraction method on extraction time.

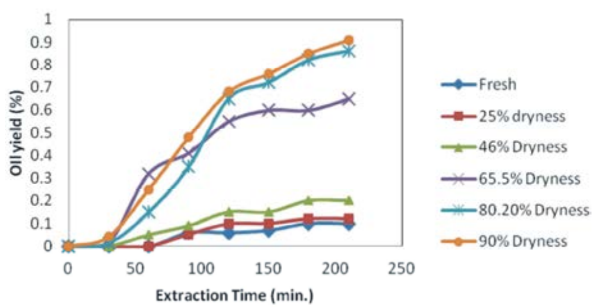

Fig. 4: Effect of extraction method and microwave power on oil yield.

absorbed by water more intensively and as a result the disruption rate of cellular texture and release of essential oils also increase. Using scanning electron microscopy, Lucchesi *et al*. reported that cells undergone MAE resulted in faster rupture than those undergone the conventional extraction [20].

The changes in the extraction yield of essential oils by HD and MAHD are shown on fig. 4. It can see from figure that the extraction yield increased with time. When considering the extraction patterns of plant, both MAHD and HD resulted in similar yields after the extraction was over. Total yield of extraction was 0.91% (w/w) for in HD and 1.2% (w/w) in MAHD. According to fig. 4, at a given time, in the early stages of extraction, extraction yield was greater with MAHD than with HD. This is in agreement with the previous findings of Lucchesi *et al.* and Chemat *et al*. that MAE of essential oils from cumin, star anise and lavender needed shorter times than did HD [20, 18]. Indeed, water with a high dielectric constant absorb the radiation from the microwaves resulting in a rise in the temperature more rapidly than that in HD. Higher temperature causes an easier degradation of plant cells and consequently a shorter extraction time can be achieved. This effect is more evident at higher power levels [21-24].

Effects of Dryness and Extraction Time on the Yield of Eucalyptus Oil: To study the effects of dryness and extraction time on the yield of the essential oil in hydrodistilation of eucalyptus citriodora, extraction was done using ground sample at different dryness (0-90%), constant volume of water (5L), constant original sample weight (500g) and extraction time was varied from 1 to 5 hr. From fig. 5, it can be seen that eucalyptus oil yield increases with increasing dryness and extraction time. It was also observed that greater part of the oil distilled out during the next 2 hours and after 3 hours of extraction approximately a constant yield of the oil collected. Therefore, in order to have minimum energy consumption, 3 hours of extraction is the ideal extraction time.

CONCLUSION

For extraction of essential oils of eucalyptus a comparison has been made between the conventional method (hydrodistilation) and MAHD. Thus it was observed that the hydrodistilation required more time heating to boiling point and therefore higher energy. Extraction with MAHD is more efficient than HD. MAHD resulted in slightly higher oil yield than compare to HD. In MAHD, the sudden warming of water in plant cells causes rupture of cell walls and release of volatile oil; components are contained in the mass of water vapor released from the plant. Thus it was possible to obtain a very fast and efficient process of releasing plant volatile components. Warming up should still be moderate; the use of high microwave power may degrade valuable components. For these reasons, MAHD is a promising tool for the extraction of essential oils from medicinal plants and aromatic herbs and also very interesting for food industry and aromatherapy.

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