Journal of Chemical Health Risks 3(2): 39-46, 2013
ISSN: 2251-6719

Comparison of Microwave-Assisted and Hydrodistillation Methods for Extraction of Essential Oil from *Achillea millefolium*

S. Mollasalehi[1], B. Kashefi[2], H. Hashemi-moghaddam[3]*

[1*]MS student, Department of Agriculture, Damghan Branch, Islamic Azad University, Damghan, Iran
[2]Assistant professor, Department of Agriculture, Damghan Branch, Islamic Azad University, Damghan, Iran
[3]Assistant professor, Department of Chemistry, Damghan Branch, Islamic Azad University, Damghan, Iran

(Received: 15 March 2013 Accepted: 20 June 2013)

Abstract: Microwave-assisted hydrodistillation (MAHD) method has been compared with hydrodistillation (HD) conventional technique for extraction of essential oil from Achillea *millefolium.* Microwave-assisted hydrodistillation were examined at three levels of microwave powers (300, 500, and 700 W). Obtained results show that MAHD offers important advantages over HD in terms of energy savings and extraction time (20 min against 2.5 h). Also, the essential oils were analyzed by GC-MS. The amount of oxygenated compounds and monoterpene, such as 1,8 -Cineole, Lavandulyl acetate,Caryophylla-dien, Aromadendrene were increased in the microwave method. All these results suggest that MAHD represents an excellent alternative method for extraction of essential oils from plant materials.

Keywords: *Achillea millefolium***,** Microwave, hydrodistillation, Essential oil.

INTRODUCTION

A. millefolium is from family of Asteraceae or Composite. In this family, there are 9000 genders and about 20000 species. Among plants of this family, there are medical types over 180 species in the world [11]. Yarrow is an herbaceous and perennial plant, which constitutes massive communities in humid lands of center and south of Europe, east of Asia and north of Africa. Height of this plant is different and depends on climate conditions; growth place of plant is between 20-90 cm or even more [9].

Flowering time is from May to September. All parts of plant have Penetrating odor and a bitter taste. *A. millefolium* species in terms of size is larger plant and has white-color flowers with aromatic odor [11]. Yarrow has these effects: nutrient, energetic, anticonvulsant, anti-inflammatory, removing hemorrhoids, blood blocker, wound healer, and injuries. Also, it is used to remove general fatigue, gastrointestinal tract and uterus spasms, asthma, disorders arising from Menopause (such as uterus bleeding), gout, rheumatism, disorders of circulatory system, varicose, urinary incontinence in children, lowering fever of Colitis inflammatory disease and virus infections [3]. Yarrow is a long-day plant, most suitable temperature for its growth and flowering is 18-26 °C [5].

Corresponding Author: Sima Mollasalehi, MS student, Department of Agriculture, Damghan Branch, Islamic Azad University, Damghan, Iran. E-mail: Sima_Salehi60@yahoo.com

MAHD is a rapid and effective extraction technique compared with traditional extraction techniques and has been applied to extract biological active compounds from different matrices. Comparing with other modern extraction techniques such as super-critical fluid extraction and pressurized liquid extraction, MAHD is easy to use and the systems are cheaper [12].

Microwave-assisted hydrodistillation (MAHD), a relatively novel extracting approach using a microwave applicator as an energy source, has received increasing attention. With the microwave distillation technique it is possible to achieve distillation with the indigenous water of the fresh plant material [13].

MATERIALS AND METHODS

Plant material

A.millefolium was collected from a mountainous region and heights of Taleghan County, Alborz Province with longitude of 50°39′43/4″ and latitude of 36°07′22/4″ and in 2258 meters height from sea level in 1/July/2012. *A.millefolium* was dried in shadow and powdered and extracted by two distillation method, Clevenger and Microwave systems. Efficiency of extraction was computed by humidity percent. All tests were conducted in three replications.

Microwave assisted hydrodistillation (MAHD)

In extraction method by microwave, 50 g from considered plant was soaked in 300 ml of distilled water in the room temperature (25 c°) for 1 hour, this phase is necessary for making initial humidity in plant, then, additional water was discharged. Wet plant materials were put into flask of Clevenger system. Microwave method was optimized in different powers (300, 500, 700Wat) in 15 minutes in three replications. Then, extraction was conducted in best power in different times (5, 15, 30 min). Essential oil was collected in penicillin glass by very law amounts of n-hexane after cooling the system and dehydrated by anhydrous sodium sulfate and preserved in 4 C°, far from light until analysis. Essential oil of considered plant after preparation was injected to gas chromatograph system connected to mass spectrometer (GC/MS) to detect type of its ingredients.

Hydrodistillation

First, 50 g from dried powder of plant was weighted and located inside balloon, then 300 ml distilled water was added and the mixture was soaked for 1 hour. Then, by regulating level of temperature and velocity of passing cold water from refrigerant, distillation was begun. Time of extraction for all repeats was 2.5 hours (until amount of essential oil was not added). Essential oil was collected in penicillin glass after cooling the system and efficiency of extraction was computed. Then, it was dehydrated by anhydrous sodium sulfate and was preserved in 4 C°, far from light for utilization.

Gas Chromatography–Mass Spectrometry

In this section, essential oil of *A.millefolium* prepared from two methods, Clevenger and Microwave were injected to gas chromatograph - mass spectrometer and by Retention time of components in peak area was achieved identifying spectrums was conducted by their retention indices (RI) in reference book and by using available of the data stored in a MS library. Thereafter, chemical components presented in each sample of essential was detected and by drawing charts related to amounts of components, based on peak areas, comparison was conducted. Mass spectrometer (MS) was used with Agilent technologies by model 7890A, with column BP-5 capillary by 30 m length, 0.25mm diameter and layer thickness was 0.25μm. Voltage of ionization was 70ev, ionization method was EI and temperature of ionization was 220 c°. Range of

scanning spectrums was regulated from 50 to 550 nm. Used software was Chemstation.

RESULTS AND DISCUSSION

Efficiency of essential oil with microwave and Clevenger methods

The obtained essential oil yield were 0.25% and 0.53% for HD and MAHD in optimum conditions, respectively, Analysis variances of different power in essential efficiency by microwave method indicated that there is a significant difference between various balances in possibility level of 1% (Table 1). The comparison of average showed that *A. millefolium* species of each power has been located in separate group. In addition, results specified that by increasing power of microwave, amount of efficiency of essential oil be increased (Table 2).

Table 1. Analysis of variance for different powers, 15 minutes in the microwave types of A.millefolium

Efficiency of essential oil	Degrees of freedom (df)	Sources of variation
0.07**	2	Treatment
0.0013	4	Error
8.9	___	Coefficient of Variation(CV%)

Significant at 1% : **

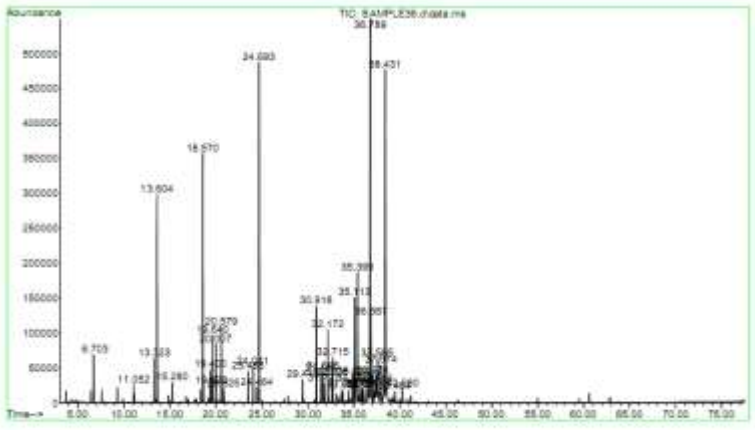
Table 2. Comparison of different methods of extraction and different powers microwave in *A.millefolium*

Efficiency of essential oil	Treatment (Different powers)	Different methods of extraction
0.23 b	300 wat	
0.46 a	500 wat	Microwave
0.53 a	700 wat	
0.25	-	Clevenger

Chemical components specified by two methods of extraction: Clevenger and microwave, by GC/MS

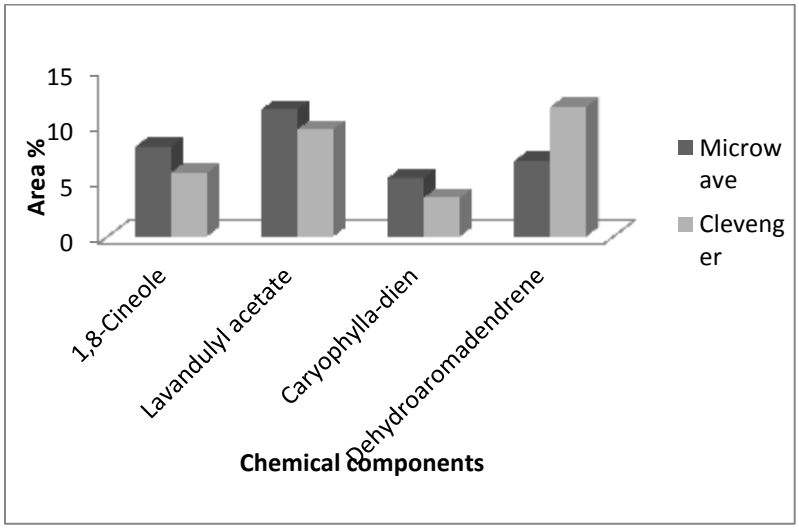
Chemical composition of essential oil of *A.millefolium by* two methods: Clevenger and microwave extraction, were analyzed by gas chromatography -mass spectrometer. Figure 1 shows GC-Mass spectrum of essential oils of *Achillea millefolium* extracted by MAHD method.

Figure 1, GC-Mass spectrum of essential oils of *Achillea millefolium* extracted by MAHD method, Microwave Extraction condition are: 700 watt and 30 min for power and time of extraction.



As it is shown in table 1, proportion of oxygenated components such as 1-8- Cineol, Pinocarvene, α- Terpineol, Lavandulyle acetate and also monoterpene hydrocarbons such as ρ-xylene, 1-8- Cineol, Lavandulyl acetate, γ-terpinen, α- trepeneol, γ- Xylene, β- Lavandolole, Pinocarvene, dimethyl adamantan was increased in Microwave method. sesquiterpenes compounds such as β-caryophyllene, Aromadenderone, α-Jurjuene in microwave method were also higher than Clevenger method (Figure 2) .

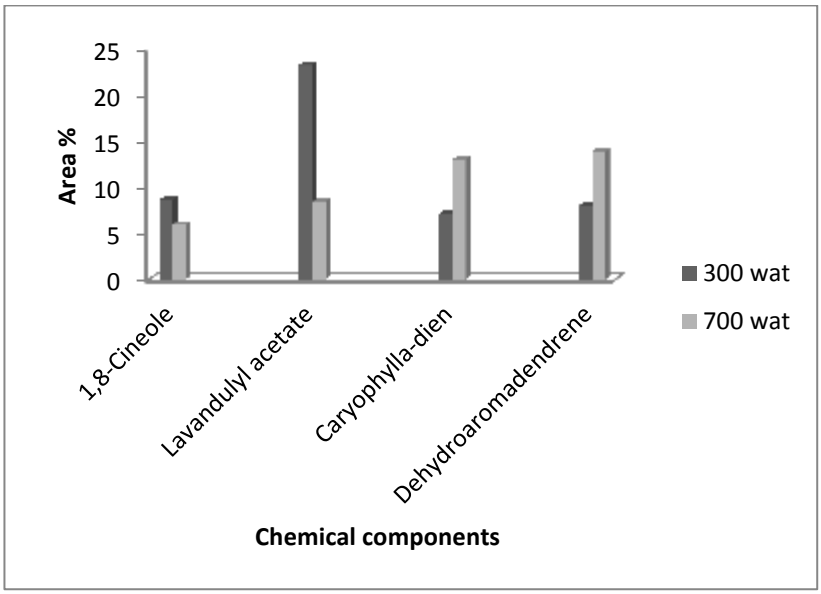
Figure 2 - Comparison of the chemical composition of the essential oil of *A. millefolium* with microwave and Clevenger



Comparison of chemical compounds of essential oil of Achillea millefolium in different powers of microwave

Results of effect of microwave power on essential oil yield indicated that 1,8- Cineol has the most value of extracted compounds, amount of this monoterpene and oxygenated compound in low power (300 W) is more than high power (700W) (Figure 3).

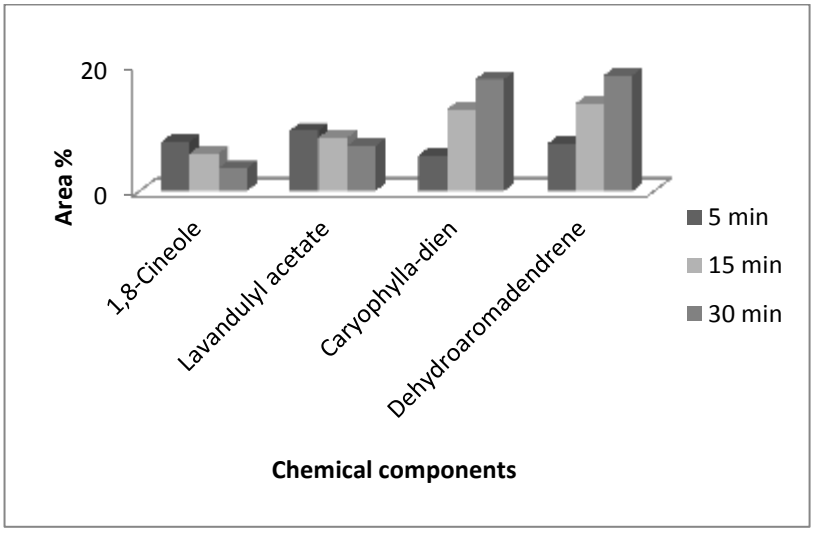
Figure 3- Comparison of chemical compounds found in the essential oil of *A. millefolium* with different microwave powers



Comparison of chemical compounds of essential oil of Achillea millefolium in different times of microwave

Comparison of chemical compounds in different times also indicated that most amount of extracted compound is 1,8- Cineol, Lavandulyle acetate and amount of monoterpene and oxygenated compounds in low times have more concentration(Figure 4).

Figure 4 - Comparison of chemical compounds found in the essential oil of *A. Millefolium* in different times of microwave



CONCLUSION

With respect to efficiency of essential oil of *A.millefolium* by percent in both Microwave and Clevenger methods, it was observed that the efficiency of essential oil was increased in microwave method. One of the causes of being low efficiency of essential oil in low powers is to lose many volatile compounds in long times [6]. As it was observed in Figure 1, portion of oxygenated compounds such as 1,8- cineol, Crysantenone, camphor, broneole, α-terpineole in microwave method was more. Also, amounts of monoterpene hydrocarbons such as ρ-xylene, α-pinene, 1,8-cineol, ρ-mentatriene, Crysantenone, camphor, broneole, γ- terpinen, α-trepineole also in Microwave method were higher than that in Clevenger method. Thus, using microwave waves to essential oil seems suitable [7].

Yang and his colleagues (2011) also in similar study showed that performance of essential oil of *Littsea cubeba* in distillation method by steam was less than that of microwave. Increase of performance of essential oil could be because of power of penetration of microwave waves into essential oil cells and leads to more extraction of essential oil [10].

With regard to comparison of percent efficiency of *A.millefolium* by two methods: distillation with water and extraction with microwave, we can conclude that extraction by microwave is not only conducted in shorter time, but also it caused to increase in amount of efficiency and velocity of extraction[2]. With respect to results from comparison of essential oil of *A.millefolium* extracted by Microwave and Clevenger methods, it was shown that in high and fast extraction, power of performance with consumption of solvent is lower and time is shorter, speed of extraction is increased, quality and quantity of essential oil is also increased and preservation of main components of medical plant is one of the most important properties of extraction with microwave [1]. In medicinal plants, extraction by microwave is an efficient tool and requires minimum time and energy in comparison with other methods [4, 8].

ACKNOWLEDGEMENTS

Authors are grateful about the valuable technical helps that were provided by Damghan Branch, Islamic Azad University and health faculty of Damghan.

REFERENCES

1. Asghari J., Ondruschka B., Mazaheritehrani M., 2011. Extraction of bioactive chemical compounds from the medicinal Asian plants by microwave irradiation, Journal of Medicinal Plants Research, 5(4) : 495-506.
2. Bayramoglu B., Sahin S., Sumnu G., 2008. Solvent-free microwave extraction of essential oil from oregano, Journal of food Engineering. 88(4):535-540
3. Emami A., Shams Ardekani M., Nekoee naeini N., 2002. Treatment plant,45(1).
4. Kanimozhi P., Ilango K., Anupam Ch., Arun B., Ammarmohammed M.A., Nethaji A., 2010. Microwave assisted extraction of *Artemisia pallens* for tyrosinase inhibitory activity,1(1):25-27
5. Mozafarian V., 1996. The names of Iranian plants, p 700.
6. Ramanadhan B., 2005. Microwave extraction of essential oils (from black pepper and coriander) At 2.46 GHz, A thesis Submitted to the College of Graduate Studies for the Degree of Master of Science in the Department of Agricultural and Bioresource Engineering University of,Saskatoon, Saskatchewan Canada, 1-169.
7. Riela S., Bruno M., Formisano C., Rigano D., Rosselli S., Saladino M.L., Senatore F., 2008. Effects of solvent-free microwave extraction

on the chemical composition of essential oil of *Calamintha nepeta (L.)* Savi compared with the conventional production method, J. Sep. Sci. (31): 1110 – 1117.

8. Tatke P., Jaiswal Y., 2011. An overview of microwave assisted extraction and its applications in herbal drug research, Research journal of medicinal plant 5(1): 21-31.
9. Tavakoli Saberi M., Sedaghat M.R., 1981. Medicinal plants, 23-28.
10. Yang G., Wang G., Li X., Zhang M., 2011. Study on New Extraction Technology and Chemical Composition of Litsea Cubeba Essential Oil, The Open Materials Science Journal, 5:93-99.
11. Zargari A., 1995. Medicinal plants, Tehran university, 695(3).
12. Zheng X., Liu B., Li L., Zhu X., 2011. Microwave-assisted extraction and antioxidant activity of total phenolic compounds from pomegranate peel, Journal of medicinal plants research, 5(6): 1004-1011.
13. Zhou T., Xiao X., Li G., Caib Z., 2011. Study of polyethylene glycol as a green solvent in the microwave-assisted extraction of flavone and coumarin compounds from medicinal plants, Journal of Chromatography A,(1218): 3608–3615.