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Research Article

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Microwave-assisted extraction of lemongrass essential oil: Study of the influence of extraction method and process parameters on extraction process

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ABSTRACT

In this study, essential oil of lemongrass was extracted by microwave-assisted hydrodistilation (MAHD) and Solvent free microwave extraction (SFME) method and the effects of individual process parameters; microwave power, irradiation time and sample particle size were evaluated. Results showed that oil yield increases with increasing microwave power, irradiation time and decreasing particle size. The maximum oil yield in MAHD was 1.72% for 90 minutes and 1.61% in SFME for 20 minutes of irradiation time. Longer irradiation time resulted in inferior quality of essential oil. Extraction using SFME was much faster than MAHD but slightly lower in essential oil yield. Solvent free microwave extraction resulted in significant reductionin extraction time and in better extraction efficiency as compared with microwave assisted hydrodistillation.

Keywords: Lemongrass, essential oil, microwave-assisted hydrodistilation, SFME.

INTRODUCTION

The use of herbs and spices by mankind for different purposes is very old all over the world. These plants have been invaluable resources as food additives, flavors, fragrances, pharmaceuticals, colors or medicine useful in daily life. Essential oil is one of the important products of plant materials. Essential oils are complex volatile compounds produced in different plants parts, which are known to have various functions in plant including conferring pest and disease resistance [1]. Chemically, Essential oils are mixtures of volatile compounds such as terpenes (mostly monoterpenes and sesquiterpenes), phenolics and alcohols [2]. Extraction of essential oils for various purposes is well known today and highly commercialized worldwide. Many different methods can be used for extraction of essential oils from plant materials, e.g. hydro-distillation (HD), steam distillation, Soxhlet extraction, and simultaneous distillation–extraction. However these molecules are thermally sensitive and vulnerable to chemical changes [3, 4]. 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 [5]. 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 supercritical fluids, ultrasound and microwave extraction [6,7]. Microwave-assisted process is successfully applied in extraction of essential oils at laboratory scales and various configuration schemes of extraction apparatus have proposed. Microwave-assisted hydrodistilation (MAHD) and solvent-free microwave extraction (SFME) are seems to be of industrial important due their simple configuration, economics and high yield of product [6, 8, 9]

Cymbopogonflexuosus(Nees), Stapf. (Gramineae), commonly known as Lemongrass, is widely used as an essential ingredient in Asian cuisines due to its sharp lemon flavor. In India, a tea prepared from lemongrass is used as a sedative for the central nervous system[10]. Lemongrass is a plant from the grass family and may have 1–2% essential oil in a dry basis. The essential oil is characterized by a high content of citral (constituted by the isomers neral and geranial), which is used as a raw material for the production of ionone, vitamin A and beta-carotene [11]. The lemongrass essential oil is also very important for perfumery since it blends well with a great variety of essential oil [12].

This work deals with the extraction of lemongrass (Cymbopogonflexuosus) essential oil by the above mentioned Microwave-assisted hydrodistilation (MAHD) and Solvent free microwave extraction method (SFME). The objectives of this work was to compare the extraction efficiency of MAHD and SFME and study the influence of process parameters e.g.; extraction time, power input of microwave anddifferent drying duration of Lemongrass leaf on percent yield of Lemongrass oil.

EXPERIMENTAL SECTION

2.1. Raw Materials

Plant material lemongrass herb wascollected from the farm of Chandra Shekhar Azad agricultural university, kanpur, situated near H.B.T.I Kanpur is a reputed agricultural university of India. The variety of the lemongrass was CKP-25. It is an interspecific hybrid herb, the cultivars CKP-25 is the variety developed from regional research laboratory, Jammu-Tawi. This variety has been commercialized in northern India.Plants were cleaned and dried in a dark room at 25°C. Plant material was chopped in different sizes before processing.

2.2. Experimental Setup

Microwave-assisted hydro-distillation(MAHD) and solvent-free microwave extraction SFME was performed at atmospheric pressure with a microwave frequency of 2450 MHz using a household microwave oven which was modified to facilitate the hydro distillation. 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 of 18.5 liter [13]. Experimental setup is shown in Fig. 1 below.

Fig. 1: MAHD reactor setup

2.3. Extraction of essential oil

For MAHD, the lemongrass plant were properly cleaned and grated in to1, 2 and 3 cm long pieces. A 100g of sample was placed in reactor with 5:1 (w/w) of water to plant ratio. 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. For the extraction of essential oil using SFME method; all the runs were conducted as in MAHD but without solvent. For SFME, each sample was soaked in water for 8 hours to increase its moisture level [14].

To investigate the effects of different parameters of the microwave lemon oil extraction on the yield of essential oil, an experimental design was formulated using one variable at a time (OVAT).

The percentage oil yield is expressed as follows;

$$Oil\ yield = \frac{mass\ of\ extracted\ oil}{mass\ of\ sample} x100 \quad (1)$$

RESULTS AND DISCUSSION

3.1. Effect of Microwave power on oil yield

Effects of microwave power on essential oil yield, using the fresh sample is shown in Fig.2. Fresh samples of sameweight,100g.eachwere extracted with three microwavepowerlevels288, 464 and 640 watt for maximum of 120min and with 500 ml of distill water in MAHD and for maximum of 20 minutes in SFME. During the experiment, the water is continuously refluxed in the flask to avoid the burning of sample.

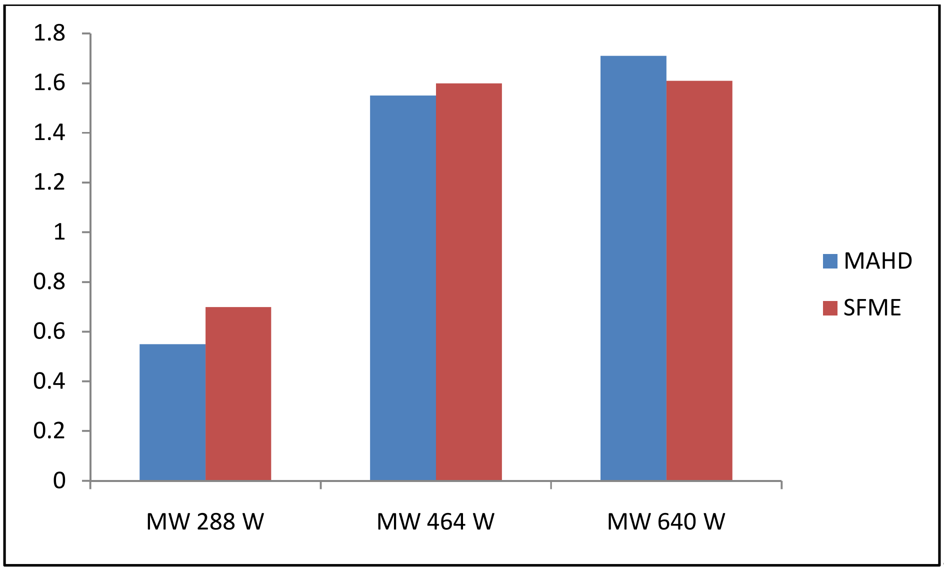

Fig. 2: Variation of oil yield with microwave power level

From the figure it can be seen that extraction at 288 watt of power oil yield was very low and SFME yield was higher in compare to MAHD. Oil yield increases and reached to a maximum at 640 watt of microwave power level.An experiment with dried sample was resulted in fast recovery of oil from sample. It took only 90 minutes for complete recovery of oil at both the power levels; 464 and 640 watt with similar effects of microwave power level and extraction time on yield as was with fresh samples. These results are in confirmation with previous studies (Ferhat*et al*[13]).

3.1. Effect of extraction time of oil yield

The changes in the extraction yield of essential oils by MAHD and SFME are shown on Fig. 3. It can see from Fig. 3 that the extraction yield increased with time. When considering the extraction patterns of plant, both MAHD and SFME resulted in similar yields after the extraction was over. Total yield of extraction was 1.72% (w/w) for in MAHD and 1.61% (w/w) in SFME. According to fig. 3, at a given time, in the early stages of extraction, extraction yield was greater with MAHD than with SFME. This is in agreement with the previous findings of Lucchesi*et al*[14] and Chemat*et al*[15]that MAE of essential oils from cumin, star anise and lavender needed shorter times thanhydrodistilation. Indeed, water with a high dielectric constant absorbs the radiation from the microwaves resulting in a rise in the temperature more rapidly than that in SFME. 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. SFME took only 20 minutes for recovery while MAHD need longer extraction time near about, 120 minute for complete recovery of oil. Recovery of oil in SFME is less than the MAHD.

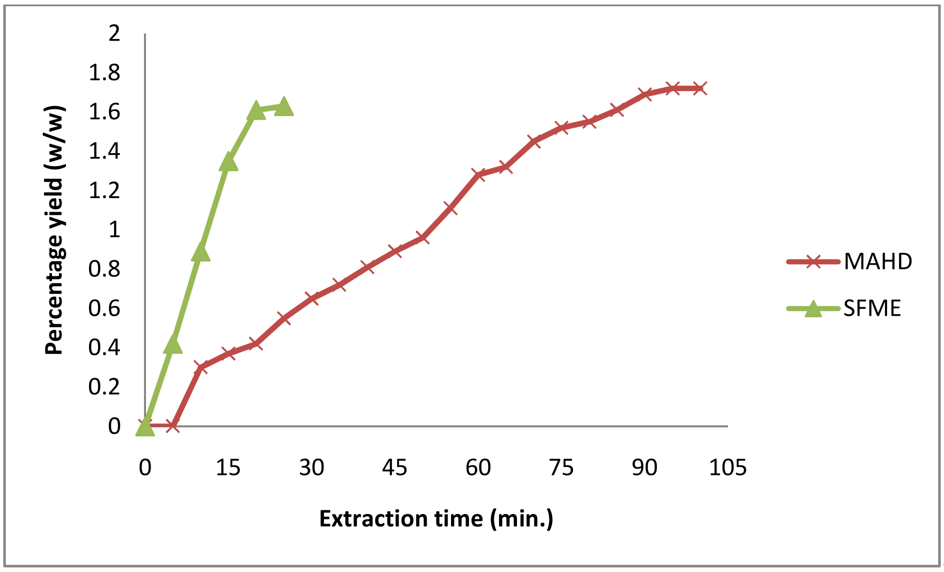

Fig. 3: Effect of extraction time on MAHD and SFME

Effects of particle size on the yield of lemongrass oil

To study the effects of particle sizeon the yield of the essential oil in MAHD of lemongrass oil, extraction was done using fresh sample of three different sizes (1-3 cm), constant volume of water (500 ml), constant original sample weight (100g) at 640 watt of microwave power level and constant time 90 minutes for MAHD and 20 minutes for SFME. From Fig. 4, it can be seen that lemongrassoil yield decreases with increasing particle size. In each comparison SFME yielded a lower quantity of oil. For particle size 1 cm highest oil recovery achieved which is also the maximum of whole experimental work. Therefore, in order to have maximumoil yield, 1 cm particle size is recommended for both the processes.

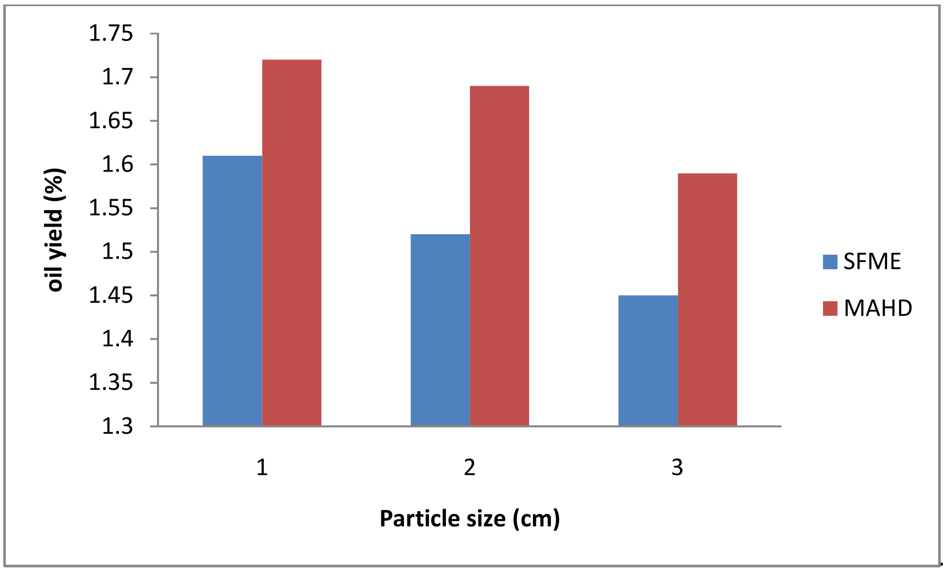

Fig. 4: Effect of particle size on oil yield

CONCLUSION

For extraction of essential oils of lemongrass a comparison has been made between the MAHD and SFME. Thus it was observed that the MAHD required more time to reach the boiling point and therefore higher energy required for same level of operation. Extraction with SFME is more efficient than MAHD. MAHD resulted in slightly higher oil yield compared to SFME. In SFME, 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, SFME 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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