VITALITY AND HEALTHINESS OF BARLEY (*HORDEUM VULGARE* L.) SEEDS TREATED WITH PLANT EXTRACTS

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Abstract: The aim of presented experiments was to determine the usefulness of plant extracts for dressing of cereal seeds. Water extracts (macerations, infusions) prepared from different morphological parts of 39 plant species were used as dressing preparations. Non-disinfected seeds of two cultivars of barley (*Hordeum vulgare* L.): Rudzik (brewing barley) and Stratus (common barley) were used for the purpose of dressing. The experiment was conducted as a filter paper test (PN-94 R-65950) while determining the germination viability (1st date) and the germination capacity (2nd date) as well as the healthiness of the seeds.

A significant differentiation of the effect of the extracts on vitality and healthiness of seeds was demonstrated depending on the origin of the extract (plant species), the way it was prepared and an interaction between these factors.

The germination viability of seeds of brewing barley was influenced mostly by infusions from fruits of *Coriandrum sativum*, from seeds of *Linum usitatissimum*, from bark of *Quercus robur*, from roots of *Levisticum officinale*, from roots of *Arctium lappa* and from flowers of *Verbascum thapsiforme*. The most favourable activity on germination capacity was revealed using the infusions from seeds of *L. usitatissimum*, from roots of *A. lappa*, from fruits of *C. sativum* and macerations from roots of *A. lappa*, from fruits of *C. sativum* and from bark of *Q. robur*. The infestation of seeds by microflora was reduced by macerations from leaves of *Betula verrucosa*, from seeds of *L. usitatissimum*, from fruits of *Juniperus communis*, and infusions from flowers of *Crataegus oxyacantha*, from seeds of *L. usitatissimum*, from leaves of *B. verrucosa*.

The most favourable impact on viability of the seeds of common barley was revealed for infusions from roots of *L. officinale*, from stigmas of *Zea mays*, from flowers of *C. oxyacantha* and macerations from flowers of *Lavandula vera*, from leaves of *Mentha piperita* and from roots of *L. officinale*. A positive effect on the germination capacity was exerted by infusions from the stigmas of *Z. mays*, from flowers of *C. oxyacantha*, from rhizomes of *Acorus calamus*, from bark of *Frangula alnus*, and macerations from bark of *F. alnus*, from leaves of *M. piperita*, from flowers of *C. oxyacantha* and from herb of *Marrubium vulgare*.

The contamination of the seeds by microflora was reduced most effectively with infusions from young sprouts of *Pinus sylvestris*, from roots of *Inula helenium*, from leaves of *Juglans regia*, from herb of *M. vulgare*, from stigmas of *Z. mays* and macerations from rhizomes of *A. calamus*, from herb of *M. vulgare*, from leaves of *J. regia*, from seeds of *L. usitatissimum* and from flowers of *L. vera*.

Key words: plant extracts, barley, seed dressing, vitality and healthiness of seeds

INTRODUCTION

In the last years, increased interest in organic agriculture has been observed, where the knowledge of the functioning of agri-ecosystems is accepted as a substitute for synthetic plant protection chemicals. In order to control agrophages, instead of pesticides, integration of different agricultural treatments is proposed, which consists of following measures:

– the increase of diversity of species or varieties of cultivated plants and the use of the allelopathy phenomenon,
– the use of organic fertilization in order to strengthen the biological activity of soil and its phytosanitary potential,
– the use of selected techniques of biological control, the use of minerals and plant extracts (Śliwa 2009; Solarska 2005).

Literature includes many reports concerning research on the application of bioactive compounds obtained from herbal plants aimed at the control of agrophages. The earlier research results of the fungicidal activity of water extracts used for the seed dressing of wheat, triticale, rye (Sas-Piotrowska *et al*. 2004) and oats (Sas-Piotrowska *et al.* 2005) demonstrated a positive activity of some of them. Vitality and healthiness of seeds dressed with biosubstances depended on the origin of a given extract, the way it was prepared and the species of protected plant.

The aim of the presented paper was to look for bioactive substances which may decrease the use of chemical pesticides and thus protect the environment of cultivated plants from an excessive chemicalization.

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MATERIAL AND METHODS

In an *in vivo* experiment, the activity of water extracts on vitality and healthiness of seeds of barley (*Hordeum vulgare* L.) was examined. The materials under investigation were as follows:

1. Water extracts (macerations, infusions) made from different morphological parts of 40 plant species: 1. *Acorus calamus* L. – rhizomes; 2. *Aesculus hippocastanum* L. – bark; 3. *A. hippocastanum* L. – flowers; 4. *Allium sativum* L. – bulbs; 5. *Archangelica officinalis* Hoffm. – roots; 6. *Arctium lappa* L. – roots; 7. *Artemisia absinthium* L. – herb; 8. *A. vulgaris* L. – herb; 9. *Betula verrucosa* Ehrh. – leaves; 10. *Calendula officinalis* L. – flowers; 11. *Camelina sinensis* L. – leaves; 12. *Carum carvi* L. – fruits; 13. *Coriandrum sativum* L. – fruits; 14. *Crataegus oxyacantha* L. – flowers; 15. *Equisetum arvense* L. – herb; 16. *Frangula alnus* Mill. – bark; 17. *Hyssopus officinalis* L. – herb; 18. *Inula helenium* L. – roots; 19. *Juglans regia* L. – leaves; 20. *Juniperus communis* L. – fruits; 21. *Lavandula vera* L. – flowers; 22. *Levisticum officinale* L. – roots; 23. *Linum usitatissimum* L. – seeds; 24. *Marrubium vulgare* L. – herb; 25. *Matricaria chamomilla* L. – inflorescence; 26. *Melissa officinalis* L. – leaves; 27. *Mentha piperita* L. – leaves; 28. *Origanum majorana* L. – herb; 29. *Pinus sylvestris* L. – young sprouts; 30. *Quercus robur* L. – bark; 31. *Ribes nigrum* L. – leaves; 32. *Rosa canina* L. – fruits; 33. *Salix alba* and *S. purpurea* L. – bark; 34. *Sambucus nigra* L. – flowers; 35. *Saponaria officinalis* L. – roots; 36. *Satureja hortensis* L. – herb; 37. *Taraxacum officinale* Web. – roots; 38. *Urtica dioica* L. – leaves; 39. *Verbascum thapsiforme* L. – flowers; 40. *Zea mays* L. – stigmas. The numbering used above is the same as the one used for the figures.

   The extracts were prepared as follows:
   - maceration: 5 g of dried material was inundated in 100 ml of sterile cold water and remained under covering for 24 hours in the temperature of 20°C,
   - infusion: 5 g of dried material was inundated in 250 ml of boiling water and remained under covering for 30 minutes.

   After filtration, the extracts were used for dressing of barley seeds.

2. Non-disinfected seeds of two forms of barley: brewing barley cultivar Rudzik and common barley cultivar Stratus.

The seeds were dressed by wetting and shaking for 10 min in a dressing device then remained for 20 hours in the ambient temperature. The seeds of barley treated with sterile and distilled water constituted the control object.

The experiment was performed as a filter paper test (PN-94 R-65950) with the purpose of the estimation of the following parameters: the germination viability: evaluation after 4 days (1st date) and the germination capacity: evaluation after 7 days (2nd date).

In the above mentioned periods, the evaluation criteria were: the number of normally germinated seeds; not normally germinated; not germinated and seeds contaminated by bacteria and fungi. The paper covers only the data concerning the impact of substances contained in plant extracts on the number of normally germinated and emerged seeds and their healthiness (contamination by microflora).

The results obtained were subjected to statistical analysis of variance with a single classification (p = 95%), separately for each cultivar, the research date and the evaluation criterion. For the comparison of results obtained for the evaluated cultivars, the date and criteria of the evaluation, correlation (r) and variability (V%) coefficients were used. The results presented in the figures were calculated in percentages in relation to the control object.

RESULTS

The *in vivo* examination conducted showed a significantly diversified effect of water extracts and the methods of their preparation on germination viability, germination capacity and healthiness of the seeds for both barley cultivars.

Brewing barley; Rudzik cultivar

The germination viability of the seeds (1st date) was stimulated by 15 plant extracts (37.5%). The range of their activity varied from +1.1 to +16.5% (Fig. 1A). The germination viability was stimulated significantly most strongly by extracts from fruits of *C. sativum* (+16.5%), from the seeds of *L. usitatissimum* (+14.9%), from roots of *A. lappa* (+14.3%) and from flowers of *V. thapsiforme* (+10.2%).

A negative impact on germination of the seeds was revealed by extracts from bark of *F. alnus* (–83.0%), from roots of *S. officinalis* (–70.5%), from stigmas of *Z. mays* (–69.1%), from flowers of *S. nigra* (–68.2%), from herb of *E. arvense* (–56.9%) and from herb of *M. officinalis* (–56.7%).

From among two methods of the extract preparation the infusions (Fig. 2, 1st date) had more favourable effect on germination of seeds. In comparison to the control combination, such an influence was revealed by biologically active substances in 20 infusions, which was 50.0% of the total. The range of their activity varied from +1.9 to +17.3%. The germination viability of seeds was influenced mostly by infusions from fruits of *C. sativum* (+17.3%), from seeds of *L. usitatissimum* (+17.3%), from bark of *Q. robur* (+16.1%), from roots of *L. officinale* (+14.5%), from roots of *A. lappa* (+14.5%) and from flowers of *V. thapsiforme* (+14.5%).

The examined extracts also had a significant impact on healthiness of seeds. Regardless of the preparation method, 11 extracts (27.5%) inhibited the development of microflora on the seed surface. Upon their influence, the number of infected seeds was reduced from –10.4 to –52.1%. The best seed protection against establishment of bacteria and fungi was ensured by extracts from leaves of *B. verrucosa* (–52.1%), from seeds of *L. usitatissimum* (–46.9%), from flowers of *L. vera* (–41.7%), from fruits of *C. sativum* (–37.5%) and from young sprouts of *P. sylvestris* (–30.2%).

From among the two methods of the extract preparation, the infusions reduced more effectively the seed contamination. Such an activity was revealed by 32.5% of infusions: the range of activity was from –14.2 to –72.9%) and 25% of macerations with the range of activity being between –2.1 and –64.6%. A particularly

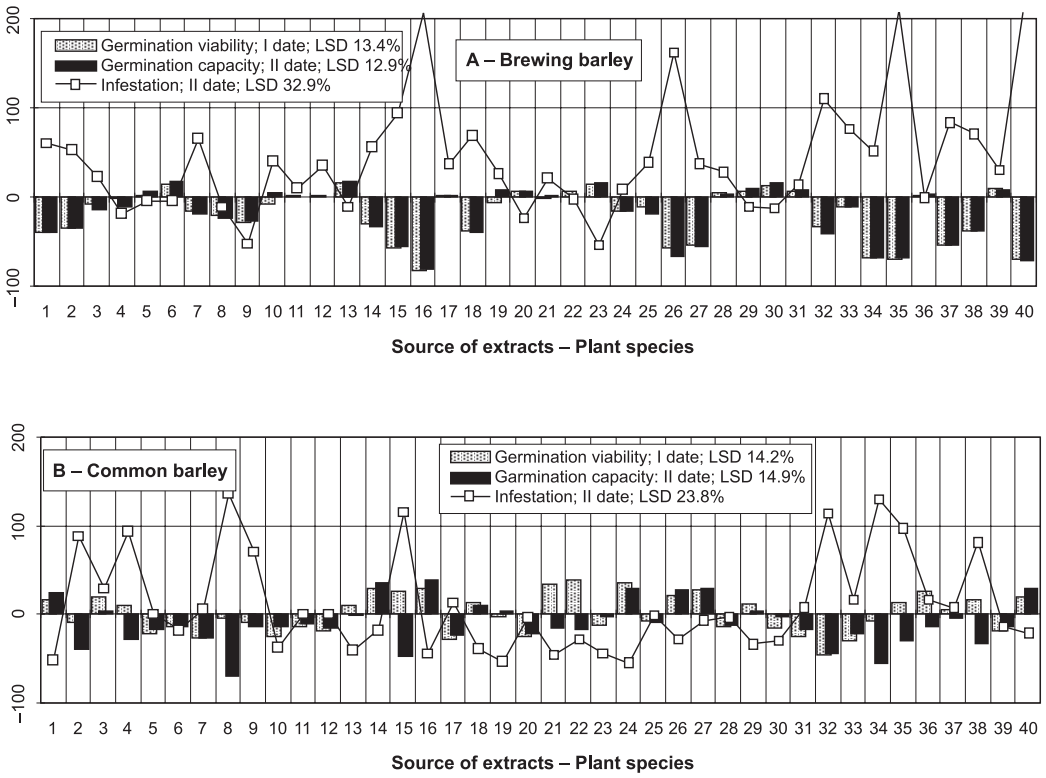

Fig. 1. Mean influence of the extracts on vitality and healthiness of barley seeds (deviation from control; %)

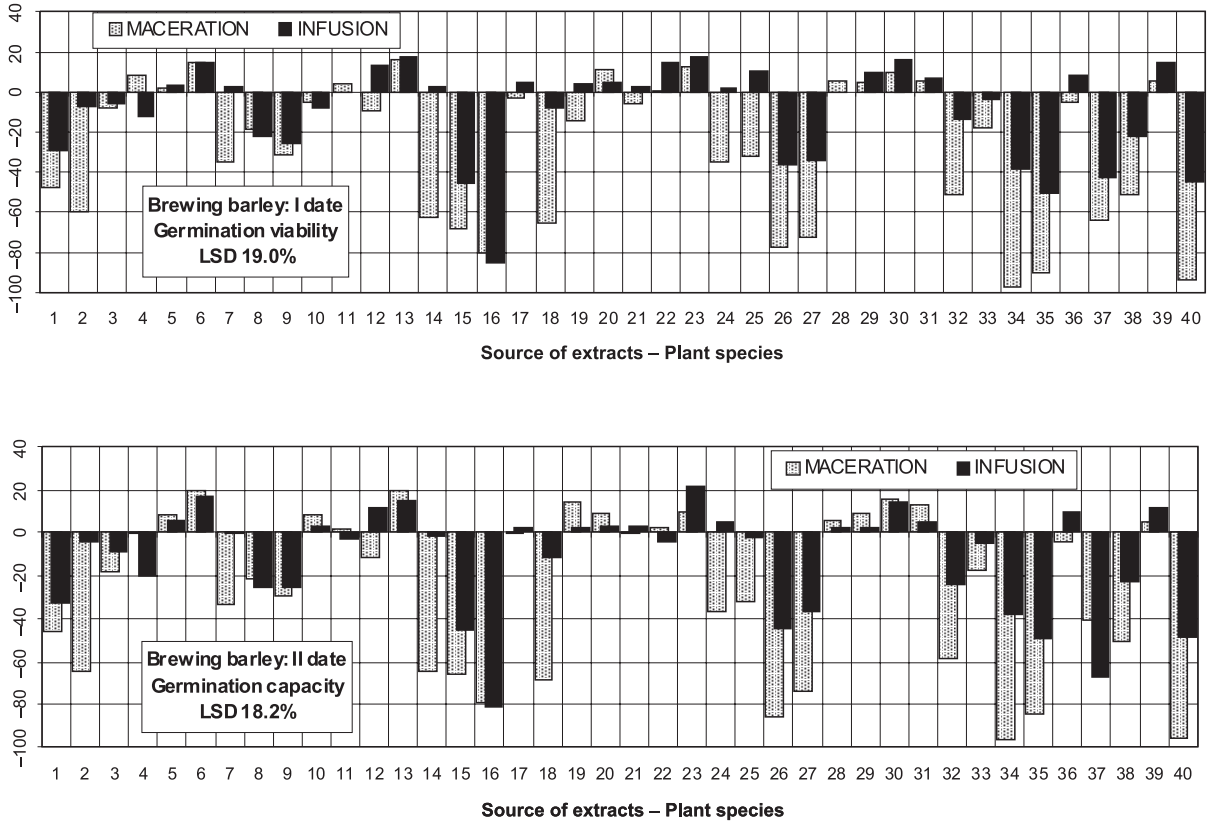

Fig. 2. Brewing barley seeds vitality depending on the source and preparation mode of the extracts (deviation from control; %)

good activity was exhibited by infusions from flowers of *L. vera* (–72.9%), from inflorescence of *M. chamomilla* (–58.3%) and from flowers of *C. oxyacantha* (–47.9%), and macerations from leaves of *B. verrucosa* (–64.6%), from seeds of *L. usitatissimum* (–64.6%), from fruits of *C. sativum* (–58.3%), from bulbs of *A. sativum* (–45.8%) and from fruits of *J. communis* (–43.7%). On the other hand the infestation of seeds was most strongly stimulated by macerations from roots of *S. officinalis* (+435.4%), from herb of *M. officinalis* (+329.2%), from leaves of *U. dioica* (+156.3%) and infusions from bark of *F. alnus* (+314.6%), from roots of *S. officinalis* (+143.7%), from stigmas of *Z. mays* (+122.9%), from herb of *E. arvense* (+114.6%).

The germination capacity of seeds (2nd date) was stimulated by 37.5% and was inhibited by 62.5% of the extracts used. The range of their activity varied from +0.9 to +18.5% and from –0.2 to –80.1% respectively (Fig. 1A).

A stimulating activity was shown by extracts from roots of *A. lappa* (+18.5%), from the fruits of *C. sativum* (+17.4%), from seeds of *L. usitatissimum* (+16.2%), from bark of *Q. robur* (+15.2%), while an inhibiting activity was revealed by extracts from bark of *F. alnus* (–80.1%), from stigmas of *Z. mays* (–70.0%), from flowers of *S. nigra* (–67.2%), from roots of *S. officinalis* (–66.9%).

From the two forms of the extracts prepared, the number of normally germinated seeds was most significantly restricted by 65.0% of all macerations used and 57.5% of all infusions used (Fig. 2, 2nd date). These were mainly infusions prepared from bark of *F. alnus* (–81.1%), from roots of *T. officinale* (–66.8%), from roots of *S. officinalis* (–49.4%) and macerations from flowers of *S. nigra* (–96.5%), from stigmas of *Z. mays* (–95.4%), from herb of *M. officinalis* (–86.1%) and from bark of *F. alnus* (–79.1%). The most favourable action on the germination capacity was revealed by infusions from seeds of *L. usitatissimum* (+22.4%), from roots of *A. lappa* (+17,0%), from fruits of *C. sativum* (+15,1%) and macerations from roots of *A. lappa* (+20,1%), from fruits of *C. sativum* (+19,7%) and from bark of *Q. robur* (+16,2%).

Also in the 2nd date of examinations, the healthiness of seeds of brewing barley depended on the plant species which was the source of the extract (Fig. 1A).

From among the 40 extracts only 30.0% reduced the development of microflora on the seed surface. Their influence ranged from –0.8 to –53.1%. The strongest activity against bacteria and fungi was revealed by extracts from leaves of *B. verrucosa* (–51.1%), from seeds of *L. usitatissimum* (–53.1%) and from fruits of *J. communis* (–23.1%). 28 extracts (70.0%) were regarded as those which stimulate the development of seed microflora, and their activity ranged between +9.2 and +223.1%. These were extracts from stigmas of *Z. mays* (+223.1%), from roots of *S. officinalis* (+211.5%), from bark of *F. alnus* (+206.9%) and from herb of *M. officinalis* (+163.1%).

From the two forms of water extracts, 27.5% of macerations and 32.5% of infusions reduced the seed infestation. The range of their activity varied from –4.6 to –66.1% and from –3.1 to –43.1% respectively (Fig. 4A). These were mainly macerations from leaves of *B. verrucosa* (–66.1%), from seeds of *L. usitatissimum* (–64.6%), from fruits of *J. communis* (–40.0%), and infusions from flowers of *C. oxyacantha* (–43.1%), from seeds of *L. usitatissimum* (–41.5%), from leaves of *B. verrucosa* (–36.9%). At the same time, the infestation of brewing barley seeds with bacteria and fungi increased when they were treated with macerations from stigmas of *Z. mays* (+429.2%), from roots of *S. officinalis* (+318.5%), from herb of *M. officinalis* (+273.8%), from fruits of *R. canina* (+153.8%) and with infusions from roots of *S. officinalis* (+104.6%), from bark of *S. alba* and *S. purpurea* (+64.6%).

Common barley; Stratus cultivar.

The germination viability of the seeds (1st date) was stimulated by 19 (47.5%) of all the plant extracts used (Fig. 1B). The range of their activity varied in comparison to the control from 5.9% to 37.6%. A normal seed germination was stimulated mostly by extracts from roots of *L. officinale* (+37.6%), from herb of *M. vulgare* (+36.5%) and from flowers of *L. vera* (+34.3%). At the same time, the germination of seeds was inhibited by extracts from fruits of *R. canina* (–45.4%), from bark of *S. alba and S. purpurea* (–29.4%), from herb of *H. officinalis* (–27.5%) and from herb of *A. absinthium* (–26.1%).

A significant differentiation of the results was also caused by a method of extract preparation (Fig. 3, 1st date). The most favourable activity on the seed germination was shown by biologically active substances contained in 23 infusions (57.5% of all the infusions used), and particularly from roots of *L. officinale* (+45.0%), from stigmas of *Z. mays* (+45.6%), from flowers of *C. oxyacantha* (+41.1%). The number of macerations revealing such an activity was only 40.0%. These were macerations from flowers of *L. vera* (+40.6%), from leaves of *M. piperita* (+34.5%) and from roots of *L. officinale* (+30.1%).

The examinations made on seeds of Stratus cultivar demonstrate that a majority of the extracts reduced microflora development on the seed surface. From among 40 extracts, only 6 stimulated the infestation. These were extracts from fruits of *R. canina* (+99.4%), from herb of *A. vulgaris* (+41.0%), from bark of *A. hippocastanum* (+31.1%), from bulb of *A. sativum* (+23.4%), from leaves of *B. verrucosa* (+23.4%) and from flowers of *S. nigra* (+13.6 %). The seed contamination was mostly reduced by extracts from herb of *M. vulgare* (–86.6%), from rhizomes of *A. calamus* (–83.5%), from bark of *F. alnus* (–83.1%), from flowers of *C. oxyacantha* (–81.0%), from roots of *I. helenium* (–78.9%) and from stigmas of *Z. mays* (–77.5%).

When comparing the activity of maceration on the seed healthiness with that of infusions made from various plants, it was found that the majority of them, namely 85% of macerations and 85% of infusions, significantly reduced microflora development. The range of their activity in relation to the seed microflora varied for macerations from –0.1 to –88.7%, while that for infusions ranged from –4.4 to –88.7%. The number of contaminated seeds was the smallest when they were treated with macerations from rhizomes of *A. calamus* (–88.7%), from herb of *M. vulgare* (–87.3%), from bark of *F. alnus* (–83.8%), from flowers of *C. oxyacantha* (–80.3%) and with infusions from roots of *I. helenium* (–88.7%), from herb of *M. vulgare* (–85.9%), from inflorescence of *M. chamomilla* (–85.9%), from stigmas of *Z. mays* (–84.5%) and from bark of *F. alnus* (–82.4%).

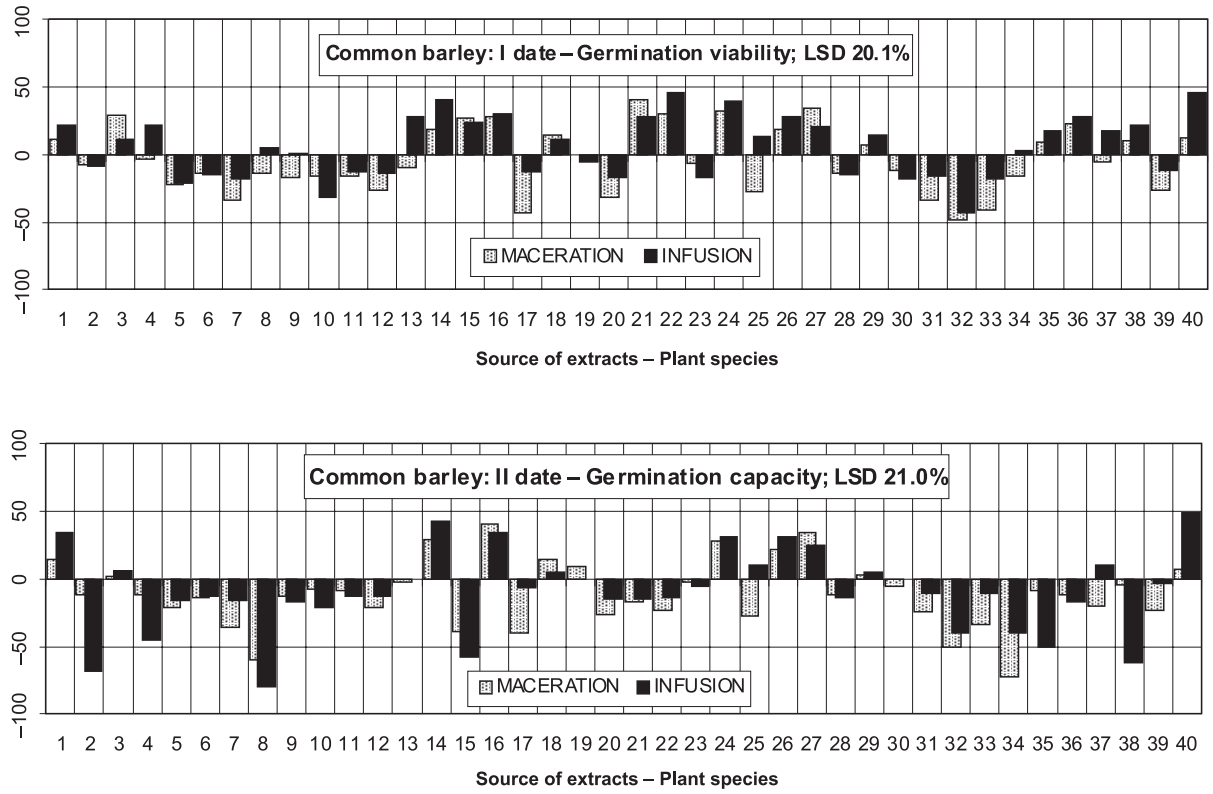

Fig. 3. Common barley seeds vitality depending on the source and preparation mode of the extracts (deviation from control; %)

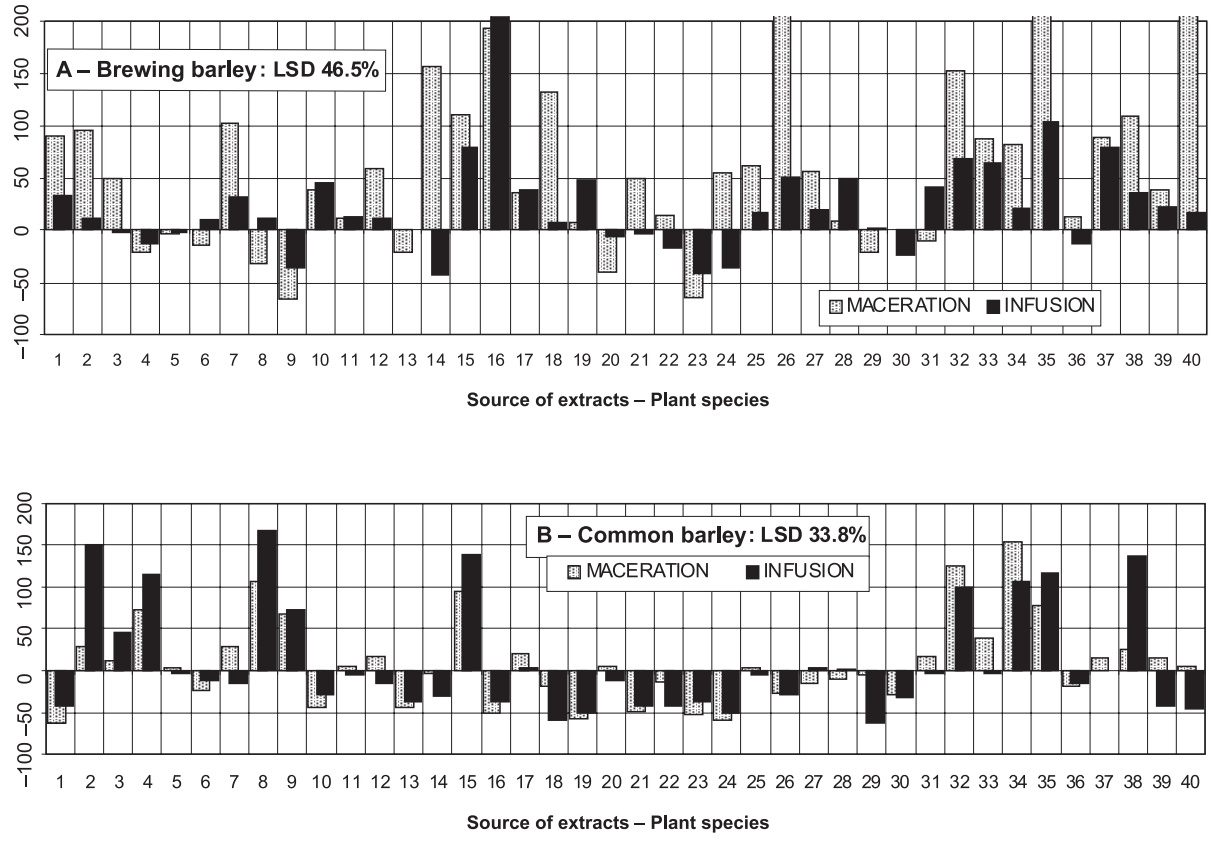

Fig. 4. Barley seeds healthiness depending on the source and preparation mode of the extracts (deviation from control; %)

A positive effect on the germination capacity (2nd date) of seeds of common barley was exerted by chemical substances contained in extracts from 11 plant species, which constituted a portion of 27.5% of all the extracts used (Fig. 1B). The range of their activity varied from +4.2 to +38.2%.

A significantly positive impact on the seed germination capacity was obtained by substances contained in extracts from bark of *F. alnus* (+38.1%), from flowers of *C. oxyacantha* (+36.3%), from leaves of *M. piperita* (+29.9%), herb parts of *M. vulgare* (+29.9%) and from stigmas of *Z. mays* (+28.8%). Seed germination was inhibited by 29 extracts (72.5% of all used). The range of their activity varied from –1.1 to –69.8%. Such an activity was revealed mostly in the case of extracts from herb of *A. vulgaris* (–69.8%), from flowers of *S. nigra* (–55.9%), from herb of *E. arvense* (–48.2%), from fruits of *R. canina* (–44.9%) and from bark of *A. hippocastanum* (–39.3%).

The seed germination capacity also depended significantly on the method of an extract preparation (Fig. 3, 2nd date). A favourable effect on the germination capacity of seeds of common barley was exerted by 30% infusions and 27.5% macerations. The infusions included extracts from stigmas of *Z. mays* (+49.6%), from rhizome of *C. oxyacantha* (+43.8%), from roots of *A. calamus* (+35.2%), from bark of *F. alnus* (+35.2%), and macerations included extracts from bark of *F. alnus* (+41.1%), from leaves of *M. piperita* (+34.7%), from flowers of *C. oxyacantha* (+28.8%) and from herb of *M. vulgare* (+28.3%). It was also noted that the majority of infusions (70.0%) and macerations (72.4%) reduced the germination capacity. Such an activity was characteristic of infusions from herb of *A. vulgaris* (–79.7%), from bark of *A. hippocastanum* (–67.9%), from leaves of *U. dioica* (–62.6%) and macerations from flowers of *S. nigra* (–72.2%), from herb of *A. vulgaris* (–59.9%), from fruits of *R. canina* (–49.8%).

The extracts examined plants had a diversified influence on the seed healthiness. As many as 24 water extracts (60%) from 40 of those examined reduced efficiently of seed infestation (Fig. 1B). Their favourable activity varied from –1.5% to –54.3%. Those extracts which reduced contamination most effectively included extracts from herb of *M. vulgare* (–54.3%), from leaves of *J. regia* (–53.9%), from rhizomes of *A. calamus* (–51.7%), from flowers of *L. vera* (–45.3%), from seeds of *L. usitatissimum* (–44.2%). Treatment of seeds with extracts from herb of *A. vulgaris* (+136.7%), from flowers of *S. nigra* (+129.6%), from herb of *E. arvense* (+116.1%) and from fruits of *R. canina* (+113.1%) stimulated the infestation by microorganisms.

The contamination of the seeds treated with extracts depended on their origin (plant species) and on the method of their preparation. The majority of extracts, i.e. 65% of infusions (the range varied from –3.4 to –61.8%) as well as 45% of macerations (ranging from –4.1% to –61.0%) reduced the infestation (Fig. 4B).

The most effective were infusions from young sprouts of *P. sylvestris* (–61.8%), from roots of *I. helenium* (–59.5%), from leaves of *J. regia* (–49.8%), from herb of *M. vulgare* (–49.8%), from stigmas of *Z. mays* (–46.8%) and macerations from rhisomes of *A. calamus* (–61.0%), from herb of *M. vulgare* (–58.8%), from leaves of *J. regia* (–58.0%), from seeds of *L. usitatissimum* (–52.8%) and from flowers of *L. vera* (–47.6%). On the other hand, the contamination of seeds was stimulated by infusions from herb of *A. vulgaris* (+168.2%), from bark of *A. hippocastanum* (+150.2%), from herb of *E. arvense* (+138.2%), from leaves of *U. dioica* (+137.4%), from roots of *S. officinalis* (+118.0%), from bulb of *A. sativum* (+115.7%) and macerations from flowers of *S. nigra* (+153.2%), from fruits of *R. canina* (+125.5%), from herb of *A. vulgaris* (+105.2%) and from herb of *E. arvense* (+94.0%).

When comparing the activity of water extracts on the germination viability and capacity of both barley cultivars, a significant positive correlation was stated. The values of the correlation coefficient were as follows: for Rudzik cultivar of brewing barley r = 0.986**, for Stratus cultivar of common barley r = 0.488** with a critical value of r = 0.314. The response variability for both cultivars of barley expressed with a variability coefficient (V%) was 34.3% (1st date) and 35.6% (2nd date) for Rudzik cultivar, and 22.0% and 27.8% for Stratus cultivar respectively.

The influence of water extracts on barley seeds infestation in 1st and 2nd date of evaluation was significantly consistent and was for brewing barley r = 0.973** and for common barley r = 0.713** > than r critical). On the other hand, the response of seeds of the tested barley forms to extracts made from various species of medicinal plants was not significantly consistent (r = 0.110 < than r critical). The variability coefficient (V%) calculated for the purpose of making a comparison of the healthiness of both forms in the two dates of evaluation was greater for common barley (1st date V = 62.4%; 2nd date V = 51.0%). For brewing barley, the values amounted to V = 57.8% and V = 45.2%, respectively.

It was furthermore stated that the stronger examined extracts reduced the seed infestation by bacteria and fungi the greater was seed vitality. However, the correlation coefficient for these features was for brewing barley significant in both dates (1st date r = –0.758**; 2nd date r = –0.789**) and for common barley only in 2nd date (r = –0.772** > 0.314). For 1st date, only some tendency in the same direction was evident (1st date r = –0.291).

DISCUSSION

The use of synthetic plant protection chemicals causes changes, which are sometimes irreversible, through a reduction of the biological activity and an impoverishment of the species composition in biocenosis, which has a negative impact on agricultural products. For that reason, the interest is increasing in the use of natural substances produced on the basis of different plant species. Biologically active substances obtained from them may be active against bacteria, fungi and insects (Ajzenman *et al.* 1984).

The effect of biological substances contained in plant extracts varies depending on herb species, the method of preparation, the plant being protected and the pathogen being tested (Burgieł and Moliszewska 1999). It is also important that the dressing substances should stimulate the healthiness and vitality of the plants (Janas and Grzesik 2005).

In the research conducted by Pietr *et al.* (2001), the usefulness was evaluated of Cedomon biological seed dressing for the protection of 5 varieties, including Rudzik cultivar of summer barley. Its efficacy and activity were established, which were not worse that that of a synthetic dressing. However, the increase of an average yield was lower and ranged from 4.3 to 11.4%. In the earlier research conducted by Sas-Piotrowska *et al.* (2004), where 20 water extracts were used for dressing of wheat seeds, rye and triticale, a significant differentiation of their efficacy was stated. The positive and stimulating effects for the seed vitality were observed with extracts from the bark of *F. alnus* and from the flowers of *C. oxyacantha*. The seed vitality was however restricted by extracts from fruits of *R. canina*, from flowers of *S. nigra* and from herb of *A. vulgaris*.

Also in the present research conducted by the authors, an essential effect was observed of 40 water extracts used as seed dressing on the seed vitality and the healthiness of two forms of barley. The stimulating effect on brewing barley seeds was revealed by extracts from the fruits of *C. sativum*, from the seeds of *L. usitatissimum* and from the roots of *A. lappa*, and in the case of common barley, these were extracts from the bark of *F. alnus*, from the herb of *M. vulgare*, from the flowers of *C. oxyacantha* and from the leaves of *M. piperita*.

The vitality of brewing barley seeds was inhibited by extracts from the bark of *F. alnus*, from the roots of *S. officinalis*, from the stigmas of *Z. mays*, from the flowers of *S. nigra* and in the case of common barley from the herb of *A. vulgaris*, from the fruits of *R. canina*, from the flowers of *S. nigra*, from the herb of *E. arvense*.

In the research conducted by Sas-Piotrowska *et al.* (2005), where the impact of 40 water extracts was tested on the vitality of oats seeds, the stimulating effect was revealed for the extract from the roots of *A. lappa*, from bark of *F. alnus* and from herb of *M. vulgare*. When comparing the above mentioned results, it was noted that some extracts showed contrasting effects. It appeared that some extracts stimulating the germination of barley seeds inhibited the germination of oats seeds, while from among the extracts inhibiting germination of barley seeds, were extracts which influenced positively germination of oats seeds. These were for instance the extracts from bark of *F. alnus* and from herb of *A. vulgaris*.

Those plants which are most often mentioned in literature to have a positive influence on vitality and healthiness of agricultural crops are *A. sativum*, *U. dioica* and *E. arvense* (Saniewska and Żuradzka 2001; Pisarek 2003, 2006; Burgieł 2005; Jarosz and Gołębiak 2005; Panasiewicz *et al*. 2007; Stampor-Chrzan 2008). In the present research, this was not confirmed, as the extract made from the mentioned plants significantly restricted vitality of barley seeds. On the other hand, infusions from herb of *E. arvense* and maceration from leaves of *U. dioica* stimulated the infestation of brewing barley seeds on the 1st date of evaluation. In the case of common barley, the same effect for 1st date of evaluation concerned the infusions and macerations from bulbs of *A. sativum*, and for 2nd date of evaluation, the infusions from 3 above mentioned plants.

In the present research, the infestation of brewing barley seeds was restricted by extracts from leaves of *B. verrucosa*, from seeds of *L. usitatissimum* and from fruits of *J. communis*, and of common barley by extracts from leaves of *M. vulgare* and *J. regia*, from rhizomes of *A. calamus* and flowers of *L. vera*. An unfavorable effect on healthiness of brewing barley seeds was exerted by extracts from roots of *S. officinalis*, from fruits of *R. canina*, from flowers of *S. nigra* and from stigmas of *Z. mays*. In the case of common barley, these were extracts from herb of *A. vulgaris*, from bark of *A. hippocastanum*, from flowers of *S. nigra* and from herb of *E. arvense*.

Somehow different results were obtained when using herbal dressings on the seeds of other cereals (Sas-Piotrowska *et al.* 2004). A positive effect was stated for extracts from bark of *A. hippocastanum*, from bulbs of *A. sativum* and from roots of *S. officinalis* on the healthiness of seeds of wheat, rye and triticale.

When analyzing the presented results of the research and comparing them with results obtained by other authors their great differentiation needs to be stressed. They also demonstrate that it may be very difficult to find herbal plants with a positive effect for several agricultural crops at a time in terms of vitality and healthiness of their seeds. This is so because each of the agricultural crops tested reacted specifically.

CONCLUSIONS

1. The effect of the biological substances contained in plant extracts is different depending on the plant (cultivar) treated, the origin of the extracts (herb species), a method of their preparation and an interaction between these factors.
2. The germination viability of the seeds of brewing barley was stimulated the most by infusions from fruits of *C. sativum*, seeds of *L. usitatissimum*, bark of *Q. robur*, roots of *L. officinale*, roots of *A. lappa* and flowers of *V. thapsiforme*. The most favourable activity on the viability of common barley was shown by infusions from roots of *L. officinale*, from stigmas of *Z. mays*, from flowers of *C. oxyacantha* and macerations from flowers of *L. vera*, from leaves of *M. piperita* and from roots of *L. officinale*.
3. When making a comparison of activity of water extracts on the germination viability and the germination capacity of both barley cultivars, a significant positive correlation was found. The value of correlation coefficient was r = 0.986** for brewing barley, and r = 0.488** for common barley.
4. The germination capacity of brewing barley seeds was stimulated with infusions from seeds of *L. usitatissimum*, roots of *A. lappa*, fruits of *C. sativum* and macerations from roots of *A. lappa*, fruits of *C. sativum* and from bark of *Q. robur*. The germination capacity of common barley was influenced positively by infusions from: stigmas of *Z. mays*, flowers of *C. oxyacantha*, rhizomes of *A. calamus*, bark of *F. alnus* and macerations from: bark of *F. alnus*, leaves of *M. piperita*, flowers of *C. oxyacantha* and from herb of *M. vulgare*.
5. The influence of water extracts on barley seeds infestation in the first and second date of evaluation was significantly consistent and amounted to for brewing

barley r = 0.973** and for common barley r = 0.713** > than r critical). It was furthermore stated that the stronger the examined extracts reduced the seed infestation by bacteria and fungi, the greater was the seed vitality. The correlation coefficient for these features was for brewing barley significant for both dates (1st date r = –0.758**; 2nd date r = –0.789**) and for common barley only in 2nd date (r = –0.772** > 0.314). For 1st date, only some tendency in the same direction was evident (1st date r = –0.291).

6. The contamination of seeds of brewing barley by microflora reduced macerations from: leaves of *B. verrucosa*, seeds of *L. usitatissimum*, fruits of *J. communis*, and infusions from: flowers of *C. oxyacantha*, seeds of *L. usitatissimum*, leaves of *B. verrucosa*. The contamination of common barley seeds was reduced by infusions from: young sprouts of *P. sylvestris*, roots of *I. helenium*, leaves of *J. regia*, herb of *M. vulgare*, stigmas of *Z. mays* and macerations from: rhizomes of *A. calamus*, herb of *M. vulgare*, leaves of *J. regia*, seeds of *L. usitatissimum* and from flowers of *L. vera*.

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POLISH SUMMARY

ŻYWOTNOŚĆ I ZDROWOTNOŚĆ NASION JĘCZMIENIA (*HORDEUM VULGARE* L.) TRAKTOWANYCH WYCIĄGAMI ROŚLINNYMI

Celem prezentowanych doświadczeń było poszukiwanie naturalnych substancji biologicznie aktywnych, przydatnych do zaprawiania nasion zbóż. Jako zaprawy wykorzystano wyciągi wodne (maceraty, napary), przygotowane z różnych części morfologicznych 39 gatunków roślin. Do zaprawiania użyto nieodkażone nasiona dwóch form jęczmienia: browarnego odmiany Rudzik i siewnego odmiany Stratus. Doświadczenie przeprowadzono jako test bibułowy (PN-94 R-65950), określając w nim energię (1. termin) i zdolność kiełkowania nasion (2. termin) oraz ich zdrowotność.

Wykazano istotnie zróżnicowane działanie wyciągów na żywotność i zdrowotność nasion obu odmian, w zależności od pochodzenia wyciągu (rośliny zielarskiej), sposobu jego przygotowania oraz współdziałania między tymi czynnikami. Niezależnie od sposobu przygotowania:

1. Energię kiełkowania nasion jęczmienia browarnego najsilniej stymulowały wyciągi z owoców *Coriandrum sativum*, nasion *Linum usitatissimum*, korzeni *Arctium lappa* oraz kwiatów *Verbascum thapsiforme*. W przypadku jęczmienia siewnego były to wyciągi z korzeni *Levisticum officinale*, ziela *Marrubium vulgare* i kwiatów *Lavandula vera*,
2. Zdolność kiełkowania nasion jęczmienia browarnego stymulowały wyciągi z korzeni *Arctium lappa*, owoców *Coriandrum sativum*, nasion *Linum usitatissimum* i kory *Quercus robur* a jęczmienia siewnego wyciągi z kory *Frangula alnus*, kwiatów *Crataegus oxyacantha*, liści *Mentha piperita*, ziela *Marrubium vulgare* i znamion *Zea mays*,
3. Zasiedlenie nasion jęczmienia browarnego ograniczały wyciągi z liści *Betula verrucosa*, nasion *Linum usitatissimum* oraz owoców *Juniperus communis*, podczas gdy w przypadku jęczmienia siewnego były to wyciągi z ziela *Marrubium vulgare*, liści *Juglans regia*, korzeni *Acorus calamus*, kwiatów *Lavandula vera* i nasion *Linum usitatissimum*.