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SHORT COMMUNICATION

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THE APPLICATION OF MICROWAVES IN ESSENTIAL OIL HYDRODISTILLATION PROCESSES

The influence of microwaves pre-treatment of raw plant materials (wooded greenery and fruits of conifers-fir, spruce, pine, juniper and Douglas fir) on the kinetics of the essential oil hydrodistillation using the Unger-type apparatus was studied. These plant materials are important feedstocks in the Republic of Srpska, as they could be used for the industrial production of essential oils for pharmaceutical, cosmetic and food industries. The main goal was to find out how the microwave pre-treatment of the raw plant materials affected the duration of hydrodistillation and the final yield of the essential oil. The application of microwaves pre-treatment shortened the hydrodistillation process which could significantly affect the economy of the essential oil production.

Key words: microwaves; hydrodistillation; essential oils; needles.

There are scarce data on the essential oil production from the wooded greenery and fruits of conifers on the territory of the Republic of Srpska. The Republic of Srpska has at disposal a significant potential of wooded greenery as possible raw materials for the production of essential oils. The essential oils of conifers should be analyzed in details from various aspects, because, if well organized [1], they could be successfully distributed to domestic and foreign markets.

Essential oils of conifers are transparent, easy floating liquids, with a very pleasant scent. They have wide application in different industrial branches. Bioactive products from medical, aromatic, spicy wild growing and cultivated herbal materials are widely used for correcting sensory (smell and aroma) and visual characteristics of pharmaceutical, cosmetics and food products. Essential and fatty oils are used in industry of paint and lacks, as well [2,3].

Essential oils are usually produced from conifers. They are found in wood, peel, needles and fruits. Most of them can be got from needles and young branches [4]. Important raw materials for getting essential oils are also wooded greenery and fruits of conifers such as fir, spruce, pine, juniper and Douglas fir. Steam distillation is mostly employed for the essential oil isolation from plant materials [5]. For determination of the essential oil content in herbal materials under the laboratory conditions, the Unger-type hydrodistillation apparatus is mostly used [5,6]. Recently, new methods have been applied to obtain the optimal quality and higher yield of the products with as smaller as possible production costs.

The influence of microwaves pre-treatment of chopped and homogenized wooded greenery and fruits of conifers, harvested at the beginning and the end of vegetation, on the kinetics of essential oil hydrodistillation using the Unger-type apparatus was studied. The main goal was to find out how the microwave pre--treatment of the raw plant materials affected the duration of hydrodistilattion and the final yield of the essential oil in order to improve the essential oil production process.

EXPERIMENTAL PART

Plant materials

Wooded greenery and fruits of different conifer were collected from a plantage (Dubrava, ZDP "Industrijske plantaže", Banja Luka), except juniper berries which were collected at the Manjača mountain near Banja Luka. The plant materials were collected during the beginning (April, 2005) and the end (Oc-

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tober, 2005) of vegetation. The conifer species used in the study were as follows: fresh trees of *Abiess grandis*, *Picea abies* and *Pinus sylvestrus*, fruits of *Juniperus communis* as well as trees of *Pseudotsuga menziesii*. The first four species were growing in natural habitats at different localities, while the fifth one, imported from the USA, was cultivated in "silva-culture".

For laboratory tests, small live branches with needles up to 1 cm diameter at the thicker end of the branch were collected in the field. The individual samples were mixed, chopped and homogenized. An amount of the cumulated sample (100±10 g) was taken for the analysis.

For the pre-treatment of plant materials, a modified commercial microwave furnace (170 W; inside temperature of 32 °C) was used. The plant material (100 g) together with water (300 g) was treated with microwaves in 10 min.

Hydrodistillation

The essential oils were isolated from both the raw plant materials and the plant materials pre-treated by microwaves using the Unger-type hydrodistillation apparatus. During the 2 h hydrodistillation, the yield of essential oil was measured on every 15 min from the beginning of the process.

The temperature and the pressure during the hydrodistillation were 93-102 °C and above the bubble point pressure of 0.5 bar; the process duration was about 3 h.

RESULTS AND DISCUSSION

The laboratory hydrodistillation of the essential oil from the microwave-pre-treated plant materials collected during different periods of vegetation was performed in order to determine if such a procedure had

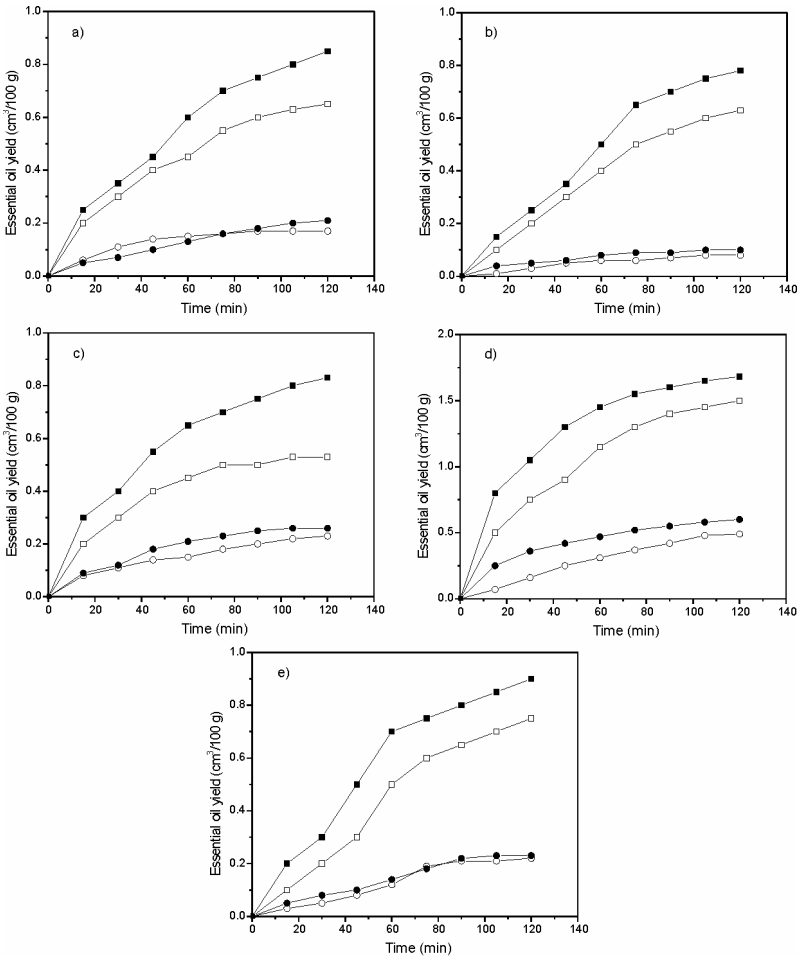

Figure 1. The influence of the microwave pretreatment on the yield of the essential oil in % from a) fresh wooded greenery of Abies grandis, b) fresh wooded greenery of Picea abies, c) fresh wooded greenery of Pinus sylvestris, d) fruits of Juniperus communis and e) fresh wooded greenery of Pseudotsuga menziesii (hydromodul: 100 g of needles and 300 cm³ of water; plant material collected at the beginning of vegetation - circles; plant material collected at the end of vegetation - squares; pretreated plant material – black symbols; untreated plant material – open symbols).

Table 1. Maximal essential oil yields obtained by 2 h hydrodistillation (hydromodul: 100 g of needles per 300 cm^3 of water) of untreated and microwave-pre-treated plant materials collected at the beginning and the end of vegetation

Plant material	Essential oil yield (cm^3 of oil/100 g)			
	Beginning of vegetation		End of vegetation	
	Control	Microwave-pre-treated	Control	Microwave-pre-treated
Abies grandis	0.17	0.21	0.65	0.85
Picea abies	0.08	0.10	0.63	0.78
Pinus sylvestris	0.23	0.26	0.53	0.83
Juniperus communis	0.49	0.60	1.50	1.68
Pseudotsuga menziesii	0.22	0.23	0.75	0.90

any influence on the process kinetics and the yield of the essential oil. The kinetic data for the distillation of the essential oil from the plant materials collected at the beginning and the end of vegetation is shown in Figure 1. As it can be concluded, the kinetics of the essential oil distillation depended on the type of the plant material, the vegetation time and the plant material pre-treatment. It is clear that the essential oil distillation was faster and the essential oil yield was higher from the plant material collected at the end of vegetation and if previously treated by microwave for 10 min. The same conclusions can be withdrawn from Table 1, which summarizes the values of maximal essential oil yields obtained by the 2 h hydrodistillation from both untreated and microwave-pre-treated herbal materials collected at the beginning and the end of vegetation. The highest maximal essential oil yield of 1.68 cm^3/100 g was achieved from microwave-pre-treated juniper berries collected at the end of vegetation. The maximal essential oil yield was higher from the plant materials collected at the end of vegetation, independently of the type of the plant material and whether they were or were not microwave-pre-treated. Also, the microwave pretreatment of all plant materials ensured a higher maximal essential oil yield, compared to the control plant materials.

CONCLUSION

The present study clearly shows that the application of microwaves for the pre-treatment of plant materials before hydrodistillation caused either a higher essential oil yield or shorter duration of hydrodistillation, or sometimes both characteristics. The highest yield using microwaves was achieved with hydroidstillation of essential oils obtained from the fruits of *Juniperus communis* – 1.46 %, and the smallest one from the needles of *Picea abies* – 0.70 %. Duration of the hydrodistillation process proceeded by the microwave pretreatment of plant materials, for the same essential oil yield, is shorten for up to 50 %. These data are important for the flow and profitability of the production, as well as for the quality of the end-product.

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