LAVENDER (*LAVANDULA ANGUSTIFOLIA* MILL.) - MEDICINAL-ALTERNATIVE SPECIES IN THE STRUCTURE OF CROPS IN AGRICULTURAL FARMS, IN THE CONTEXT OF CLIMATE CHANGE

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ABSTRACT

From the medicinal species Lavender, the inflorescences (Flores Spicae Lavandulae), with a pleasant, characteristic smell, with notes of freshness, are used for therapeutic purposes. The active principle of lavender flowers is the volatile oil, the content of which differs depending on the species, variety, variety, time of harvest or the form of conditioning. Fresh flowers contain up to 0.8% volatile oil, and dried ones up to 1.5 %.

Lavender flowers have a high content of linalool (a terpene alcohol, which helps to synthesize vitamin E and a non-toxic insecticide), they also contain tannin, bitter principles, resins, pectins and other alcohols (nerol, lavandulol).

The volatile oil whose main component is free linalool (40-60 %) or in the form of linalyl acetate (40-50 %) has medicinal uses.In the volatile oils of Lavandula angustifolia L., 22 compounds were identified, of which 14 major compounds (in concentration above 0.2 %) represented 99.53 % of the total.

***Key words**: medicinal plant, aromatic, volatile oil, linalool, inflorescences*

INTRODUCTION

Cultivation of medicinal and aromatic plants has become important in the context of their multiple exploitation, as well as in the protection of the spontaneous flora (Simion, 2012). On a global level, but especially in Europe, a new, quite strong requirement has emerged, which has turned into a real movement, for the production of agri-food products, through clean, non-polluting technologies, without synthetic chemical substances, agricultural products, which ensures the health of consumers, under the conditions of environmental protection and conservation of natural resources. Lavender is the main ingredient for obtaining perfumes and delicate perfume essences and is successfully used in aromatherapy, cosmetics and natural medicine.

Lavender is most often associated with its distinctive fragrance and vivid color. Indeed, fields with lavender have become popular lately, and this plant is increasingly used, both for its decorative role, but also for its properties. Around 30 species of lavender are known, the most cultivated being *Lavandula angustifolia.* Lavender species are cultivated according to their end use, thus, not the same species are

cultivated for therapeutic uses and for the cosmetic or detergent industry.

The therapeutic properties of the essential oil extracted from the flowers were rediscovered at the beginning of the 20th century, when René-Maurice Gattefosse, a chemist perfumer, burned his hands in an explosion in his laboratory, prevented gangrene by immersing them in a container, which contained lavender essential oil. The characteristic aroma of lavender, which makes it so sought after in the perfumery and cosmetic industry, is given by the volatile oils extracted from the inflorescences.The oil is also used in Indian Ayurveda medicine to alleviate depression, as well as by Tibetan Buddhist doctors to treat certain mental disorders. In French hospitals, essential oils, including lavender, are used to clean and purify the air, helping to fight against microbial and fungal infections.Due to its powerful antioxidant, antimicrobial, sedative, calming and antidepressant properties, lavender oils have been used both cosmetically and therapeutically for centuries. Science has only recently begun to evaluate the range of benefits that lavender essential oil contains, and there is already a wealth of evidence that highlights the amazing capabilities of this oil. Its ability to calm the mind and body continues to be lavender's most notable quality. Lavender essential oil has stood the test of time, inspiring interest in so many eras, cultures and generations, being a testament to the varied and effective capabilities it brings. It takes 100 kg of flowers to produce approximately 600 ml of essential oil.Lavender is used both as a decoration plant in gastronomy and as a main ingredient in sherbets or ice cream. After the distillation of the fresh inflorescences, the volatile oil (0.7-1.4%) is obtained, with wide uses in the industry of perfumes, cosmetics,soaps,detergents and porcelain, being a good solvent and fixative of paints for making manual paintings.

Due to its aromatic, antimicrobial and antifungal properties, the volatile oil is used to perfume clothes and linens and as an insecticide to combat moths. Due to its antibacterial properties, lavender oil can be mixed with natural agents, in order to obtain effective cleaning products for household use. Repellent to insects, therefore the plant is used in organic farming. For a sustainable agriculture, numerous researchers recommend use the allelopathic plants that release allochimicsas an alternative to the use of pesticides. Various aromatic plants of the Lamiaceae family have been studied for their allelopathic effect (Bonea, 2018). According to Bonea (2018), Bonea and Urechean (2018) and Bonea (2020), the cogermination with sweet marjoram seeds may be an alternative to biostimulation of maize initial growth, and aqueous extracts of sweet marjoram (*Origanum majora* L.), basil (*Ocimum basilicum* L.) and sage (*Salvia officinalis* L.) in low concentrations, could be used as growth bioregulators for maize.Cultivated on steep, sunny, calcareous slopes, the plant is used for anti-erosion purposes. It is a good melliferous, valuable nectar-polyferous species, obtaining 50-100 kg/ha of honey, with a specific aroma, with a very pleasant taste, dark yellow in color and with greenish reflections.It can be cultivated for ornamental purposes, in parks, gardens, rockeries, solitary or in various floristic compositions.

MATERIAL AND METHOD

Cultivation technology

The lavender plantation was established in November 2014, on an area of 1 ha.

The cuttings were planted on the type of soil - glazed cambic chernoziom, in the commune of Ştefan cel Mare, Olt county. About 20,000 rooted cuttings were used, belonging to the varieties: Sevastopol, from Bulgaria and Grosso, from England.

The cuttings were purchased from Bulgaria, near the city of Kazanlak.

The catch rate was very good, about 95-96%. Planting was done manually, at a distance of 1 m between rows and 50 cm between plants per row. Fighting weeds: in the spring of 2015, 2 manual and mechanical weedings were carried out with the help of a chainsaw. In the first year, 3-4 weedings were needed, so that the land would not get weeded and the cuttings could develop as well as possible.

The plants bloomed even in the first year of planting, but the quantity was small. Starting from year 2, the number of sedges was reduced to 2. The herbicide Pantera (2 l/ha) was also used to combat the sorghum (*Sorghum halepense*).A production beyond expectations was obtained. Flowering takes place at the end of May - beginning of June (photo 1).

Photo 1. Lavender plants in bloom

If the summer is rainy, there is also a second flowering in August - September. In the area, however, it usually doesn't rain much in the summer and there is no question of a second harvest. Only a few inflorescences appear on the bush.

The amount of inflorescences of lavender plants was analyzed according to the year of vegetation, the average weight of an inflorescence and the average weight of a bush,the total production of inflorescences, the extraction of the volatile oil was carried out, and its chemical composition was determined. A 50 m^2 solarium was set up where the flowers were dried. An excellent quality of dried flowers was thus obtained. Since from the 3rd year of planting, the production increases considerably, the picking was staggered, every 2-3 days, in order to have time for the flowers to dry in the solarium (photo 2; 3).

Photo 2. Dried lavender plants

Photo 3. Solar for drying

In the 3rd year, 455 kg of dried flowers were obtained. In the 4th year, 700 kg of dried flowers were obtained per hectare. In year 5, although it was hoped that production would increase by 50% compared to year 4, this did not happen, due to the spring weather conditions.

It was a rather cold spring, with considerably low temperatures during the night, which affected the development of the inflorescences. Thus, the floral stem was small, the bushes also had a smaller number of inflorescences. And so, although a higher production was expected, only 500 kg of dry plant was obtained. From here it was deduced that the spring temperature has a very important role for the development of the inflorescences. Although there were precipitations, which were considered the most important, reality showed that the temperature could not be lower either.

To develop, lavender needs exposure to the sun for at least 6-8 hours a day and prefers a warm and moderately dry climate, not very cold winters and hot summers. The plant comes from the Mediterranean countries, where the average temperatures vary between 20 and 30 degrees Celsius, in the spring and summer months. Thus, if the soil temperature is around 18 degrees Celsius, the plant will be stimulated to regenerate and grow after harvesting. Although it prefers high temperatures, lavender also tolerates low temperatures.

Being a perennial species, in the following years, a temperature of 10-14°C is necessary for it to start growing. Young plants withstand temperatures of -8 ... -10°C, and mature ones up to -15°C in winters without snow and up to -30°C, under a protective layer of snow, but they are sensitive to reported frosts suddenly at the end of autumn. In order to obtain a constant production of inflorescences and volatile oil, a high temperature is necessary throughout the vegetation period so that: the sum of the temperature degrees in a year is 3,600°C, and in the interval: start of vegetation-flowering is 1,200- 1,250°C.

The picking was done manually, with a sickle (photo 4) but also with a device adapted for picking lavender (photo 5).

Photo 4.Hand picking lavender

Photo 5. Device adapted for harvesting

In autumn, with the drop in temperatures, the trimming of the plants (about a third of their height) begins. This operation is very important for the development of the lavender bushes, as best as possible. Lavender loves heat and scissors.

If they are not "trimmed", the bushes grow a lot in height and when the snow falls,

they can break under its weight. If the summer and autumn are dry, the bushes develop less, and in the autumn they no longer need to be cut. He faced this phenomenon in 2019 and the bushes were no longer cut in the fall. The production obtained: 2016- production 260 kg\ha; 2017 – 455 kg/ha; 2018 – 700 kg/ha; 2019- 500 kg\ha (unfavorable climate, production decreasing compared to the previous year); 2020- 925 kg/ha.

RESULTS AND DISCUSSIONS

QUANTITATIVE AND QUALITATIVE DETERMINATION OF VOLATILE OIL IN SEVASTOPOLI AND GROSSO LAVENDER VARIETIES

Aromatic and medicinal plants are a large and diverse group of botanical species, each with its own biological characteristics and a differentiated adaptation to climatic and soil conditions.

They could be scientifically defined as plant species that, as a result of their metabolic activity, produce substances of immediate therapeutic interest (active ingredients) or pharmaceuticals (precursors for hemisynthesis or substances and mixtures thereof, used in the conditioning of medicines for administration). The active principle of lavender flowers is the volatile oil, the content of which differs depending on the species, variety, variety, time of harvest or the form of conditioning. Fresh flowers contain up to 0.8% volatile oil, and dried ones up to 1.5%.

From a quantitative point of view, the main components, which also imprint the basic smell of the *Lavandulae aetheroleum* product, are linalool (20-35%) and linalyl acetate (30-55%), but the aroma is also determined by the contribution of cineole, camphor or geraniol.Lavandulol, lavandulyl acetate, cis- and trans-ocimene are the characteristic compounds of lavender oil, and perilla - alcohol is important due to its pharmacological action. Other compounds identified in the vegetable product are: flavonoids (especially in the form of flavon-7-glucosides, which accumulate predominantly in the leaves), coumarins (dihydrocoumarin,herniarin, umbelliferone), phytosterols and, last but not least, tannins (5-10%), among which rosmarinic acid stands out as a pharmacologically important ingredient, which is actually a depside formed by the esterification of α-hydroxy-dihydro-caffeic acid with caffeic acid; the product also contains oleanolic acid and ursolic acid.

Regarding the chemical composition of lavender volatile oils used in aromatherapy, it differs from one species to another. If for *Lavandulae angustifoliae aetheroleum*, aromatherapy requires a content of 40-50% esters (predominantly lilayl acetate), 30-40% monoterpenols (mainly linalool), 7-13% monoterpene hydrocarbons (mainly ocimene), 8% sesquiterpenes and 1.5% oxides, in the case of the volatile oil separated from *Lavandula Latifolia,* the monoterpenol content must be between 35 and 40% (mainly linalool), 25 and 35% oxides (especially 1,8-cineole), 10 and 20% monoterpencetones (with quantitatively important borneone), 5 and 8% monoterpene hydrocarbons and up to 2% sesquiterpenes and esters.

Lavender oil (*Lavandala burnati* Briquet) contains between 35 and 45% esters, 30-40% monoterpenols, 5-10% monoterpene hydrocarbons and 4.5-5.5% monoterpene ketones, among which the same borneone predominates.

The chemical composition of the standard *Lavandula stoechas* volatile oil provides: 70-80% monoterpene ketones (mainly fenchone),10%monoterpene hydrocarbons

(mainly camphene), up to 5% oxides (mainly 1,8-cineole) and up to 3% monoterpenols and esters.
(https://plantemedicinale.site/plante-medicinale/lavanda-lavandula-sp/.)

Lavandulae flos is used - dried flowers detached from the peduncles of the inflorescences, blue-violet in color. The flowers have ovate, brown, membranous bracts, the calyx is cylindrical, hairy and glandular, with unicellular or 8-12 cellular glandular hairs, they are 4-6 mm long and 3-4 mm in diameter; grayish violet color with 10-15 parallel ribs, with 5 small teeth, two of which are more developed.

Corolla bilabiate, 5-8 mm long, blue-violet, pubescent and glandular, with almost straight tube. The upper lip is bilobed, the lower is trilobed with obtuse lobes.

The shade of the flowers varies from violet-blue to light blue. The smell is pleasant, aromatic, and the taste slightly bitter(http://larix.freetzi.com/PLANTE/lavanda.htm).

LAVENDER SAMPLES ANALYSIS REPORT ANGUSIFOLIA LAVANDA – CRAIOVA

In the "Stejarul" Biological Research Center Piatra Neamţ, analyzes were carried out by hydrodistillation of dry plant material

The plant material was made up of lavender flowers harvested in June 2019. The isolation and quantitative determination of the volatile fraction was carried out by hydrodistillation, for 3 hours, of the dry plant material, in the Neo-Clevenger apparatus. The volatile oil content of the vegetable product was expressed according to Ph Eur provisions. 6th ed., namely: mL of volatile oil per kg of vegetable product.

The identification of the substances from the gas-chromatographic analyzed samples was made based on the comparison between the mass spectrum and the spectra from the Wiley library.

Extracts made at CCB "Stejarul", by Neo Clevenger hydrodistillation of 100 g of naturally dried plant material:

- LAV-1: 7.28 ml /100 g = 72.8 ml / kg dry flower, Sevastopoli variety, origin Bulgaria;
- LAV-2: 8.57 ml /100 g = 85.7 ml / kg dried flower, Grosso variety, origin England.

The chemical composition of the volatile oil was determined by gas chromatographic analysis coupled with mass spectrometry (GC-MS) using an Agilent Technologies type 6890N gas chromatograph coupled with a 5975 inert XL Mass Selective Detector (MSD).

The chromatography conditions were:

- Column HP 5MS dim. ext. 30 m x 0.25 mm – dim.int. 0.25 µm (5% Phenylmethylsiloxane);
- Mobile phase: Helium - flow rate: 1 mL/min;
- Injector temperature: 250°C;
- Detector temperature: 250°C;
- Temperature regime: from initial 40°C (6 degrees/min.) to 280 degrees (constant 5 minutes);
- Injected volume: 0.1-0.3 µl volatile oil;
- Splicing rate 1:100.

By measuring the volume of volatile oil resulting from hydrodistillation, the following was established:

• The linalool content was 39.47% in the Sevastopoli variety, from Bulgaria and 40.02% in the Grosso variety, from England.

• The Sevastopoli variety, from Bulgaria, recorded a linalyl acetate content of 13.89%, and the Grosso variety, from England, of 15.44%.

• Lavender acetate had values between 3.39% for the Sevastopoli variety, from Bulgaria and 5.26% for the Grosso variety, from England.

• The European Pharmacopoeia 6.0 provides for the product Lavandulae aetheroleum (monograph 01/2008:1338) the composition in linalool between 20 and 45% and linalyl acetate between 25 and 46%, and lavandulyl acetate greater than 0.2% (table 1, fig. 1, 2).

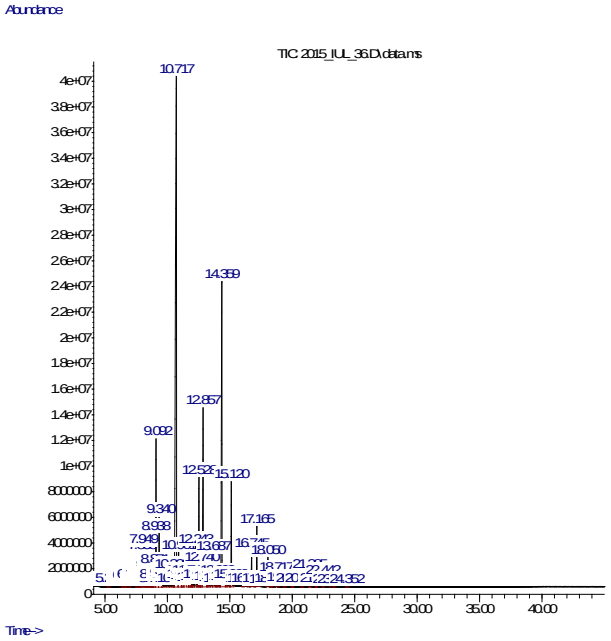

Figure 1. GC-MS chromatogram for lavender volatile oil (Lav-1)

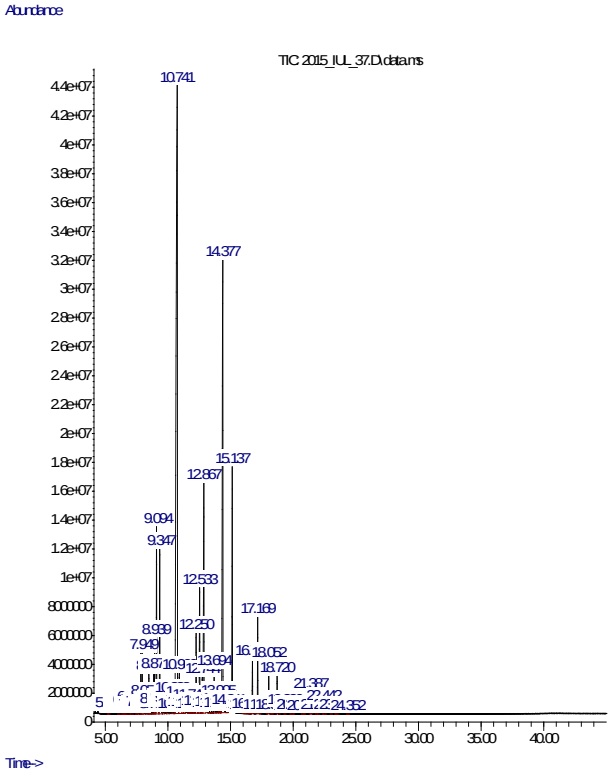

Figure 2. GC-MS chromatogram for lavender volatile oil (Lav-2)

Both varieties are characterized by the fact that they have a very good linalool and lavandulyl acetate content, which falls within the limits provided by the European Pharmacopoeia, but the linalyl acetate content is unsatisfactory, below the values presented.The low content in monoterpene esters could be explained by the fact that the average daily temperature during the flowering period is lower in the town of Ştefan cel Mare, compared to the one in the Mediterranean area.

TR (min)	Compounds	Area %	
		LAV 1	LAV 2
6.63	α-pinene	0.14	0.13
6.97	camphene	0.16	0.18
7.84	3-octanone	0.99	1.25
7.96	β-myrcene	1.19	1.20
8.77	o-cymene	0.18	0.15
8.87	limonene	0.61	0.94
8.94	1,8-cineole	1.70	1.60
9.10	trans-β-ocimene	4.68	3.84
9.35	cis-β-ocimene	2.47	3.54
10.72	**linalool**	**39.47**	**40.02**
10.91	1-octenol acetate	2.28	1.22
11.75	camphor	0.47	0.33
12.25	borneol	1.61	1.91
12.53	4-terpineol	3.55	2.79
12.74	crypton	0.92	0.87
12.86	**α-terpineol**	7.31	6.59
13.70	cis-geraniol	1.29	1.05
14.38	**lynalil acetate**	**13.89**	**15.44**
15.14	**lavandulyl acetate**	**3.39**	**5.26**
18.06	caryophyllene	1.01	1.20
18.72	β-farnesene	0.39	0.82
21.39	caryophyllene oxide	0.59	0.51
	Other compounds (area < 0.5%)	11.72	9.17

Table 1.GC-MS analysis of lavender volatile oils

The lavender oil used in aromatherapy is obtained from plants grown at 800-1200 m above sea level. In these conditions, when starting from 01.05.2011, the European Community imposes compliance with the

conditions of admissibility of plant products for pharmaceutical use, depending on their alignment with European standards, before bringing them to the pharmaceutical market, the producers of volatile oils would have to control them from a chemical point of view, even if they know for sure that they have respected the prescriptions regarding the botanical origin and the plant organ (mentioned in the definition) during the processing.
(file:///C:/Users/hp/Downloads/1431-Other-2873-1-10-20181001.pdf).

CONCLUSIONS

The cultivation of lavender for the production of essential oils can be an interesting alternative for agriculture in Romania.

The active principle of lavender flowers is the volatile oil, the content of which differs depending on the species, variety, variety, harvesting time or conditioning form.

Lavender is a rich source of valuable volatile compounds, carotenoids, chlorophylls, polyphenols, flavonoids, volatile compounds with significant biological activities, with different applicability.

The main product is the volatile oil obtained by distilling fresh or dried inflorescences and has wide uses in the perfume industry, cosmetics, pharmacy, aromatherapy, etc.

The main component of the volatile oil in lavender flowers is linalool, free or esterified (mostly as acetate).

The dried inflorescences can be used in sedative, antiseptic, diuretic teas for the nervous system. As a result, they are used to treat migraines, headaches, heart conditions with a nervous substrate, and digestive disorders.

The fresh and clean aroma was the favorite additive to perfume the bath waters of the Greeks and Romans, thus being known many centuries ago.

In the volatile oils of *Lavandula angustifolia* L., 22 compounds were identified, of which 14 major compounds (in concentration over 0.2%) represented 99.53% of the total.

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