OBTAINING ACTIVE INGREDIENTS FROM AROMATIC PLANTS DURING THE PROCESSING OF WILD THYME (Thymus serpyllum L.)

ABSTRACT

Essential oils are highly volatile liquids obtained from various plant materials (flowers, buds, seeds, leaves, twigs, bark, herbs, trees, fruits, roots and other plant parts). Wild Thyme (Thymus serpyllum L.) is a popular remedy regarding both traditional and conventional medicine. It is used as the antiseptic, aromatic, expectorant, stomachic, antispasmodic, carminative and preservative substance. Wild Thyme is a constituent of numerous herbal preparations made in pharmacies and the pharmaceutical industry due to its pharmacodynamic effects. It is extensively utilised in medicine, pharmacy, the food industry, the cosmetic industry, the alcoholic and non-alcoholic beverage industry, and the paint and varnish industry. For the purpose of this paper, Wild Thyme essential oil was isolated from the dried herb T. serpyllum by hydrodistillation. The following processing equipment was used for the hydrodistillation of T. serpyllum essential oils: 1) a semi-industrial distillation device SP-130 performing distillation by water and steam, 2) a Clevenger apparatus operating according to the procedure prescribed by the Euro Ph. 6.0. The temperature during the hydrodistillation in the device SP-130 ranged from 100 °C – 102 °C at atmospheric pressure, and the whole process lasted 5 hours. The isolated essential oil is a liquid of light yellow colour and the odour characteristic of the genus Thymes. The weight of treated dried plant biomass was 5.5 kg. After drying by means of anhydrous sodium sulphate, 4.1 g of pure essential oil was obtained. Obtained yield of essential oil by applying the distillation device SP-130 was 0.08 %. For comparative purposes, the same plant material used in the first trial with the device SP-130 was crushed and subjected to hydrodistillation in the Clevenger apparatus with the ratio of plant material and water 1:10 (m/v) for 2 hours. The yield of essential oil was 0.1%.

Key words: Thymus serpyllum L., hydrodistillation, essential oil, hydrolat, processed biomass.
varnish industry. Wild Thyme (T. serpyllum) contains all the medicinal properties of the more commonly used Garden Thyme (T. vulgaris), though in a lesser degree (Zarzuelo and Crespo, 2002). Chemical polymorphism is characteristic of the species of Thymus and numerous chemotypes have been defined such as carvacrol and thymol, α-terpineol, thujone, geraniol, linalool, and others (Thompson et al., 1998). Several studies have focused on the antimicrobial and antioxidant activity of the essential oils of thyme and thyme extracts (Babovic et al., 2010a, Babovic et al., 2010b; Bhaskara et al.; 1998; Ložiené et al.; 2007, Burt, 2004; Ahmad et al., 2006). Lee et al. (2005) showed that the main components of thyme extract, particularly eugenol, thymol and carvacrol, have higher antioxidant activity than synthetic antioxidant butylated hydroxytoluene (BHT) and α-tocopherol. Thyme essential oil has an antibacterial effect and Rota et al. (2008) confirmed that the essential oil of Thymus species, especially T. hyemalis, T. zygis, and T. vulgaris, can be used as strong bactericidal agents in the food industry to extend the shelf life of food products. Erkan (2012) reported that the shelf life of hot smoked rainbow trout stored in cold storage (2 °C) was 5 weeks for the vacuum-packaged samples (untreated) and 7 weeks for the thyme-oil-treated vacuum-packaged smoked fish. The content of essential oil in the Wild Thyme drug varies to a great extent depending on the origin of the plants and ranging between 0.1 and 0.6 % (Wichtl, 1994), or between 0.1 and 1% (Evans; 2000; Blinkova, 1996). Main components of the essential oil of Wild Thyme are thymol (up to 30% in essential oil) and carvacrol (up to 20%) (Wichtl, 1994; Evans, 2000). This study presents the results of obtaining active ingredients from aromatic plants during the processing of Wild Thyme (T. serpyllum L.). Moreover, it opens a discussion about the positive ecological aspects and the free-waste technology employed in the processing of Wild Thyme. Consequently, the abovementioned equipment and technology, which meet the environmental criteria for producing essential oils, will be utilised.

MATERIAL AND METHOD

Plant material

The plant Thymus serpyllum was collected at the flowering stage during June in 2012 in Central Serbia on Mount Pašjača, near the town of Žitorađa. The collected plant materials were dried in the shade.

Isolation of the essential oils

For the purposes of this paper, Wild Thyme essential oil was isolated from the dried herb T. serpyllum by hydrodistillation. The following processing equipment was used for the hydrodistillation of T. serpyllum essential oils: 1) a semi-industrial distillation device SP-130 performing distillation by water and steam, 2) a Clevenger apparatus operating according to the procedure prescribed by the European Pharmacopia. The apparatus consists of a 1000 ml round-bottomed flask, a condenser assembly (see Fig. 1) closely fitting the flask, and a suitable heating device allowing good control. A 0.1 ml graduated measuring tube was used. The obtained essential oils were dried by means of anhydrous sodium sulphate and stored at +4 °C.

Fig. 1. Clevenger apparatus according to the procedure prescribed by the Euro Ph. 6.0.

The most appropriate type of device was determined on the basis of the amount of processed raw plant material. An original distillation device SP-130 was used. According to its characteristics, it is a discontinuous device with the volume of 130 l.
The process of steam distillation with the device SP-130 has many advantages over the existing ones (Petrović et al., 1996; Škala et al., 1999; Sovilić and Spasojević, 2001; Petrović et al., 2012). Multi-year studies of patent documents in ex-Yugoslavia and abroad, as well as the relevant literature, have shown that the best results are obtained by distillers ranging from 125 to 130 l. In distillers with large volume, it is almost impossible to control the behaviour of the steam and preserve essential properties of the treated oil feedstock (especially in the lower layers). The device SP - 130 performs the separation of oil and water simultaneously by means of the condensation process, without any additional devices. Working with SP - 130 is safe and completely reliable. It is an open system where the hydrostatic pressure of the charge does not exceed 10132.5 Pa. The device SP - 130 is made of the finest stainless steel Type 4578 and Type 4580. A condenser and splitter are made of finest stainless steel as well as fireproof and acid resistant laboratory glass. Devices of this type use all forms of energy (solid, liquid, gaseous fuel and electric energy).

RESULTS AND DISCUSSION

Yield of obtained essential oil

The temperature during the hydrodistillation in device SP-130 ranged from 100 °C – 102 °C at atmospheric pressure, and the whole process of the hydrodistillation lasted 5 hours. The isolated essential oil is a liquid of light yellow colour and the odour characteristic of the genus Thymus. The weight of treated dried plant biomass was 5.5 kg. After drying by means of anhydrous sodium sulphate, 4.1 g of pure essential oil was obtained. Obtained yield of essential oil by applying the system SP-130 was 0.08 %. For comparative purposes, the same plant material used in the first trial with the device SP-130 was crushed and subjected to hydrodistillation in the Clevenger apparatus with the ratio of plant material and water 1:10 (m / v) for 2 hours. The yield of essential oil was 0.1%.

The advantages of using distillation device SP-130 in relation to the Clevenger apparatus are the following:

- In distillation device SP-130 direct contact between water and plant material is avoided, which means that plant material is expose only to the influence of pure molecules of water vapor, which leads to the production of extremely pure essential oils.
- Further advantage of distillation device SP-130 as compared to the Clevenger apparatus is significantly greater working volume of the device.
- SP-130 is perfect for the distillation of root parts of plants (angelica, valerian, celery) and also for the fruits (juniper, etc.) as with Clevenger apparatus is not the case.

Other practical advantages of SP-130 distillation device is that the stills are inexpensive, it is easy to construct and suitable for field operation.

Ecological Aspects

Nowadays, the demand for medicinal and aromatic plants and their derivatives has increased due to natural, eco-friendly and safety features of such products. Therefore, aromatic plants and their extracts have the potential to become new generation substances for human and animal nutrition and health (Efterpi et al., 2012). During the processing of medicinal and aromatic plants by distillation in order to obtain essential oils, waste biomass and hydrolats remain as by-products. Waste biomass and hydrolats have been usually considered as waste products of the distillation process and discarded as such. Waste biomass is rich in carbohydrates, proteins, other nutrients and chemically pure elements which are extremely important for the human body. Moreover, with the development of clean technologies such as composting, the waste biomass resulting from the production and processing of medicinal plants can be reused and recycled. Hydrolats, also known as hydrosols, floral water, distillate water or aromatic water, are the aqueous product of aromatic plant distillation, and carry the hydrophilic properties (water-soluble components) of the plant in solution as well as microscopic droplets of essential oils in suspension (Inouye et al., 2008). Every litre of hydrosol contains between 0.05 and 0.2 millilitres (less than 1%, typically 0.01 - 0.04 %) of dissolved essential oil, depending on the water solubility of the plant components and the distillation parameters. Hydrosols also contain carboxylic acids, which may explain their anti-inflammatory activity (Catty, 2001). Since hydrosols are not as highly concentrated as essential oils, they can be used undiluted in the food and cosmetic industries. They may be used as air deodorisers, for cleansing and for toning the skin. Thyme, peppermint, sage, black pepper and garlic have commonly been used in foods mainly for their flavour, aromas and preservation, herbal tea, alternative medicines and natural therapies. According to Paolini et al. (2008), hydrosols are also used in biological agriculture against mushrooms, mildew, insects, and for soil fertilization. The proposed technology for obtaining essential oils by hydrodistillation using the device SP-130 is environment friendly and favourable due to the following reasons:

- rational use of waste biomass remains after obtaining essential oils by hydrodistillation,
- cultivation of rare and endangered plant species,
- proposed technology is completely environmentally clean, because there is no pollution of air, water and land, and the residues (hydrosol and waste biomass) after distillation does not pollute the environment,
- residue after processing can be transformed into products with antimicrobial properties,
- with additional preparation waste biomass may be used as raw material for the production of compost and dietary supplements,
- residue after processing can be transformed into products for human consumption, livestock or subjected to further processing.

CONCLUSION

The ultimate goal of this work was to show the justification of investments in this field. Briefly, the conclusions of this study suggest:

1. It is necessary, with the knowledge and support of biologists, to take the seeds of Wild Thyme from the wild and cultivate them. Therefore, the destruction of Wild Thyme in the wild will be prevented and the production of biomass will be increased in order to obtain ecologically pure raw materials and products.
2. It provides adequate biological and legal use of existing resources.
3. It shows that great human resources are not necessary for mastering organizational and technological problems in the chain of collecting and growing medicinal and aromatic herbs, and producing final products.
4. It enables the transfer of clean technology which does not pollute the environment.
5. There is no disturbance of the natural balance, and the existing is enriched.
6. There are a series of original distillation devices type SP - 130 l which may represent the primary equipment for processing the collected and cultivated medicinal and aromatic plants by
means of water and water steam in accordance with the strictest international standards for these types of devices.

7. Development of clean technologies such as composting enable the reusing and recycling of by-products or waste resulting from the production and processing of medicinal plants.

8. From the environmental viewpoint, this approach is one of the cleanest. Working with medicinal and aromatic plants and their processing in a described way does not disturb and does not pollute the environment. On the contrary, the residues of the processing can be used as compost, an antiseptic against weeds or pests, a food supplement, in the cosmetic and pharmaceutical industry, and for domestic animals. They can be applied as new generation compounds for human and animal health and nutrition. It is also important to take into consideration that improved animal health can translate to improved food safety and quality, which benefits the consumer, as well as the environment.

REFERENCES


Received: 12.02.2013.. Accepted: 04.04.2013.