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Quantitative Estimations for the Volatile Oil by Using Hydrodistillation and Microwave Accelerated Distillation Methods from *Ruta graveolens* L. and *Ruta chalepensis* L. leaves from Jerusalem Area / Palestine

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Abstract

Background: In the recent years new techniques were applied for extraction and isolation of natural phytochemicals from living organisms by using microwaves to assist extraction, decrease the time and cost of isolation methods in the same time these methods must guarantee the highest yield from the plants.

Objectives: this research aimed to evaluate two methods of volatile oils extraction, the microwave accelerated distillation and hydrodistillation also to find the best source of Rue oil *Ruta graveolens* or *Ruta chalepensis* leaves. In this research, the effect of microwave power on the yields of volatile oils in *R. graveolens* and *R. chalepensis* is the first time proven in the literature.

Method: Microwave accelerated distillation was applied for the extraction of volatile oils from the leaves of *Ruta graveolens* and *Ruta chalepensis*. The microwave assisted extraction method had been compared with hydrodistillation conventional technique, in terms of extraction yields, cost and time.

Results: The volatile oils of the dried *Ruta graveolens* collected from the Jerusalem area of Palestine were recovered by microwave accelerated distillation method with approximately 2.2% yield in *Ruta graveolens* and approximately 1.8% yield of the volatile oils in *Ruta chalepensis* on a dry weight basis, in the same time the yield was approximately 1.2% in *Ruta graveolens* while was 0.6% yield of the volatile oils in *Ruta chalepensis* by using hydrodistillation method.

Conclusion: The results showed that the isolation of the volatile oils from *R. graveolens* and *R. chalepensis* by microwave assisted extraction is more efficient in time cost and yield rather than hydrodistillation; also the results showed that the best economical source for Rue oil is *R. graveolens* for food, cosmeceuticals and pharmaceutical industries.

Keywords: *Ruta graveolens; Ruta chalepensis; Microwave Accelerated Distillation; Hydrodistillation; Volatile* oil.

1. Introduction

Since the ancient times medicinal plants considered primary sources of new therapeutic agents and used as crude drugs in several administration forms as herbal teas, powders, tinctures, oils, poultices, creams and other herbal formulations [1,2]. At the end of the 18th century new epoch in dugs discovery started with various processes of isolations for the active phytochemical compounds in single forms, as salicylic acid from Willow bark, morphine from Opium Poppy capsule and others [3]. In the recent history, the use of medicinal plants as medicines has involved mainly in the use of isolated active compounds with some modifications in their structures to be more potent with fewer side effects or used their structure as modules for synthesis of chemical analogues medications [4]. *Ruta graveolens* L., English common names are Garden Rue, herb-of-grace and Common Rue belonged to the Rutaceae family and wildly distributed all over the world especially grown in the Mediterranean Sea regions and Europe and has been considered among the key plants of the European Pharmacopoeia from a long time [5,6]. Garden Rue is a perennial small shrub or herb with a characteristic odor grows erect about 1 meter high with two or three alternate dark green leaves (Fig. 1)which are 1.5 -2 cm long. The flowers are tiny, greenish yellow with fringe petals which born in terminal clusters [7]. Rue oil is utilized from the ancient times as flavoring agent in beverages and foods and used as a fragrant ingredient in manufacturing of shampoo and soaps [8]. Historically the Rue flowers, leaves and stems were used in the traditional medicine for relieving of rheumatic arthritis, psoriasis, menstrual cramps, stiff neck, headache, leukoderma, earache, vitiligo, nasal congestion, nose bleeding, multiple sclerosis and for fertility regulation, as well as its decoctions used as emetic, digestive stimulant and diaphoretic [5,6,9,10]. Rue plant has been pharmacologicaly and chemically studied extensively and the recent studies prove the chemical constituents for this plant which belonged to various phytochemical classes as alkaloids (acridone, 8-methoxy-taifine, isotaifine, taifine, rutacridone, ribalinidine, 3-hydroxygraveoline, 1-hydroxy-n-metailfuracridone, 1-hydroxy-n-metilacridone, kokusaginine, graveolinine, graveoline, gamma-fagarine, arborinine, arborine and skimmianine), Flavonoids (rutin, quercitin, kaempferol,) coumarins (psorlen, bergapten, gravelliferon, bergapten, ratamarin, herniarin, coumarin, rutaretin) terpenoids, furoquinolines, volatile oils and tannins [11-19].

Experimental modern trials and clinical studies proved the abortifacient, antifungal, antibacterial, antihistaminic, anti-hypertensive, anticancer, antihelminthic, anti-inflammatory, anti-fertility, antiarrhythmic, antispasmodic and analgesic effects of Rue plant in addition to some central nervous system effects [20-22].

Ruta chalepensis L. other synonym scientific names are Ruta bracteosa DC., Ruta angustifolia and common names are ruda, rue fragrant, fringed rue, Egyptian Rue, citronelle Marron, herb-of-grace and African Rue considered a member of Rutaceae family [23]. African Rue is a perennial shrubby small tree that reaches a one meter height and more. The branches and leaves color are dark green (Fig. 1) with strong distinguishes odor [24]. In Saudi Arabia the aerial parts of the plant are used as anti-inflammatory and a laxative as well as used to treat rheumatism pain, headache and colic and in India it is prescribed for dropsy, neuralgia, rheumatism, and menstrual bleeding and other bleeding disorders. In Africa, an aqueous decoction of the leaves serves as a treatment for fever and the heated leaves have been placed inside the ear to treat earache [25,26].

However, larger consumption of the roots known to work as abortifacient, and various reports mentioned cases of death as a result of bleedings after abortion.

The volatile oil which isolated from Rue fresh leaves is used in perfumery and as a food flavoring agent in small doses but it can cause nephrotoxicity and hepatotoxicity in large doses with long term of administrations [27].

Figure 1: *Ruta graveolens* (1), *Ruta chalepensis* (2)

2.Material and methods

2.1 Plant material

The *Ruta graveolens* L. and *Ruta chalepensis* L. plants were collected during the spring (May–June, 2014) from the hills and mountains of Jerusalem area in the West-bank/ Palestine. A voucher specimen (number Pharm-PCT-2084-5) was deposited at the Herbarium of the Faculty of Medicine and Health Sciences, Department of Pharmacy laboratories at An-Najah National University.

To extract the oil, the leaves were separated with a meticulous care then the leaves were washed twice with distilled water, dried for 7–10 days in the shade at room temperature to avoid extra damaging and minimizing cross contamination of the plant leaves then the dried leaves were grounded and the powder was stored in cloth bags at 50C until transferring them to the laboratory for further experiments.

2.2. Hydrodistillation experiment

Typical hydrodistillation was accomplished with a Clevenger apparatus. In the round bottom flask placed 100g of the dried leaves of Ruta *graveolens* L. and *Ruta chalepensis* L. plants with 500 ml deionized water , For each distillation time (10 minutes, 30 minutes, 60 minutes, 120 minutes) the volatile oil collected and weighed the procedure repeated twice The yield of the volatile oils were then collected in a beaker and then added to them drying agent CaCl2 to absorb any contaminations, weighed and placed in well closed amber colored bottles and the resulted yield presented in (table 1).

2.3. Microwave accelerated distillation experiment

In the recent method used modified microwave device (Ultrasonic-microwave Cooperative Extractor/ Reactor Lab.Kits, China). The power of the oven was regulated at (1000W=100% power, 700W=70% power, 500W=50% power, 300W=30%) power were examined. By shearing a hole at the top of the oven Clevenger apparatus was placed into the oven. Round bottom flask 1000ml was placed inside the oven and above

connected the Clevenger apparatus throughout the hole and the hole closed well by using Rock wool to prevent seepages of the waves.

In the round bottom flask placed 100g of the leaves of *Ruta graveolens* L. and *Ruta chalepensis* L. plants with 500 ml deionized water. Microwave accelerated distillation method repeated for the two plants with different times (10 minutes, 30 minutes, 60 minutes, 120 minutes) and different powers of the microwaves (1000 W, 700W, 500 W, 300 W), this procedure repeated twice for each plant . The yield of the volatile oils were then collected in a beaker and then added to them drying agent $CaCl_2$ to absorb any contaminations, weighed and placed in well closed amber colored bottles and the resulted yield calculated in (Table 1 and Table 2).

3. Results and discussion

Hydrodistillation method of volatile oil extraction was assisted and compared with the microwave accelerated method of extraction in terms of extraction time and yields for two plants species. The volatile oils were extracted and isolated by using old conventional techniques such as steam distillation or water distillation which needed a long time to approach the required temperature for evaporation of volatile oils with maximum lost of energy and waste of laboratory time and add to all that the contamination with the used organic solvents may be occurred and these methods damaged a lot of the phytochemical compounds which damaged at the walls of the contacted glass of the flasks and flame. The new techniques using microwaves can save time, energy without contamination in organic solvents and with minimum hydrolysis of the active components. Regarding the showed results in (Table 1 and Table 2) the microwave accelerated method is the best method for extraction the volatile oils from the two presented plant species (*R. graveolens, R. chalepensis)* with less time, less cost and minimum energy consumption without damaging the active constituents than conventional hydrodistillation method, also the presented results in (Table 1 and Table 2) showed that *Ruta graveolens* leaves have 2.2% yield of the volatile oil, with microwave power 300W in 10minutes while Ruta *chalepensis* yield was1.8 % volatile oils with 300W power within 10 minutes, which proven that *Ruta graveolens* is the best source for Rue oil for pharmaceutical and cosmeceuticals industry.

3.1.The effects of microwave power and time on essential oil yield:

Table 1: The volatile oil yield percentage of *Ruta graveolens* by using microwave accelerated method and hydrodistillation method

Method	The strength of the waves	The Yield of the volatile oil isolated from *Ruta graveolens* leaves (%)			
		Time of extraction (minutes)			
		10	30	60	120
Hydro-distillation	-	-	-	1.2	0.9
Microwave accelerated distillation	300	2.2	1.77	0.8	-
	500	1.9	1.5	0.6	-
	700	1.4	0.9	0.2	-
	1000	0.6	-	-	-

In this method observed that the volatile oil yield decreased with rising in the microwave power which means that the higher power of the microwaves can damage these volatile oils which explain the low yield of the volatile oils with the increasing of the power of the microwaves with long extraction time.

Table 2: The volatile oil yield percentage of *Ruta chalepensis* by using microwave accelerated method and hydrodistillation method

Method	The strength of the waves (Watts)	The Yield of the volatile oil isolated from *Ruta chalepensis* leaves (%)			
		Time of extraction (minutes)			
		10	30	60	120
Hydro-distillation	-	-	-	0.6	0.2
Microwave accelerated distillation	300	1.8	1.4	1.0	-
	500	1.5	1.1	0.5	-
	700	1.1	0.5	0.2	-
	1000	0.2	-	-	-

4. Conclusion

Our comparative study of the volatile oils yields from the leaves of *R. graveolens* and *R. chalepensis* plants shows that the best method of extract with high yield, short time and less cost is microwave accelerated distillation method than conventional hydrodistillation method, also the results showed that the best economical source for Rue oil is *R. graveolens* for food, cosmeceuticals and pharmaceutical industries.

5. References

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