THE ACTION OF SOME ESSENTIAL OILS ON THE GROWTH OF *HORDEUM VULGARE* L. VAR. GERLACH

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RESEARCH ARTICLE

Abstract
The research followed the mode of action of allelopathic substances from essential oils (bay laurel, clove, pine, rosemary, eucalyptus) on the germination of caryopses and plants growth of Hordeum vulgare L. var. Gerlach. The microemulsions from essential oils with the following concentrations 0.2%, 0.1%, 0.02%, 0.01%, 0.002% and 0.001% were used. The barley caryopses did not germinate under the action of the microemulsions with concentration 0,2% and 0,1% from clove essential oil. Also a small decrease in the germination capacity was found at the concentration 0,2% of bay laurel, rosemary and eucalyptus essential oils. The essential oils used in the experiments showed the following descending order of phytotoxicity: clove, bay, rosemary, eucalyptus and pine.

Keywords: bay laurel, clove, pine, rosemary, eucalyptus essential oil, *Hordeum vulgare* L. var. Gerlach, allelopathy
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INTRODUCTION

Essential oils due to their chemical composition have allelopathic properties with inhibitory or stimulatory effects on the germination and growth of various species (Creț et al., 2020; Mirmostafaee et al., 2020; Todoran et al., 2022; Zheljazkov et al., 2021). For this reason the analysis of the effects of these natural compounds is constantly increasing (Bellache şi colab., 2022; Muhammad et al., 2019; Sarić-Krsmanović et al., 2019; Semerdjievaab şi colab., 2022). Many studies investigated the rosemary (Atak et al., 2014; Chen et al., 2013; Frabboni et al., 2019; Maccioni et al., 2020; Mahdi et al., 2020), clove (Ahuja et al., 2015), pine (Amri et al., 2021; Ibánez et al., 2019) eucalyptus (Aragao et al., 2015; Amri et al., 2023; Benchaa et al. 2018; Vishwakarma and Mittal, 2014) or bay laurel (Bahram, 2016) for essential oil allelopathic potential. The natural products with allelopathic effects can be used for weeds control.

In this work the resistance of barley to treatments with essential oil emulsions was tested and their order of phytotoxicity was determined.

MATERIAL AND METHOD

In the experiments was used the caryopses of barley Gerlach variety with germination capacity above 98%.

The essential oils produced by Mayam-Elemental Laboratories had the following chemical composition:

Laurus nobilis (bay laurel oil from leaves): Eucalyptol 52%, Linaloon 15%, alpha-Pinene 10%, beta-Pinene 10%, Methyleugenol, alpha-Terpinelol, d-Limonene , Eugenol, Terpinene-4-ol , Myrcene , p-Cymene, p-Mentha-1,4-diene.

Eugenia caryophyllus (clove oil from leaves): eugenol 100%.

Pinus sylvestris (pine oil from leaves): alpha-Pinene 45%, beta-Pinene 35%, d-Limonene 20%, delta-3-Carene, Myrcene, Terpinolene, Camphene, Eucalyptol, beta-Phellandrene, cis-beta-Ocimene, beta-Caryophyllene, 3,7-Dimethyl-1,3,6-octatriene.

Rosmarinus officinalis (rosemary oil from leaves and branches): Eucalyptol 55%, Camphor 20%, alpha-Pinene, beta-Pinene 15%, Camphene, beta-Caryophyllene, d-Limonene, Borneol, Myrcene , alpha-Terpineol, Terpinene-4-ol, p-Cymene, p-Mentha-1,4-diene.

Eucalyptus globulus (eucalyptus oil from leaves): Eucalyptol 80%, alpha-Pinene 15%, d-Limonene, p-Cymene, alpha-Terpineol, Linalool, beta-Caryophyllene, p-Mentha-1,4-diene.

These were dispersed in water by ultrasound with the Emmi-04D device with frequency 40 KHz. A quantity of 100 ml of distilled water and an amount of 0,2 ml of essential oil were introduced in an Erlenmayer glass with a glass stopper. After this operation a microemulsion with a concentration of 0,2% (V_1) was obtained. With graduated cylinders and distilled water, dilutions of 0,1%, 0,02%, 0,01%, 0,002% and 0,001% were made. These represented the experimental variants (V_2, V_3, V_4, V_5 and V_6).

Figure 1. **The seedlings resulting from caryopses after 9 days of germination (original image).**

For germination transparent and colourless plastic casseroles were used. The filter papers with 35 ml of distilled water or with same amount from different dilutions of oils were moistened. For all experimental variants and control lots 50 caryopses in each casserole were placed. The germinators were kept at room temperature (T = 21-23°C) and semi-darkness. After 9 day the germination ability and seedling growth (arithmetic media for the length of three roots, coleoptile and first leaf) of the Hordeum vulgare L. Gerlach variety plantlets were determined. Statistical analysis included: arithmetic media (M) and Student's test (SigmaPlot 2001 software). Arithmetic media of the control lots were considered 100%. Percentage differences relative to the control lots of the plantlets grown on various dilutions (V1-V6) of essential oils had their statistical significance (a-significant P<0,001; b-significant P<0,05; c-insignificant).

RESULTS AND DISCUSSIONS

Barley caryopses (Hordeum vulgare L. Gerlach variety) did not germinate in the case of the experimental variants of concentration 0,2% (V1) and 0,1% (V2) of the essential oil of cloves. A small decrease in germination was found at the concentration of 0,2% (V1) of bay laurel, rosemary and eucalyptus essential oils. At the other concentrations of the essential oils used in the experiment, there were no changes in germination compared to the control lots.

Table 1.

The germinative faculty of the caryopses of Hordeum vulgare L. var. Gerlach in control lots and in the lots with various concentrations (V1-V6) of essential oils (bay laurel, clove, pine, rosemary, eucalyptus)

Essential oil	Control	V1 0.2%	V2 0.1%	V3 0.02%	V4 0.01%	V5 0.002%	V6 0.001%
bay laurel	94%	87%	90%	97%	99%	94%	97%
clove	96%	-	-	98%	96%	100%	100%
pine	98%	92%	100%	100%	100%	100%	94%
rosemary	96%	84%	98%	96%	94%	100%	96%
eucalyptus	98%	86%	98%	94%	96%	98%	96%

The growth of barley plantlets on various microemulsions (V1-V6) of bay laurel essential oil (Laurus nobilis) was studied. The radicles length in experimental variants V1-V5

registered significant decreasing inhibitions (-66,8%, -63,5%, -22,1%, -16,8%, and -10,5%). Only V6 showed an insignificant stimulation compared to the control. The following experimental variants regarding barley coleoptiles growth on different concentrations of bay essential oil significant inhibition showed (V1 of -62.4% and V2 of -62,1%). At V3-V5 experimental variants insignificant influences observed (see Table 2).

The V6 experimental variant showed an insignificant stimulation compared to the control (+23.6%). In the experimental variants V1 and V2 the leaves did not appear. In the other variants V3, V4 and V5 the growth was almost as in the control lots. The growth of leaves obtained after germination at the V6 dilution registered a significant stimulation (+12.3%).

Barley plantlets did not grow under the action of clove essential oil (Eugenia caryophyllus) concentration 0.2% and 0,1% (V1 and V2). The growth in length of roots at V3 was significantly inhibited (-29,9%). In the other variants (V4, V5 and V6) stimulations were recorded (see Table 2). Looking at the growth in the length of the coleoptile at V3 a significant inhibition (-24.1%) was found; otherwise (V4-V6) insignificant pluses and minuses. The growth in the length of the first leaf was significantly inhibited (-11.2%) at V3. At V4-V6 experimental variants insignificant influences observed.

The effect of microemulsion from pine essential oil (Pinus sylvestris) concentration 0.2% (V1) on the growth of barley roots was -32.4% ($p<0.001$). At the following concentrations the influences were insignificant. In the growth of the coleoptiles insignificant pluses and minuses were recorded. The growth in the length of the leaves registered the signifiant stimulations (Table 2).

Under the action of rosemary (Rosmarinus officinalis) essential oil microemulsion of concentration 0.2% (V1) the growth of roots was completely inhibited. Significant inhibitions were also present at V2 of -64.8% and V3 of -12.5%. The experimental variants V4-V6 were characterized by insignificant stimulations regarding the growth in the length of the roots. Coleoptile growth was significantly inhibited by -48.9% (V1) and -20.6% (V2). Starting with V3 the pluses and minuses were insignificant. In the case of V1 the leaves did not appear until the 9th day of germination. At V2 (0.1%) the growth of the first leaf is significantly inhibited (-19%). Starting with V3 we have pluses, significant ones (Table 2).

The growth in the length of the roots of barley seedlings on the microemulsions of essential oil of eucalyptus (Eucalyptus globulus) recorded a significant inhibition of -22.7% (V1) and -11.7% (V2).

All concentrations used in the experiments insignificantly influenced coleoptile growth. In the experimental variant V1 the leaves did not appear. In the case of experimental variants V2-V6 the growth of the first leaf was inhibited (Table 2).

Table 2.

The procentual differences (control lots represent 100%) of the roots length, coleoptiles height and leaves height of the barley plantlets witch was grow on microemulsions of essential oils (V1-V6) (bay laurel, clove, pine, rosemary, eucalyptus) (significance level is noted with a-significant P<0,001; b-significant P

Essential oil	Vegetative organs	V_1 0,2%	V_2 0,1%	V_3 0,02%	V_4 0,01%	V_5 0,002%	V_6 0,001%
bay laurel	Roots	-66,8% **a**	-63,5% **a**	-22,1% **a**	-16,8% **a**	-10,5% **b**	+3,6% **c**
	Coleoptile	-62,4% **a**	-62,1% **a**	+0,5% **c**	+5,3% **c**	-3,9% **c**	+23,6% **b**
	Leaf	-	-	-0,9% **c**	+8,8% **c**	+1% **c**	+12,3% **b**
clove	Roots	-	-	-29,9% **a**	+2,7% **c**	+13,1% **b**	+21,6% **a**
	Coleoptile	-	-	-24,1% **a**	-4,9% **c**	-2% **c**	+0,3% **c**
	Leaf	-	-	-11,2% **b**	-6,9% **c**	+1,9% **c**	+0,6% **c**
pine	Roots	-32,4% **a**	-6,9% **c**	+9,2% **c**	+6,4% **c**	+7,3% **c**	+7,2% **c**
	Coleoptile	+3,7% **c**	+0,8% **c**	+2,9% **c**	+0,1% **c**	+0,2% **c**	+1,3% **c**
	Leaf	+10,2% **b**	+10% **b**	+7% **c**	+13,8% **a**	+13,9% **a**	+14% **a**
rosemary	Roots	-	-64,8% **a**	-12,5% **b**	+4,1% **c**	+4,8% **c**	+6,2% **c**
	Coleoptile	-48,9% **a**	-20,6% **a**	+0,7% **c**	+0,2% **c**	+2,8% **c**	+2,5% **c**
	Leaf	-	-19% **b**	+3,3% **c**	+5,1% **c**	+28% **a**	+22,1% **a**
eucalyptus	Roots	-22,7% **a**	-11,7% **a**	+6,5% **c**	+6,3% **c**	-4,1% **c**	+1,2% **c**
	Coleoptile	-8,4% **c**	+4% **c**	+2,1% **c**	-0,2% **c**	-3,5% **c**	-1,6% **c**
	Leaf	-	-8,3% **b**	-8,5% **b**	-9,4% **b**	-12,4% **b**	-3% **c**

CONCLUSIONS

1. The barley caryopses did not germinate in the case of the microemulsions of concentration 0.2% and 0.1% from clove essential oil. Also a small decrease in the germination capacity was found at the concentration 0.2% of bay laurel, rosemary and eucalyptus essential oils. At the other concentrations of the essential oil microemulsions used in the experiments (0.02%; 0,01%; 0.002% şi 0,001%) no changes in germination were recorded.

2. The growth of barley vegetative organs on microemulsions of 0,2% and 0,1% concentration of bay laurel essential oil was significantly inhibited. Root length growth was also significantly inhibited at 0,02%, 0,01% and 0.002% dilutions; coleoptile and first leaf growth were insignificantly modified. At dilutions 0.001% the growth of vegetative organs was stimulated.

3. Barley plantlets did not grow under the action of microemulsion of clove essential oil concentration 0.2% and 0.1%. The growth of vegetative organs at 0.02% microemulsion was significantly inhibited. In the other variants 0.01%, 0.002 and 0.001%, roots stimulations was recorded; the growth of the coleoptile and first leaf was insignificantly modified

4. The effect of microemulsion from pine essential oil with concentration 0.2% on the growth of barley roots was significant inhibitory; at the following concentrations the influences were insignificant. In the growth of the coleoptiles insignificant pluses were

recorded. The growth in the length of the leaves registered the signifiant stimulations.

5. The growth of roots was completely inhibited and coleoptile growth was significantly inhibited under the action of the microemulsions of rosemary essential oil 0,2%. The same the plantlets growth was significantly inhibited at 0.1%. At 0.02% concentration of the microemulsions the roots were significantly inhibited but coleoptiles and leaves registered pluses. In the variants 0,01%, 0,002 and 0,001% the growth of vegetative organs was stimulated even significant.

6. The growth in the length of the roots of barley plantlets on the microemulsions 0,2% and 0,1% of essential oil of eucalyptus a significant inhibition recorded. All concentrations used in the experiments insignificantly influenced coleoptile growth. In the experimental variant 0.2% the leaves did not appear. The growth in the length of the leaves registered the signifiant inhibition.

7. The essential oils used in the experiments showed the following descending order of phytotoxicity: clove, bay laurel, rosemary, eucalyptus and pine.

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