Production of Organic Essential Oils from Conifers

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Abstract: The aim of this project is dissemination of innovative technologies and knowledge related to the technologies of processing of medicinal and aromatic herbs with the goal of production of essential oils. Production of essential oils in rural areas of Bosnia and Herzegovina is done in the conditions, which are not, at this moment, at the level of sophisticated techniques and technologies. Essential oils are produced partly from widely grown medicinal and aromatic herbs and mostly from plantation-grown herbs. The aspects of processing of medicinal and aromatic herbs into distillates and all the measures, which follow the processing, should go through the transfer of technologies, so we could meet quality requirements as well as the European standards. Therefore, the intention is to certify the products as organic and according to HACCP system. Concerning the distillation of medicinal and aromatic herbs grown in natural population, we want to become a part of sustainable and rational exploitation in the way that we will identify economically important, rare, endangered and protected plants and to take care about the total biodiversity.

Introduction

Bosnia and Herzegovina has a significant amount of resources in the form of evergreen forest trees, especially fir, spruce, and pine trees, for the organic production of essential oil. In comparison with other medicinal plant

species, the production of essential oil from fir, spruce, and pine trees is significantly simpler and more profitable. Especially favorable conditions are the availability of raw materials throughout the whole year and the simplicity of the procedure of essential oil production. The number of processing facilities that have adjusted their production concept to the process of separation of essential oils from the aforementioned forest woods and that are particularly certified on organic principles is small.

Production of essential oils from conifers is labor-intensive, export-oriented, and highly profitable. The interest in a greater number of producers of essential oil, particularly conifer oil, is constantly growing. Steam distillation is mostly used for production of essential oil. Water distillation has not yielded good results in broader production practice, because, using this procedure, it is not possible to ensure a vapor pressure necessary for efficient separation of essential oil.

Conifer essential oil is used in medicine and pharmaceutical industry. Those are aromatic, readily evaporable substances, compounds of terpenic hydrocarbons and their derivatives. They are transparent and usually colourless. When exposed to air, they get dark and evaporate quickly. They are dissolved in organic solvents, fats, and oils.

Essential oils do not have a specific and constant structure. Their structure often depends on different agro-ecological conditions. Sometimes the structure of conifer essential oil differs in content depending on the stage of the raw materials used for distillation. Essential oils of different organs of the same plant have different compositions, sometimes of the same organ in different stages of development, and sometimes the differences are significant depending on the procedure used for distillation. In principle, forest plant species that grow in conditions with more sun have a greater content of essential oil in relation to temperate areas.

Extraction of essential oils from medicinal plant species and conifers is done by means of “extractors”. This concept implies all devices in which isolation, i.e. extraction, of contained active substances from drugs is done regardless of the specific features and physicochemical characteristics of the extraction itself. For more precise definition of the procedure, the terms used are: extraction with organic solvents, water extraction, liquid gas extraction, water vapour extraction (often called hydro distillation), oil extraction, etc.

In a part of the scientific community, there is a division into extraction and hydro distillation. It is common to call every isolation of active substances from drugs “extraction”, and differentiate them only based on the kind of extractant and not by the state of matter of the extractant and manner of separation of the extract.

The term “extractors” encompasses all devices in which diffusion of active substances from drugs into extractant is directly performed. The basic classification of extractors by the manner of operation is into continuous and discontinuous. It is not necessary to particularly explain that the continuous devices have a much greater capacity than the discontinuous and that is why they are applied only in the cases when the processing of greater quantities of one or at most a few drugs is planned.

Material and Methodology

The raw material for the production of essential oil is needles of fir, spruce, and pine trees, with the presence of twigs of a diameter of one centimetre. Those are mostly one-year growths of green and wood mass. For our analysis, the raw material in two production areas, primarily the area of Olovo and the area of Mostar, was distilled. The distillation was done in the production plant Vogosca on a test distiller. Before the distillation, the conifer needles with wood mass were cut to the length of one centimetre.

The cutting was done on an electric cutter intended for the cutting of conifer materials. Extraction of essential oil was done in two parallel procedures, by hydro distillation and steam distillation. The source of energy for hydro distillation was the gas on the test distiller with the construction for determination of precise analyses and steam distillation with the usual distillation procedure.

The chemical composition of essential oil was examined on the gas chromatograph of the Federation Institute of Agriculture in Sarajevo. The chromatographic method allows for quick and accurate extraction of numerous compounds that compose essential oil. Certain constituents of essential oil appear in the form of peaks. Each peak corresponds to a certain component from which the quantitative value of the component of essential oil is determined.

In the production of essential oil, both hydro and steam distillation was performed on two distillers of different construction and operation. With hydro distillation, water vapor required for the distillation developed in the same part of the distiller in which the plant mass was located. A characteristic of this principle of distillation is the inability of creation of higher pressure. With steam distillation, the vapor under greater pressure comes from the boiler and has the ability of a greater effect in relation to hydro distillation.

Results

The constants that were determined in the determination of essential oil are primarily the acid and ester content. The acid content is the KOH quantity expressed in milligrams, which is required to neutralize the acid located in one gram of essential oil. The ester content EN is the KOH quantity expressed in milligrams, which is required to saponify the ester located in one gram of essential oil. Ester content is calculated on bornyl acetate and is expressed in percents. The most important components used in evaluation of essential oils are the specific gravity, optical activity and refractive index. On the bases of these values, evaluation of quality of the essential oil is made.

According to *Gildemeister*, the average values of essential oil in the region of Tyrol (P. Miletic and associates) are within the ranges stated in Table no. 1, and the results of our research are in the same range.

Constants	Fir		Pine		Spruce	
	Olovo	Mostar	Olovo	Mostar	Olovo	Mostar
Specific gravity	0.78	0.81	0.84	0.86	0.88	0.88
Optical activity	- 33.8	- 40.2	6.2	7.8	-28.5	-31.5
Refractive index	1.46	1.48	1.50	1.55	1.46	1.46
Acid content	2.2	2.2	2.6	2.8	0.5	0.7
Esters (bornyl acetate)	5.5 -9%	6.2 – 10.5%	1.3 – 1.9%	1.5 – 1.8%	6.5 – 8.5%	7.2 – 9.5%

Table. 1 Constant of essential oils at the locality of Mostar and Olovo obtained by steam distillation

It is important to note that conifer essential oil contains other extracts as well, but bronyl acetate is predominant, and that is why it is the basis for calculation (S. Kapetanovic, 1988). The main component used in evaluation of essential oil are specific gravity, optical activity and refractive index. Specific gravity is determined by means of pycnometer and analytical scales; optical activity by means of polarimeter, and refractive index by means of refractometer. On the basis of such analysis, conclusion can be made about the value of individual essential oils.

Constants	Fir		Pine		Spruce	
	Olovo	Mostar	Olovo	Mostar	Olovo	Mostar
Specific gravity	0.43	0.49	0.42	0.53	0.58	0.58
Optical activity	- 32.0	- 38.2	5.2	4.8	-17.0	-21.8
Refractive index	1.32	1.34	1.40	1.46	1.50	1.39
Acid content	2.0	2.0	2.2	2.5	0.4	0.6
Esters (bornyl acetate)	5.2 -8%	5.2 – 9%	1.1 – 1.6%	1.5 – 1.6%	5.5 – 8.0%	7.0 – 9.2%

Table . 2 Constant of essential oils at the locality of Mostar and Olovo obtained by hudro distillation

In relation to steam distillation, the values obtained by hydro distillation are significantly lower, and primarily: the specific gravity, optical activity and refractive index. Therefore, the very principle and procedure of distillation on different types of distillers affects not only the quantity of essential oil but its quality as well.

Raw material	Olovo	Mostar	Average
Fir	0.24	0.29	***0.27***
White pine	0.27	0.32	***0.29***
Spruce	0.16	0.17	***0.16***

Table. 3 Yield of conifer essential oil (% of essential oil fir, pine and spruce) obtained by steam distillation

Essential oil yields in different localities differ significantly, although they range within the limits of average values of 0.1 – 0.5 *(Miletic and associates*). In different periods of vegetation, the differences in the content of essential oil are significant. In all species of evergreen trees, the percentage is significantly greater during vegetation (spring and summer) in relation to fall and winter.

Raw material	Olovo	Mostar	Prosjek
Fir	0.14	0.22	***0.18***
White pine	0.22	0.24	***0.23***
Spruce	0.11	0.13	***0.12***

Table. 4 *Yield of conifer essential oil (%* of essential oil *fir, pine and spruce) obtained by hydro distillation*

Essential oil yields obtained from the same mass on a distiller for hydro distillation are significantly lower in relation to the results for all the coniferous trees obtained by steam distillation.

Conclusion

Coniferous tress (fir, pine and spruce) are a good raw material for production of high-quality essential oil certified as organic raw material. The distillation of conifers is optimal by using the system of introduction of steam into the distillation apparatus with the lowest pressure of 0.5 bars. Prior to that, it is necessary to cut the raw material with the wood mass to the thickness of up to 1 cm.

By their chemical structure, essential oils are a compound composed of a greater number of different compounds, primarily of terpenic character. The main components of essential oil are hydrocarbons, different alcohols and esters.

The yield (%) of essential oil of all analyzed coniferous trees is greater in the Mediterranean region in relation to the continental region, i.e. the oil content is greater at the locality of Mostar in comparison with the locality of Olovo.

The yield and quality of essential oil is greater when it is obtained by steam distillation in relation to hydro distillation.

From the economic point of view, the production of essential oil from coniferous trees is justified and significantly more profitable in relation to the majority of medicinal plan species.

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