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# THE EFFECTS OF PRE-SOWING TREATMENTS WITH AQUEOUS ALLELOPATHIC PLANT EXTRACTS ON THE GERMINATION PARAMETERS OF AGED SOYBEAN SEEDS

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**Abstract:** The aim of the paper was to examine the allelopathic influence of aqueous extracts of herbs and medicinal plants on the quality parameters of aged soybean seeds. The research was carried out at the Institute of Field and Vegetable Crops in Novi Sad on aged seeds of two soybean varieties, NS simba and NS viseris. The seeds were aged for 20 months. In order to determine the allelopathic effect, the seeds were primed in aqueous plant extracts: geranium (*Geranium sinense*), dill (*Anethum graveolens*), andy everlasting (*Helichrysum arenarium*), creeping thyme (*Thymus serpyllum*), celery (*Apium graveolens*), oregano (*Origanum vulgare*), basil (*Ocimum basilicum*), lemon balm (*Melissa officinalis*), rosemary (*Rosmarinus officinalis*), wormwood (*Artemisia absinthium*), peppermint (*Mentha x piperita*), sage (*Salvia officinalis*), and lavender (*Lavandula angustifolia*). The results show that it is not possible to talk about the universal application of a particular aqueous extract, because the effect of the allochemicals was significantly influenced by the variety. In the variety NS viseris, all aqueous extracts except *Melissa officinalis*, significantly reduced GE, GP, and VI. The most negative effect was achieved with the use of *Apium graveolens*, *Thymus serpyllum*, and *Ocimum basilicum*. *Apium graveolens* and *Thymus serpyllum* also had the greatest impact on quality reduction in the NS simba variety. However, in the NS simba variety, a significant increase in seed quality was achieved in addition to the reduction. The use of the aqueous extract of *Salvia officinalis* increased GE and GP by 13.7%, and VI by 10.21%. A positive effect was achieved with the use of *Melissa officinalis*. All aqueous extracts had a significant effect on T50 in both varieties, even the aqueous extracts that had a negative effect on GE and GP.

**Key words:** allelopathy, aqueous extracts, priming, soybean.

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## Introduction

Seeds are the basic link to our agricultural past (Navazio, 2021). Seed trade has been a key component in the spread of crops since very early in the domestication process (Allaby et al., 2021). However, the commercial sale of seeds did not become common in North America and Europe until the second half of the 19$^{th}$ century, and the seed trade of that era consisted almost entirely of small packets of vegetable, flower, or herb seeds that served as starter packets (Navazio, 2021). With the advent of commercial seed companies, farmers and gardeners bought speciality seeds and hard-to-find items. Sometimes they purchased seeds of a particular species that was difficult to produce in their climate (Fernandez-Cornejo and Just, 2007). Along with the growth of commercial seed production, different methods are also being developed to improve seed quality. Today, in many countries, there is a growing awareness that healthy and safe food is also important in addition to quantity (Dozet et al., 2017). For this purpose, scientists are increasingly studying the natural mechanisms by which plants communicate with each other and influence each other. One of the most important mechanisms is allelopathy. Although the term allelopathy is most often used to describe chemical interactions between two plants (allelopathy in the narrow sense), it can also be used to describe chemical communication between plants and microbes, plants and insects, and plants and herbivores (allelopathy in the broad sense) (Weir et al., 2004). Seed quality plays an important role in agricultural and animal husbandry production, the effective utilization of genetic resources, the conservation of biodiversity, and the restoration and reconstruction of plant communities (Han et al., 2022). Soybean seeds reach their maximum potential for germination and vigor in the phase of physiological maturity, while the value of these parameters decreases with aging (Ebone et al., 2020). The aging of seeds is a common physiological phenomenon during storage. It is a natural, irreversible process that occurs and develops along with the extension of seed storage time. It is not only related to growth, yield, and seed quality, but also has a significant impact on the conservation, utilization, and development of soybean germplasm resources (Rao et al., 2023).

The aim of the research is to examine the allelopathic potential effects of aqueous extracts of herbs and medicinal plants on the quality parameters of aged soybean seeds.

## Material and Methods

In order to study the allelopathic effect of aqueous extracts of herbs and medicinal plants on the quality of aged seeds, two soybean varieties, NS viseris and NS simba, were chosen for the study. The varieties were selected at the Institute of Field and Vegetable Crops in Novi Sad. The seeds were produced at the Rimski Šančevi experimental field during 2022. The seeds were aged for 20 months during the analysis.

Seed treatment

Before being primed, the seeds were surface sterilized with a 3% solution of sodium hypochlorite (NaOCl) for two minutes and washed under a stream of distilled water. In order to determine the allelopathic effect, the seeds were primed in aqueous plant extracts: geranium (*Geranium sinense*), dill (*Anethum graveolens*), andy everlasting (*Helichrysum arenarium*), creeping thyme (*Thymus serpyllum*), celery (*Apium graveolens*), oregano (*Origanum vulgare*), basil (*Ocimum basilicum*), lemon balm (*Melissa officinalis*), rosemary (*Rosmarinus officinalis*), wormwood (*Artemisia absinthium*), peppermint (*Mentha x piperita*), sage (*Salvia officinalis*), and lavender (*Lavandula angustifolia*).

In the preparation of all aqueous plant extracts, 100 g of plant material was used, which was cut into small pieces measuring 1–4 cm. After cutting, the plant material was poured into 1 liter of distilled water and left to ferment with daily stirring. After fermentation, the obtained aqueous plant extract was filtered through gauze and left to stand at a temperature of 18–22 °C in hermetically sealed glass bottles. Prior to foliar treatment of the soybean plants, the aqueous extract was diluted with water in a ratio of 1:15.

The seeds were primed for 6 hours. They were then dried naturally to their original moisture content. The working sample consisted of 4 × 50 seeds. Seeds were evenly distributed on sterile filter paper in 9-cm diameter Petri dishes. All Petri dishes were closed with paraffin tape to prevent moisture loss and contamination. The Petri dishes containing the seeds were placed in a germination chamber at a temperature of 25 °C for 8 days. Every day, the germination of the seeds was noted, assuming that seeds with radicles of 2 mm or longer were considered to have germinated. After five days, the germination energy was determined, and the germination percentage after eight days (ISTA, 2019).

- The coefficient of velocity of germination (CVG) was determined using the formula of Nikolas and Heydeker (1968):

$$CVG = 100 \times \sum Ni / \sum NiTi \quad (1)$$

where: Ni=number of germinated seeds per day, Ti=number of days from the start of the experiment (Nikolas and Heydeker, 1968).

- Time to 50% germination (T50) was determined using the formula of Coolbear et al. (1984):

$$T50 = ti + (N/2 - ni)(tj - ti) / (nj - ni) \quad (2)$$

where N is the final number of germinating seeds, nj and ni are the cumulative number of seeds germinated at times t j and t i, respectively, when $ni < N/2 < ni$.

- Vigor index (VI) was calculated according to the following formula:

$$VI = GP \times SL, \quad (3)$$

where GP=germination percentage and SL=seedling length after 8 days (Abdul-Baki and Anderson, 1973).

The research results were processed by analyzing the variance of the two-factorial experiment (Hadzivukovic, 1991), and the significance of the differences was tested by the LSD test at the level of significance 0.01 and 0.05 (statistical program "Statistica 10.0").

## Results and Discussion

Germination energy and germination percentage

According to many scientists, priming is a pre-sowing treatment to improve the quality of soybean seeds (Murungu et al., 2005; Rouhi et al., 2011; Miladinov et al., 2015; Lewandowska et al., 2020). However, when aqueous plant extracts are used for priming, the allelopathic relationship must be taken into account. In recent years, allelopathy has been the subject of numerous studies by scientists who seek to find various alternative methods that can be successfully used in agriculture and thus reduce the use of synthetic compounds. Certain plants have the ability to secrete one or more biochemical substances that affect the growth, reproduction, and survival of other plants. These substances have an inhibitory or stimulating effect on other plants (Cheng and Cheng, 2015). Allelopathy offers a new alternative for the development of ecologically acceptable environmental measures that fulfil a dual purpose, on the one hand, increasing productivity and, on the other hand, maintaining the stability of the ecosystem (Scavo et al., 2019). At the very beginning, before applying any measure, in this case priming, it is necessary to determine the allelopathic compatibility between the plant from which the aqueous extract is produced and the donor, i.e., the plant whose seeds are treated.

When observing the influence of aqueous extracts on GE, it can be seen that most of them lead to a decrease in this parameter (Table 1).

The most significant reduction is seen with the application of aqueous extracts: *Apium graveolens* (22.86%), *Thymus serpyllum* (21.43%), *Ocimum basilicum* (18.57%), and *Artemisia absinthium* (17.14%). However, looking at the variety-aqueous extract interaction, it can be seen that the varieties reacted differently to most aqueous extracts. In the ns simba variety, the use of *Salvia officinalis* and *Melissa officinalis* increased GE by 13.70% and 8.70%, respectively. They had a greater effect on the reduction of GE. The reduction was caused by the use of *Thymus serpyllum* by 20.63%, Apium graveolens by 19.05%, and *Artemisia absinthium* by 15.87%. In the variety NS viseris, all aqueous extracts, except for *Melissa officinalis*, reduced GE. The reduction ranged from 8% to 24%. The use of aqueous extracts of *Ocimum basilicum* (24%), *Apium graveolens* (22.67%), *Thymus serpyllum* (21.33%), *Anethum graveolens* (18.67%), *Artemisia absinthium* (17.33%), *Helichrysum arenarium* (13.33%), and *Rosmarinus officinalis* and *Lavandula angustifolia* (12%) led to a significant reduction. When considering the influence of the aqueous extracts on seed germination, it can be seen that most of them influenced the reduction of GP. The most significant reduction was observed with the use of *Thymus serpyllum*, 21.42%; a positive effect was only observed with the use of *Salvia officinalis* and *Melissa officinalis*, but without a significant increase. As for GE, the varieties reacted differently to aqueous extracts. In the NS simba variety, even three aqueous extracts had a significant effect on the increase in GP, while three led to a significant decrease. The application of *Salvia officinalis* increased GP by 13.70%, *Melissa officinalis* by 11.27%, *Mentha x piperita* by 10%, *Anethum graveolens* and *Lavandula angustifolia* by 8.70%, and *Rosmarinus officinalis* by 7.35%. The reduction was caused using *Thymus serpyllum* by 20.63%, *Apium graveolens* by 15.87%, and *Artemisia absinthium* by 12.70%.

Table 1. The influence of the aqueous extract application on the germination energy and germination percentage of soybean seeds.

| Treatment (B) | Germination energy (GE) | | | Germination percentage (GP) | | |
|---|---|---|---|---|---|---|
| | NS simba | NS viseris | Average (B) | NS simba | NS viseris | Average (B) |
| Control | 63 | 75 | 70 | 63 | 76 | 70 |
| *Geranium sinense* | 63ns | 69* | 65 ns | 65 ns | 69* | 67 ns |
| *Anethum graveolens* | 64ns | 61** | 63* | 69* | 61** | 65* |
| *Helichrysum arenarium* | 60ns | 65** | 63* | 62 ns | 66** | 64* |
| *Thymus serpyllum* | 50** | 59** | 55** | 50** | 60** | 55** |
| *Apium graveolens* | 51** | 58** | 54** | 53** | 58** | 56** |
| *Origanum vulgare* | 66ns | 69* | 68 ns | 66 ns | 69* | 68 ns |
| *Ocimum basilicum* | 57* | 57** | 57** | 59 ns | 60** | 60** |
| *Melissa officinalis* | 69* | 75 ns | 72 ns | 71** | 75 ns | 73 ns |
| *Rosmarinus officinalis* | 67ns | 66** | 67 ns | 68* | 67** | 68 ns |
| *Artemisia absinthium* | 53** | 62** | 58** | 55** | 63** | 59** |
| *Mentha x piperita* | 68ns | 68* | 68 ns | 70* | 69* | 70 ns |
| *Salvia officinalis* | 73** | 69* | 71 ns | 73** | 70* | 72 ns |
| *Lavandula angustifolia* | 68ns | 66** | 67 ns | 69* | 67** | 68 ns |
| Average | 62 | 66 | - | 64 | 66 | - |

| Factor | $LSD_{0.05}$ | | $LSD_{0.01}$ | |
|---|---|---|---|---|
| | GE | GP | GE | GP |
| A | 3.31 | 1.97 | 4.11 | 2.94 |
| B | 5.45 | 4.89 | 9.83 | 7.12 |
| A x B | 6.37 | 5.84 | 11.48 | 7.13 |

*, ** Significant at the 0.05 and 0.01 probability levels, respectively (LSD test); ns = not significant.

In the ns viseris variety, all extracts led to a decrease in GP. The decrease ranged from 1.32% to 23.68%. The use of *Apium graveolens* (23.68%), *Thymus serpyllum* (21.05%), *Anethum graveolens* (19.76%), *Artemisia absinthium*

(17.11%), *Helichrysum arenarium* (13.16%), *Rosmarinus officinalis* (11.84%), and *Lavandula angustifolia* (11.84%) led to a significant reduction. Only the application of *Melissa officinalis* had no effect on GP in the ns viseris variety. The use of an extract of *Salvia officinalis* in the ns simba variety led to an increase in both parameters of germination. The results are in contrast to research conducted on barley and lettuce (Bajalan et al., 2013), where the application of an aqueous extract of *Salvia officinalis* significantly reduced seed germination in these plant species. Similar results were obtained using an extract of *Mentha x piperita*. In these studies, germination was increased by 10%. However, Shakir et al. (2021) found in the seeds of *Cicer arietinum* L. that the application of the aqueous extract of *Mentha longifolia* led to a decrease in seed germination. Możdżeń et al. (2019) determined the negative influence of *Mentha x piperita* extract on the germination of cereal seeds. This is attributed to the fact that *Mentha longifolia* and *Mente x piperite* extracts contain high concentrations of effective compounds, such as phenols, alkaloids, and tannins. These compounds have the ability to inhibit the germination and growth of plants (Shakir et al., 2021). An allelopathic effect is mainly referred to as a type of negative interaction (De Albuquerque et al., 2011), but positive interactions have also been reported, depending on the allelochemical considered, the target plant, and the concentration tested (Eichenberg et al., 2014), and in these studies also on the variety.

Coefficient of velocity of germination and time to 50% germination

Total percentage germination after a specific period of time does not give a full explanation of the dynamics of germination (Joosen et al., 2010). The timing of seed germination is one of the key steps in the plant life cycle, determining when plant growth begins in natural or agricultural ecosystems. In nature, many seeds exhibit various types and levels of dormancy (Baskin et al., 2000). Therefore, different parameters are used to determine, first of all, the time required for seed germination. This is particularly important in field conditions for uniform germination, emergence, and a uniform crop. The timing of seed germination is one of the key steps in the plant life cycle, determining when plant growth begins in natural or agricultural ecosystems (Miladinov, 2020). When observing the influence of the aqueous extracts on CVG, it can be seen that, on average, only the application of *Melissa officinalis* significantly increases the value of this parameter by 18.11% (Table 2).

However, if the variety x aqueous extract interaction is observed, it can be noted that the varieties reacted differently to most aqueous extracts. In the NS simba variety, all aqueous extracts had a significant effect on the increase of CVG, ranging from 12.5% to 30.28%. The greatest effect was achieved with the use of *Salvia officinalis* (30.28%) and *Melissa officinalis* (27.39%). In the NS viseris variety, only *Melissa officinalis* aqueous extract had a significant effect on increasing CVG by 9.02%. All other aqueous extracts significantly reduced their value. The reduction ranged from 25% for *Mentha x piperita* and *Salvia officinalis* to 49.59% for *Apium graveolens*.

Table 2. The influence of the aqueous extract application on the coefficient of velocity of germination and time to 50% germination of soybean seedllings.

| Treatment (B) | Coefficient of velocity of germination (CVG) | | | Time to 50% germination (T50) | | |
|---|---|---|---|---|---|---|
| | NS simba | NS viseris | Average (B) | NS simba | NS viseris | Average (B) |
| Control | 17.5 | 22.2 | 19.9 | 3.30 | 4.2 | 3.75 |
| *Geranium sinense* | 22.2** | 16.6** | 19.4ns | 2.10** | 2.77** | 2.44** |
| *Anethum graveolens* | 23.8** | 14.0** | 18.9ns | 1.54** | 2.58** | 2.06** |
| *Helichrysum arenarium* | 22.1** | 14.6** | 18.4ns | 1.93** | 2.35** | 2.14** |
| *Thymus serpyllum* | 20.7** | 13.6** | 17.2ns | 2.31** | 2.81** | 2.56** |
| *Apium graveolens* | 20.9** | 12.3** | 16.2ns | 2.37** | 2.82** | 2.60** |
| *Origanum vulgare* | 23.8** | 14.6** | 19.2ns | 1.49** | 2.81** | 2.15** |
| *Ocimum basilicum* | 22.3** | 13.3** | 17.8ns | 1.57** | 1.81** | 1.69** |
| *Melissa officinalis* | 24.1** | 24.4* | 24.3** | 1.32** | 1.42** | 1.37** |
| *Rosmarinus officinalis* | 23.7** | 15.4** | 19.6ns | 1.62** | 1.79** | 1.71** |
| *Artemisia absinthium* | 21.1** | 14.2** | 17.7ns | 1.98** | 2.37** | 2.18** |
| *Mentha x piperita* | 23.9** | 18.3** | 21.1ns | 1.79** | 1.40** | 1.60** |
| *Salvia officinalis* | 25.1** | 18.3** | 21.7ns | 1.31** | 1.64** | 1.48** |
| *Lavandula angustifolia* | 23.7** | 14.7** | 19.2ns | 1.65** | 1.66* | 1.66** |
| Average | 22.49 | 16.18 | - | 1.88 | 2.32 | - |

| Factor | $LSD_{0.05}$ | | $LSD_{0.01}$ | |
|---|---|---|---|---|
| | CVG | T50 | CVG | T50 |
| A | 2.11 | 0.57 | 3.97 | 0.84 |
| B | 3.15 | 0.89 | 3.38 | 1.18 |
| A x B | 2.17 | 0.74 | 4.18 | 0.98 |

*, ** Significant at the 0.05 and 0.01 probability levels, respectively (LSD test); ns = not significant.

On average, all aqueous extracts had a significant effect on the reduction of T50, ranging from 31.73% to 63.47%. The greatest effect was achieved using *Melissa officinalis* (63.47%) and *Salvia officinalis* (60.53%). The inhibitory effect on the process of seed germination can be explained by the presence of biologically active compounds in the donor plants that act on the components of the cell membranes of the recipients of the analyzed culture species (Harper and Balke, 1981). These substances cause, among other things, enzyme malfunction and disturbances in the absorption of water and mineral substances, which have a negative effect on seed germination (Siyar et al., 2017). In addition, compounds from the extract impede the breathing process (Keating, 1999), plant hormones and protein synthesis (John and Sarada, 2012), and the ion absorption process (Qasem and Hill, 1989). Moreover, the aqueous extract plays an indirect role in cell death by producing reactive oxygen, which causes lipid oxidation and damages the cell membranes (Mutlu et al., 2011). Consequently, this leads to stunted plant growth and death.

When observing the interaction of variety x aqueous extract, it can be seen that the varieties reacted similarly to most aqueous extracts. In ns simba, all extracts significantly reduced the T50 value. The decrease ranged from 28.18% to 60.30%. The most significant effect was achieved by using *Salvia officinalis* and *Melissa officinalis* (60.38% and 60%, respectively). In the NS viseris variety, the effect of the aqueous extracts on the reduction of the T50 parameter was even more significant, namely from 32.86% to 66.67%. The most significant effect was achieved with the use of *Mentha x piperita* (66.67%) and *Melissa officinalis* (66.19%). Seed priming with aqueous extracts in the ns simba variety significantly reduced T50, which may be a consequence of the initiation of metabolitic processes in primed seeds (Yaldagard et al., 2008). According to Mohamed et al. (2018), priming leads to the repair of aged seeds by resuming metabolic activity to restore cellular integrity by improving enzyme activities and protein synthesis, a repaired cell membrane, and increased antioxidant defense mechanisms, which enhances the seed and seedling performance compared with non-primed seeds.

The results show that all aqueous extracts had a significant influence on the germination rate in the initial period for both varieties. Even the aqueous extracts, which had a negative effect on GE and GP, had a stimulating effect on the germination rate, especially in the initial period, which can be seen from the value of the parameter T50, which shows when 50% of the seeds have germinated. Those aqueous extracts that had a favorable effect on these parameters reduced T50 the most, while aqueous extracts that significantly reduced GE and GP had the least impact on T50, but still significantly reduced germination time. The varieties reacted similarly, regardless of the fact that aqueous extracts have significantly different effects on their parameters, GE and GP. The results show that, in the ns simba variety, all aqueous extracts accelerated the entire germination period, regardless of whether they had a favorable or unfavorable effect on GE and GP. However, in the ns viseris variety, all aqueous extracts except *Melissa officinalis* increased CVG, i.e., extended the germination time compared to the control. Otherwise, in this variety, all aqueous extracts had a negative effect on GE and GP, except for *Melissa officinalis*, which had no significant effect.

Vigor index

When looking at the influence of the aqueous extracts on VI on average, only the application of *Melissa officinalis* led to a significant increase in the value of this parameter, namely by 10.91%. The other aqueous extracts either reduced or had no significant effect on the VI value. The reduction was greatest with the application of *Apium graveolens* and *Thymus serpyllum*, 27.51% and 27.30%, respectively. However, looking at the interaction of variety x aqueous extract, the varieties reacted differently to most aqueous extracts. In the variety NS simba, the use of *Mentha x piperita* increased VI by 10.54%, *Salvia officinalis* by 10.21%, and *Melissa officinalis* by 7.28%. Plant aqueous extracts had a greater effect on the reduction than on the increase of VI. The use of *Thymus serpyllum* and *Apium graveolens* led to a significant reduction of 16.64% and 15.67%, respectively. In the NS viseris variety, all aqueous extracts, except for *Melissa officinalis*, led to a decrease in VI, ranging from 5.78% to 20.96%. A significant decrease was caused by the use of the aqueous extracts of *Ocimum basilicum* (20.96%), *Apium graveolens* (20.93%), *Thymus serpyllum* (19.75%), *Helichrysum arenarium* (17.92%), *Anethum graveolens* (19.34%), and *Rosmarinus officinalis* (17.16%). *Melissa officinalis* increased VI by 13.53% (Table 3).

Table 3. Effects of the aqueous extract application on the vigour index of soybean seedlings.

| Treatment (B) | Vigor index (VI) | | |
|---|---|---|---|
| | NS simba | NS viseris | Average (B) |
| Control | 510.19 | 658.12 | 584.11 |
| *Geranium sinense* | 520.1ns | 610,12* | 565.11ns |
| *Anethum graveolens* | 525.18ns | 530.84** | 528.01* |
| *Helichrysum arenarium* | 505.13ns | 540.20** | 522.67* |
| *Thymus serpyllum* | 425.20** | 528.12** | 476.66** |
| *Apium graveolens* | 430.18** | 520.40** | 475.29** |
| *Origanum vulgare* | 507.40ns | 605.15* | 556.28ns |
| *Ocimum basilicum* | 510.15ns | 520.18** | 515.17* |
| *Melissa officinalis* | 550.18* | 761.12** | 655.65** |
| *Rosmarinus officinalis* | 530.20ns | 545.18** | 537.69* |
| *Artemisia absinthium* | 515.65ns | 610.12* | 562.89ns |
| *Mentha x piperita* | 570.20** | 615.10* | 592.65ns |
| *Salvia officinalis* | 568.12** | 620.05* | 594.09ns |
| *Lavandula angustifolia* | 530.35ns | 605.58* | 567.97ns |
| Average | 514.16 | 590.73 | - |

| Factor | VI | |
|---|---|---|
| | $LSD_{0.05}$ | $LSD_{0.01}$ |
| A | 67.12 | 84.09 |
| B | 41.77 | 51.37 |
| A x B | 2.17 | 0.74 |

Allelopathy research has traditionally focused on evaluating the phytotoxicity of plant residues or crude extracts (Weston, 1996). In recent years, when agricultural producers began to look for alternative methods, allelopathy or allelopathic relationships have been given great importance. By making appropriate use of allelopathic crops in agriculture, agricultural producers try to reduce the use of pesticides and thus reduce environmental and food pollution, decrease costs in agriculture, improve food security in poor regions and soil productivity, and increase biodiversity and sustainability in the agro-ecosystem (Islam et al., 2018). However, improving products using allelopathic compounds, which are mainly secondary metabolites, is not easy (Bhowmik and Inderjit, 2003). Furthermore, the use of allelopathic relations requires knowledge of the allelochemicals involved and fluctuations depending on environmental conditions and agricultural practices. However, as a pre-sowing seed treatment to improve seedling performance, the use of allelochemicals has not yet found significant application. One of the reasons for this is that there is not much research on this topic. Therefore, more attention should be paid to the application of allelopathy to improve seed quality in the future.

## Conclusion

The results show that the phenomenon of allelopathy can play a significant role in the pre-sowing treatment of soybean seeds to improve quality parameters. In this way, it is possible to obtain a cheap and simple presetting measure that will find its place in organic production. However, before applying any treatment, it is necessary to carry out preliminary tests because, in addition to the positive influence of allelochemicals, they can significantly reduce the quality of the seeds. It is therefore not possible to speak of the universal application of a certain extract because the effect of allelochemicals is significantly influenced by the variety. In the variety ns viseris, all extracts, except *Melissa officinalis*, significantly reduced GE, GP, and VI. The most negative effect was obtained by using *Apium graveolens*, *Thymus serpyllum*, and *Ocimum basilicum*. *Apium graveolens* and *Thymus serpyllum* also had the greatest impact on quality reduction in the ns simba variety. However, in the ns simba variety, a significant increase in seed quality was achieved in addition to the reduction. The use of *Salvia officinalis* extract increased GE and GP by 13.7%, and VI by 10.21%. All extracts had a significant effect on the germination rate in both varieties, even the extracts that had a negative effect on GE and GP.

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# UTICAJ PREDSETVENIH TRETMANA VODENIM EKSTRAKTIMA ALELOPATSKIH BILJAKA NA PARAMETRE KLIJANJA STAROG SEMENA SOJE

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R e z i m e

Cilj rada je bio da se ispita alelopatski uticaj ekstrakta začinskog i lekovitog bilja na kvalitet starog semena soje. Ispitivanje je obavljeno na Institutu za ratarstvo i povrtarstvo u Novom Sadu, na starom semenu dve sorte soje ns simba i ns viseris. Seme je bilo staro 20 meseci. Radi utvrđivanja alelopatskog uticaja seme je potapano u biljne vodene ekstrakte: geranijuma (*Geranium sinense*), mirođije (*Anethum graveolens*), smilja (*Helichrysum* arenarium), majčine dušice (*Thymus serpyllum*), celera (*Apium graveolens*), origana (*Origanum vulgare*), bosiljka (*Ocimum basilicum*), matičnjaka (*Melissa officinalis*), ruzmarina (*Rosmarinus officinalis*), pelina (*Artemisia absinthium*), nane (*Mentha x piperita*), žalfije (*Salvia officinalis*), i lavande (*Lavandula angustifolia*). Rezultati su pokazali da se ne može govoriti o univerzalnoj primeni određenog ekstrakta, jer na efekat alelohemikalija značajan uticaj ima sorta. Kod sorte ns viseris, svi ekstrakti, osim ekstrakta *Melissa officinalis*, značajno su smanjili GE, GP i VI. Najnegativniji efekat ostvaren je primenom *Apium graveolens*, *Thymus serpyllum* i *Ocimum basilicum*. *Apium graveolens* i *Thymus serpyllum* su najviše uticali na smanjenje kvaliteta i kod sorte ns simba. Međutim, kod sorte ns simba, pored smanjenja ostvareno je i značajno povećanje kvaliteta semena. Primenom ekstrakta *Salvia officinalis*, GE i GP su povećani za 13,7%, a VI je povećana za 10,21%. Dobar efekat je ostvaren i upotrebom *Melissa officinalis*. Svi ekstrakti, kod obe sorte, imali su značajan uticaj na brzinu klijanja, čak i ekstrakti koji su negativno delovali na GE i GP.

**Ključne reči:** alelopatija, vodeni ekstrakti, potapanje, soja.

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