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# Vitality and Healthiness of Seeds of Cereal Plants Treated with Plant Extracts

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## 1. Introduction

Development of the modern management systems in agriculture is strongly connected with a progress in plant protection methods. Owing to a short-term and effective action of a plant protection chemical they are appreciated in conventional and integrated agriculture. On the other hand they have many defects i.e. high prices of pesticides and cost of their application, the possibility of a resistance developing in target organisms, accumulation of their residues in a plant material and environment, negative effect on beneficial organisms as well as general ecological equilibrium disturbance.

The above mentioned circumstances influence the development of the management systems compatible with requirements of protection of environment and nature. The such system may be the organic agriculture based on sustainable farming. That system can ensure a good fertility and sanitary state of a soil as well as high biological quality of agricultural products and raw materials. Implementing of the system is one of 9 agricultural and environmental packages included in Program of Development of Rural Areas 2007-2013 supported by European Fund for Agricultural Development of Rural Areas (Dz.U.2008, no 34 pos.200; www.doradcaprow.pl/prow/).

The plant protection in organic agriculture is based mainly on preventive measures in the field of crop production and particularly on:

- biodiversity through a right crop rotation, cultivation of mixed crops and intercropping as well as cultivation of plant varieties adjusted to a local environment in order to use of allelopathy phenomenon and giving protection of useful organisms and their refuges;

- rational use of organic manure, strengthening the soil phytosanitary potential and reducing survival rate of pests;
- accurate crop cultivation reducing a weed density being a source of hosts for many pests.

The intervention methods, undertaken only in extremity are based on non-processed mineral and biological chemicals. In Poland there have been registered for organic agriculture 29 plant protection formulations, where the following substances are used: biohumus, chitozan, granulosis virus - CpGV, fungi *Coniothyrium minitans* and *Pythium oligandrum,* extracts from garlic, dried herbs and garlic, grapefruit, extract mixture from garlic and grapefruit, from tissues of *Quercus falcata, Opuntia lindheimeri, Rhus aromatica, Rhizoporia mangle,* oil from oranges, paraffin oil , copper generally in a form of copper oxidchloride, sulfur and compositions of soap, magnesium sulphate and micronutrients (www.ior.poznan.pl/index.php?strona=19).

From the researches on protection of organic crops carried out in 14 European countries under 6-th Framework Program results the evidence of a low efficiency of plant protection methods in control of some pests in these crops. So, in 9 European countries a need to develop the research in this field is pointed out (Kowalska 2006).

The aim of these researches, being a continuation of the earlier ones presented by Sas-Piotrowska et al. (2004) is a search of natural active substances occurring in herb plants most of which produce allelopathic, biocidial or biostatic compounds (Achremowicz, Cież 1992), as well as their use in plant protection.

## 2. Material and methods

In the *in vivo* carried out experiments the activity of water plant extracts used as a seed dressing on viability and healthiness of three cereal species: ***Triticum aestivum*** L., ***Secale cereale*** L., ***Triticosecale*** Wittm. was evaluated.

The material used in investigations was as follows:

- Water extracts (maceration, infusion) made from different morphological parts of 20 plant species: 1. ***Levisticum officinale*** L (root); 2. ***Coriandrum sativum*** L (fruit); 3. ***Pinus sylvestris*** L. (sprout); 4. ***Satureja hortensis*** L. (green parts); 5. ***Lavandula vera*** L. (flover); 6. ***Linum usitatissimum*** L. (seed); 7. ***Quercus robur*** L. (bark); 8. ***Arctium lappa*** L. (root); 9. ***Calendula officinalis*** L. (flover); 10. ***Juglans regia*** L. (leaf); 11. ***Salix alba*** L and ***S.purpurea*** L. (bark); 12. ***Origanum majorana*** L. (green parts); 13. ***Archangelica officinalis*** Hoffm. (root); 14. ***Ribes nigrum*** L. (leaf); 15. ***Camellia sinensis*** L. (leaf); 16. ***Artemisia absinthium*** L. (green parts); 17. ***Ver-***

***bascum thapsiforme*** L. (flover); 18. ***Hyssopus officinalis*** L. (green parts); 19. ***Juniperus communis*** L. (fruit); 20. ***Carum carvi*** L. (fruit). The numbering given for the species is the same as on the diagrams. The dried plant material was derived from Zakład Zielarski „Kawon-Hurt".

Water extracts were prepared as follows:

- Maceration: to 5 g of plant dried material a 100 ml of sterile, cold water was added and it was set aside for 24 hours in a temperature of 20°C under cover;
- Infusion: to 5 g of plant dried material a 250 ml of boiling water was added and it was set aside for 30 min under cover.

The received after filtration extracts were used to a seed dressing of cereal plants.

- Non-disinfected seeds of three cereal plants: ***Triticum aestivum*** L. cv. 'Almary'; ***Secale cereale*** L. cv. 'Dańkowskie Złote' and ***Triticosecale*** Wittm. cv. 'Marko', were wet dressed by inundation in the extracts and shaken out for 10 min in a dressing device and then set aside for 20 hours in an ambient temperature. As a control the treated by distilled water seeds of the cereal plants were used.

The experiment was carried out as a filter paper test according to requirements of Polish Standard (PN-94R-6595) in order to determine:

- a germination viability, carried out after 4 days for all seeds (I time);
- a germination capacity, carried out after 7 days for rye and after 8 days for wheat and triticale (II time).

In the above mentioned periods the evaluation criteria were: a number of normally germinated seeds; not normally germinated; not germinated and infected seeds. In the presented work only an impact of the extracts on a number of normally germinated and emerging seeds as well as their healthiness was examined.

The results obtained were statistically elaborated with a method of a single variance analysis (P=95%), separately for each cultivated plant, an evaluation criterion and a feature to be observed. The response of the grain plants on the extract tested were compared using the method of linear correlation and of variability coefficients (V%). The significance of correlation coefficients at P=95% were designed with a mark "*" and at P=99% with two marks "**".

## 3. Research results

The extracts made from individual plant species and prepared according to different procedures significantly differentiated a germination viability and capacity as well as seeds healthiness of *T. aestivum, S. cereale* and *Triticosecale.*

Germination viability

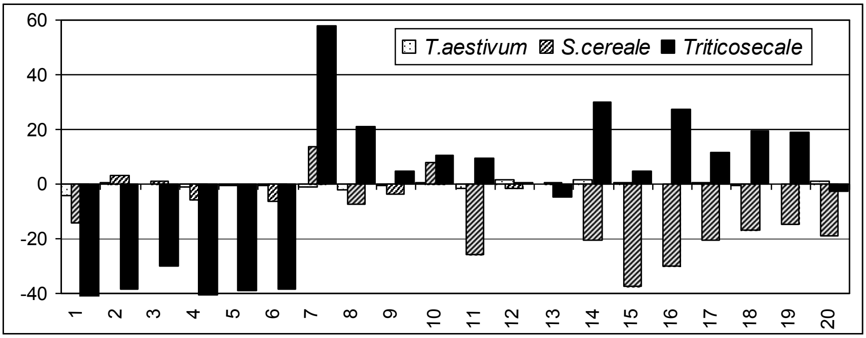
Percent of normally germinated seeds expressed as a deviation from a control amounted: -0.3% (range -8.0% to +2.0%) for *T. aestivum*; -9.9% (range -44.2 to +14.7%) for *S. cereale*; -1.2% (range -46.8 to +69.7%) for *Triticosecale.*

Regardless of a mode of an extract preparation the germination viability was negatively influenced (Fig.1A): ***T. AESTIVUM*** – by 5 extracts (range -4.2 to -0.06%); the germination viability was significantly most strongly inhibited by an extract from a roots of ***L. officinale*** (-4.2%); ***S. CEREALE*** – by 7 extracts (range -37.3 to -0.2%). Significantly most strongly influenced extracts from green parts of ***A. absinthium*** (-30.1%), bark of ***S. alba*** and ***S. purpurea*** (-25.7%), leaves of ***R. nigrum*** and flovers of ***V. thapsiforme*** (-20.7%); ***TRITICOSECALE*** – by 4 extracts (range -40.6 to -2.5%). The germination viability was significantly most strongly inhibited by extracts from roots of ***L. officinale*** (-45.1%), green parts of ***S. hortensis*** (-40.6%), flovers of ***L. vera*** (38.9%), fruits of ***C. sativum*** (-38.7%), seeds of ***L. usitatissimum*** (-38.4%) and sprouts of ***P. sylvestris*** (-30.0%).

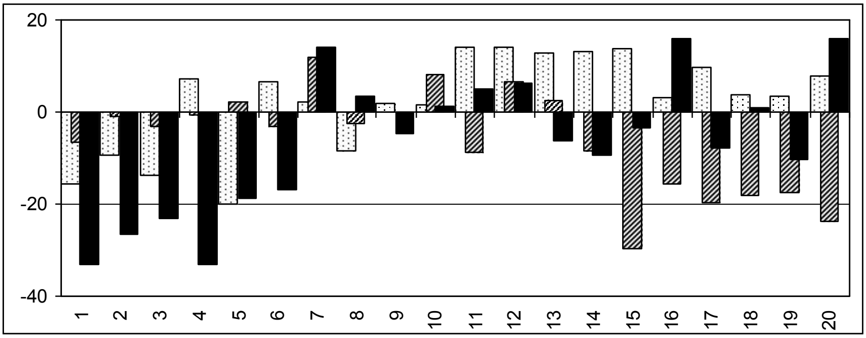
The germination viability of grain plants tested was inhibited in a different degree by an extract from a roots of ***L. officinale***, green parts of ***S. hortensis***, flovers of ***L. vera*** and seeds of ***L. usitatissimum***, and stimulated by an extracts from leaves of ***J. regia***.

The germination viability of seeds was stimulated by:

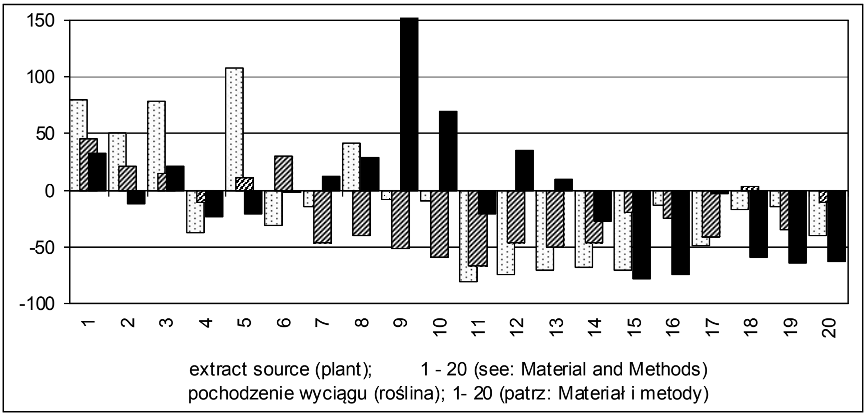
- ***T. AESTIVUM*** - by 50% of plants extracts tested. Their activity was however under a limit of an error of a control variant. Among those most favourably influenced the germination extracts from green parts of ***O. majorana*** (1.5%) and leaves of ***R. nigrum*** (1.4%);
- ***S. CEREALE*** - was significantly most strongly stimulated by an extracts from bark of ***Q. robur*** (13.5%);
- ***TRITICOSECALE*** - was significantly most strongly stimulated by an extracts from bark of ***Q. robur*** (57.7%), leaves of ***R. nigrum*** (30.3%), green parts of ***A. absinthium*** (27.2%), roots of ***A. lappa*** (21.0%) as weel extracts by green parts of ***H. officinalis*** and fruits of ***J. communis*** (ok.19.0%).




A. Germination viability – energia kiełkowania




B. Germination capacity – zdolność kiełkowania




C. Infected seeds – porażenie nasion

**Fig. 1.** A mean influence of the extracts on a seeds vitality and healthiness (deviation from control in %)

**Rys. 1.** Przeciętne oddziaływanie wyciągów na żywotność i zdrowotność nasion (odchylenie od kontroli w %)

Regardless of an extract source (plant), the germination viability of seeds of *T. aestivum* was inhibited by maceration (-0.8%), when the activity of the infusion was under an error of a control variant. A germination of *S. cereale* was inhibited by an maceration (-13.5%), as well as by infusion (-6.3%). In a case of *Triticosecale* an average activity of maceration and infusions was under an error of a control variant.

Significant was also an interaction between source × preparation mode of the extracts, however the conformity of response of investigated cereal plants on the extracts used was non significant (wheat × rye r=0.119; wheat × triticale r=0.189; rye × triticale r=-0.145; critical value of correlation coefficient r for number of observations N=20 and significance level P=95% amount to 0.443). It indicates that a interaction significance resulted from an extent of reaction of cereal plants on used extracts as well as from its direction.

So, the germination viability of seeds was significantly most strongly inhibited (Fig. 2): ***T. AESTIVUM*** – by macerations from roots of ***L. officinale*** (-8.5%) and bark of ***S. alba*** and ***S. purpurea*** (-3.2%). The negative impact of remaining 10 macerations and 7 infusions was under a limit of a control error; ***S. CEREALE*** – by maceration from bark of ***S. alba*** and ***S. purpurea*** (-44.2%), infusion from green parts of ***A. absinthium*** (-39.0) and maceration and infusion from leaves of ***C. sinensis*** (-35.5%; -39.9%). Moreover significantly negatively influenced the germination viability 7 macerations and 3 infusions made from other plants; ***TRITICOSECALE*** – by macerations and infusions from roots of ***L. officinale*** (-46.8; -43.4%), fruits of ***C. sativum*** (-44.0; -33.3%), green parts of ***S. hortensis*** (-42.9; -38.4%) and from seeds of ***L. usitatissimum*** (-42.9; -33.9%). Aside from that, a negative impact was shown by 5 macerations and 4 infusions made from other plants.

The germination viability of seeds was stimulated:

- ***T. AESTIVUM*** - by 8 macerations i 13 infusions, especially by infusion from green parts of ***A. absinthium*** and maceration from leaves of ***R. nigrum***. Their activity was between the limits of a control error.
- ***S. CEREALE*** – significantly favourably influenced by maceration and infusion from a bark of ***Q. robur*** (12.4; 14.7%). Positively, but non significantly influenced the germination 2 maceration and 6 infusion from another plants, especially from leaves of ***J. regia*** and sprouts of ***P. sylvestris*** (+11.2%);
- ***TRITICOSECALE*** – was significantly stimulated by a macerations and infusions from bark of ***Q. robur*** (69.7; 45.6%), leaves of ***R. nigrum*** (32.8; 27.7%) and macerations from roots of ***A. lappa*** (36.1%), green parts of ***H. officinalis*** (35.6%) and green parts of ***A. absinthium*** (30.5%).

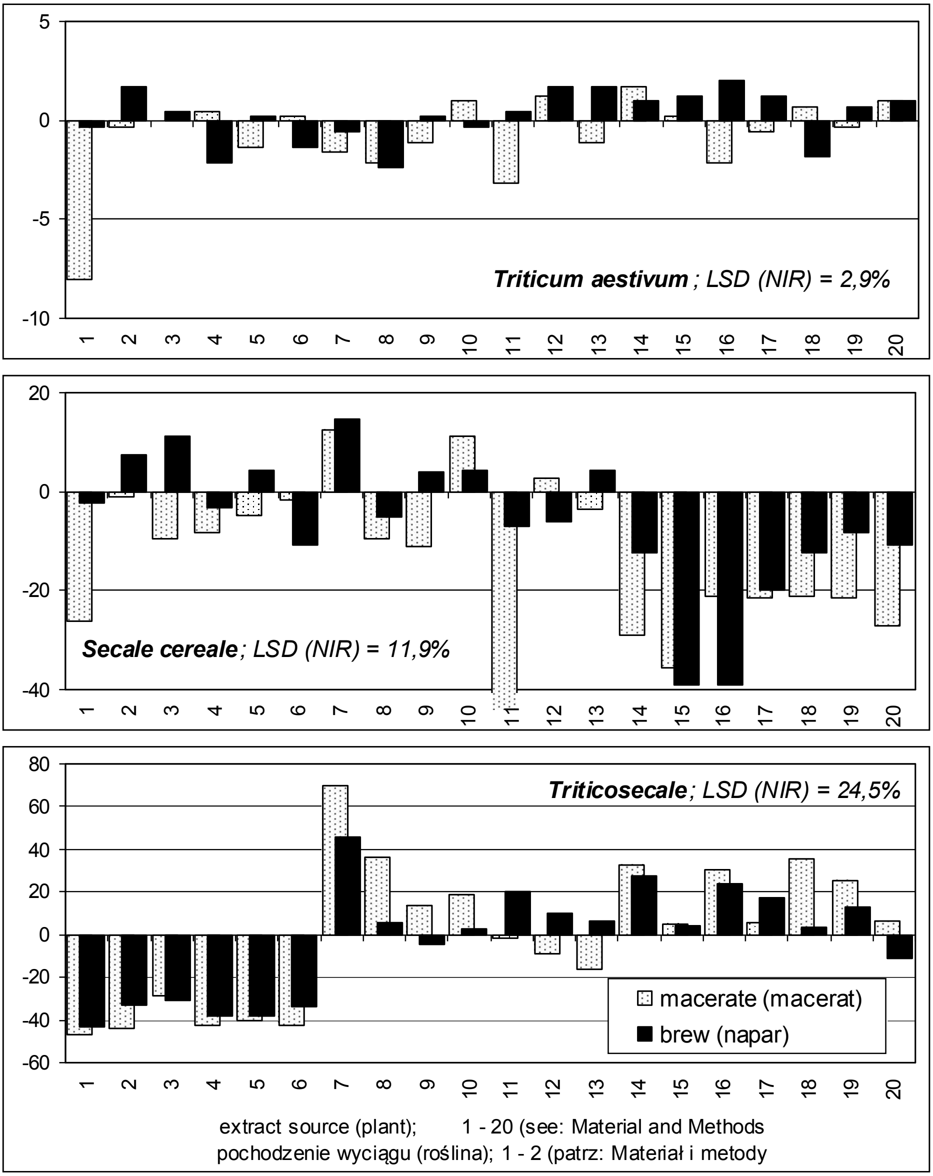



**Fig. 2.** Seeds vitality depending on a source and a preparation mode of the extracts (I time; number of normally germinated seeds – deviation from control in %)

**Rys. 2.** Żywotność nasion w zależności od pochodzenia i sposobu przygotowania wyciągów (I termin; liczba nasion normalnie kiełkujących – odchylenie od kontroli w %)

The impact of used extracts on germination viability and capacity of grain seeds was reciprocally positively correlated. Values of correlation coefficients amounted 0.496* for *T. aestivum;* 0.864** for *S. cereale* 0.798** for *Triticosecale*. Also a variability (V%) of grain plant reaction on the investigated extracts was slight and oscillated from 1.85% for *T. aestivum* to 16.6% for *S. cereale* and 29.85% in case *Triticosecale*.

Germination capacity

In a case of germination capacity a percent of normally germinated seeds expressed as a deviation from a control amounted: 2.4% (range from -24.5 to +15.3%) for *T. aestivum*; -6.4% (range from -33.0 to +12.7%) for *S. cereale*; -6.5% (range from -42.4 to +21.8%) for *Triticosecale*.

Regardless of a mode of an extract preparation, the germination viability of grain plants was significantly most strongly inhibited by (Fig.1B): ***T. AESTIVUM*** – 5 extracts (range from -19.9 to -8.3%), it was: extracts from flowers of ***L. vera*** (-19.9%), roots of ***L. officinale*** (-15.6%), sprouts of ***P. sylvestris*** (-13.7%), fruits of ***C. sativum*** (-9.4%) and roots of ***A. lappa*** (-8.3%); ***S. CEREALE*** – 8 extracts (range from -29.7 to – 0.5%), it was extracts from leaves of ***C. sinensis*** (-29.7%), fruits ***C. carvi*** (-23.7%), flovers ***V. thapsiforme*** (-19.8%), green parts of ***H. officinalis*** (-18.2%), fruits of ***J. communis*** (-17.3%) and green parts of ***A. absinthium*** (-15.6%); ***TRITICOSECALE*** – 6 extracts (range from -33.2 to -16.8%). Germination of seeds was inhibited by extracts from green parts of ***S. hortensis*** (-33.2%), roots of ***L. officinale*** (-33.0%), fruits of ***C. sativum*** (-26.5%), sprouts of ***P. sylvestris*** (-23.1%), flowers of ***L. vera*** (-18.6%) and seeds of ***L. usitatissimum*** (-16.8%).

A significantly stimulating effect on germination capacity showed however:

- ***T. AESTIVUM*** – 9 extracts (range from +1.5 to +14.1%), especially extracts from bark of ***S. alba*** and ***S. purpurea*** and green parts of ***O. majorana*** (+14.1%), leaves of ***C. sinensis*** (+13.78%), leaves of ***R. nigrum*** (+13.2%), roots of ***A. officinalis*** (+12.8%);
- ***S .CEREALE*** – extracts from bark of ***Q. robur*** (+11.9%) and leaves of ***J. regia*** (+8.1%);
- ***TRITICOSECALE*** – extracts from fruits of ***C. carvi*** (+16.1%), green parts of ***A. absinthium*** (+15.9%) and bark ***Q. robur*** (+14.0%).

Regardless of an extract source (plant), the germination capacity of seeds of *S. cereale* and *Triticosecale* was inhibited by both kinds of water extracts, when an infusion had a stimulating effect. A germination of *T. aestivum* seeds was significantly stimulated by maceration.

The analysis carried out revealed that beside of a proved interaction between a source of an extract and preparation mode, a significantly consistent reaction was observed only between *T. aestivum* a *Triticosecale* (r=0.429**). The impact of extracts on germination capacity of *T. aestivum* × *S. cereale* and *S. cereale* × *Triticosecale* was different, both in respect of intensity and a direction of response.

So, most significantly the germination capacity was reduced by (Fig.3): ***T. AESTIVUM*** – macerations and infusions from roots of ***L. officinale*** (-19.5; -11.4%) and flovers of ***L. vera*** (-15.5; -24.5%) as well as infusions from sprouts of ***P. sylvestris*** (-20.4%) fruits of ***C. sativum*** (-14.7%); ***S. CEREALE*** – macerations and infusions from leaves of ***C. sinensis*** (-26.5; -33.0%), fruits of ***C. carvi*** (-29.6; -17.9%), flowers of ***V. thapsiforme*** (-16.5; -23.0%), green parts of ***H. officinalis*** (-21.6; -14.8%), green parts of ***A. absinthium*** (-18.6; -12.7%) and macerations from fruits of ***J. communis*** (-25.8%) and bark of ***S. alba*** and ***S. purpurea*** L (-20.2%); ***TRITICOSECALE*** – macerations and infusions from green parts of ***S. hortensis*** (-30.6; -35.9%), roots of ***L. officinale*** (-42.4; 23.7%), fruits of ***C. sativum*** (-27.8; -25.3%), sprouts of ***P. sylvestris*** (22.1; -24.1%), flovers of ***L. vera*** (-15.2; -22.1%), seeds of ***L. usitatissimum*** (-18.0; -15.6%) and maceration from fruits of ***J. communis*** (-20.0%) and infusion from leaves of ***C. sinensis*** (-19.6%).

Most favourably influenced the germination capacity of seeds of:

- ***T. AESTIVUM*** – macerations and infusions from bark of ***S. alba*** and ***S. purpurea*** L (+13.8; +14.4%), leaves of ***C. sinensis*** (+14.1; +13.2%), macerations from leaves of ***R. nigrum*** (+14.7%) and flowers of ***V. thapsiforme*** (+13.5%) and infusion from green parts of ***O. majorana*** (+15.3%);
- ***S. CEREALE*** – maceration and infusion from bark of ***Q. robur*** (+11.0; +12.7%) and maceration from leaves of ***J. regia*** (+11.3%);
- ***TRITICOSECALE*** – macerations from fruits of ***C. carvi*** (+21.8%), bark of ***Q. robur*** (+19.3%) and green parts of ***A. absinthium*** (+17.7).

Healthiness

The influence of infusions upon healthiness of cereal seeds was more differentiated than that on germination viability and capacity. The variability coefficients (V%) amounted 66.8% (wheat); 44.1% (rye) and 104.7% (triticale). Furthermore their impact on a number of infected seeds and on a germination viability and capacity (number of normally germinated seeds) was different. The correlation coefficients amounted respectively -0.860** and -0.999** for *T. aestivum*; -0.081 and -0.130 for *S. cereale*; -0.005 and -0.061 for *Triticosecale*.

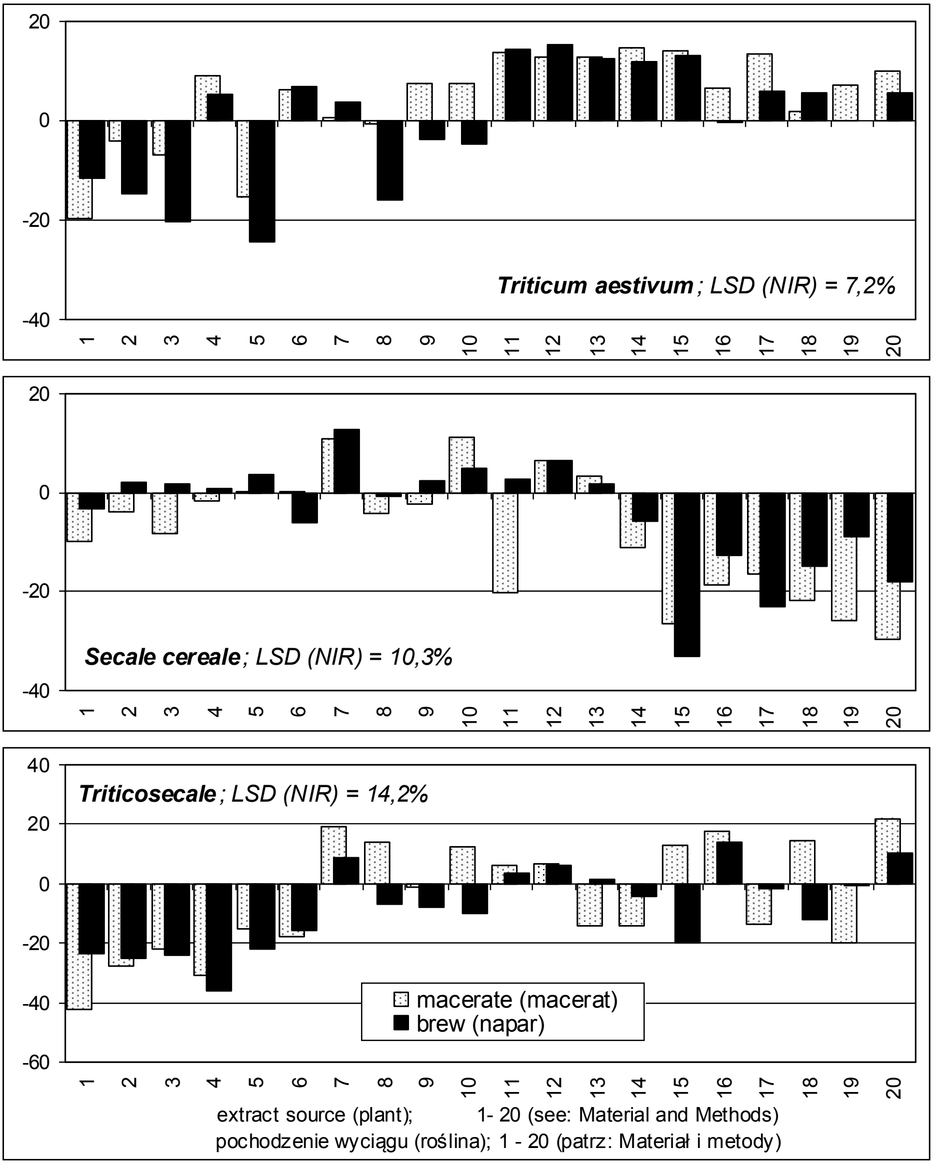



**Fig. 3.** A seeds vitality depending on a source and a preparation mode of the extracts (II time; a number of normally germinated seeds – deviation from control in %)

**Rys. 3.** Żywotność nasion w zależności od pochodzenia i sposobu przygotowania wyciągów (II termin; liczba nasion normalnie kiełkujących – odchylenie od kontroli w %)

In a case of healthiness a percent of infected seeds expressed as a deviation from a control amounted in average: -11.9% (range from -80.8 to +107.7%) for *T. aestivum*; -21.1% (range from -66.7 to +45.0%) for *S. cereale*; -4.6% (range from -78.5 to +155.1%) for *Triticosecale*.

Regardless of a preparation mode an increase of a number of infected seeds was significantly caused by (fig.1C): ***T. AESTIVUM*** – 5 extracts. It was extracts from flowers of ***L. vera*** (+107.7%), roots of ***L. officinale*** (+80.1%), sprouts of ***P. sylvestris*** (+78.5%), fruits of ***C. sativum*** (+50.9%) and roots ***A. lappa*** (+41.0%); ***S. CEREALE*** – 2 extracts: extract from roots of ***L. officinale*** (+45.8%) and from seeds of ***L. usitatissimum*** (+30.6%); ***TRITICOSECALE*** – 5 extracts, made from flowers of ***C. officinalis*** (+155.1%), leaves of ***J. regia*** (+69.2%), green parts of ***O. majorana*** (+34.7%), roots of ***L. officinale*** (+32.3%) and from roots of ***A. lappa*** (+28.7%). The number of infected seeds of three cereal plants was increased in a small or greater degree by extracts from roots of ***L. officinale*** and sprouts of ***P.sylvestris***.

The number of infected seeds was reduced however most strongly by:

- ***T. AESTIVUM*** – extracts from 7 plant species. It was extracts from roots of ***S. alba*** and ***S. purpurea*** (-80.8%), green parts of ***O. majorana*** (-73.9%), roots of ***A. officinalis***, leaves of ***C. sinensis*** (-70.1%) and leaves of ***R. nigrum*** (-68.6%), flowers of ***V. thapsiforme*** (-48.7), fruits of ***C. carvi*** (-39.5%) and seeds of ***L. usitatissimum*** (-31.0%);
- ***S. CEREALE*** – extracts from 8 extracts, especially from bark of ***S. alba*** and ***S. purpurea*** (-66.7%), leaves of ***J. regia*** -59.7%), flowers of ***C. officinalis*** (-51.4%), roots of ***A. officinalis*** (-50.0%), bark of ***Q. robur***, green parts of ***O. majorana*** and leaves of ***R. nigrum*** (-45.8%) ;
- ***TRITICOSECALE*** – 5 extracts, namely from leaves of ***C. sinensis*** (-78.6%), green parts of ***A. absinthium*** (-74.9%), fruits of ***J. communis*** and ***C. carvi*** (-64.3% and -63.1% respectively), green parts of ***H. officinalis*** (-59.5%).

In a case of *S. cereale* both a maceration (-15.8%) and an infusion (-26.6%) (regardless of a source) reduced significantly a number of infested seeds, while an infection of seeds of *T. aestivum* was reduced only by maceration (-23.7%).

It was proved also a diverse influence of the extracts upon a healthiness of seeds of cereal plants depending on a source and preparation mode of the extracts. The significantly consistent response was observed only in a case of *T. aestivym* and *S. cereale* (r=0.512*).

It was accompanied by that fact (fig.4) that significantly negatively on healthiness of seeds influenced: ***T. AESTIVUM*** – 3 macerations and 5 infusions, especially macerations and infusions from flowers of ***L. vera*** (+85.4; +129.9%), roots of ***L. officinale*** (+103.8; +56.3%), sprouts of ***P. sylvestris*** (+36.4; +120.7%) and infusions from fruits of ***C. sativum*** (+80.8%) and roots of ***A. lappa*** (+77.8%); ***S. CEREALE*** – macerations from two plant species, namely from roots of ***L. officinale*** (+72.2%) and flowers of ***L. vera*** (+38.9%); ***TRITICOSECALE*** – 2 macerations and 5 infusions. It was: maceration and infusion from flowers of ***C. officinalis*** (+226.7; +83.5%), maceration from roots of ***L. officinale*** (+50.1%) as well as infusions from leaves of ***J. regia*** (+147.9%), sprouts of ***P. sylvestris***, green parts of ***O. majorana*** (+52.5%) and roots of ***A. lappa*** (+47.8%).

Similarly a number of infected seeds were reduced by:

- ***T. AESTIVUM*** - 8 macerations and 5 infusions: especially from macerations and infusions from bark of ***S. alba*** and ***S. purpurea*** (-81.6; -80.1%), green parts of ***O. majorana*** (-69.3; -78.5%), roots of ***A. officinalis*** (-73.9; -66.3%), leaves of ***C. sinensis*** (-70.9; 69.3%), leaves of ***R. nigrum*** (-72.4; -64.7%) and macerations from flowers of ***V. thapsiforme*** (-67.8%) and fruits of ***C. carvi*** (-52.5%);
- ***S. CEREALE*** – 9 macerations and 9 infusions. Most favorably influenced the healthiness of seeds macerations and infusions from bark of ***S. alba*** and ***S. purpurea*** (-61.1; -72.2%), leaves of ***J. regia*** (-69.4; -50.0%), flowers of ***C. officinalis*** (-4.4; -58.3%), roots of ***A. officinalis*** (-55.6; -44.4%), bark of ***Q. robur*** (-47.2; -44.4%), green parts of ***O. majorana*** (-44.4; -47.2%) and infusion from flowers of ***V. thapsiforme*** (-52.8);
- ***TRITICOSECALE*** – 5 macerations and 7 infusions, especially from leaves of ***C. sinensis*** (-71.4; 85.7%), green parts of ***A. absinthium*** (-73.8; -76.2%), fruits of ***J. communis*** (-54.7; -73.8%), fruits of ***C. carvi*** (-64.3; -61.9%), green parts of ***H. officinalis*** (-52.3; -66.6%) and infusion from leaves of ***R. nigrum*** (-54.7%).

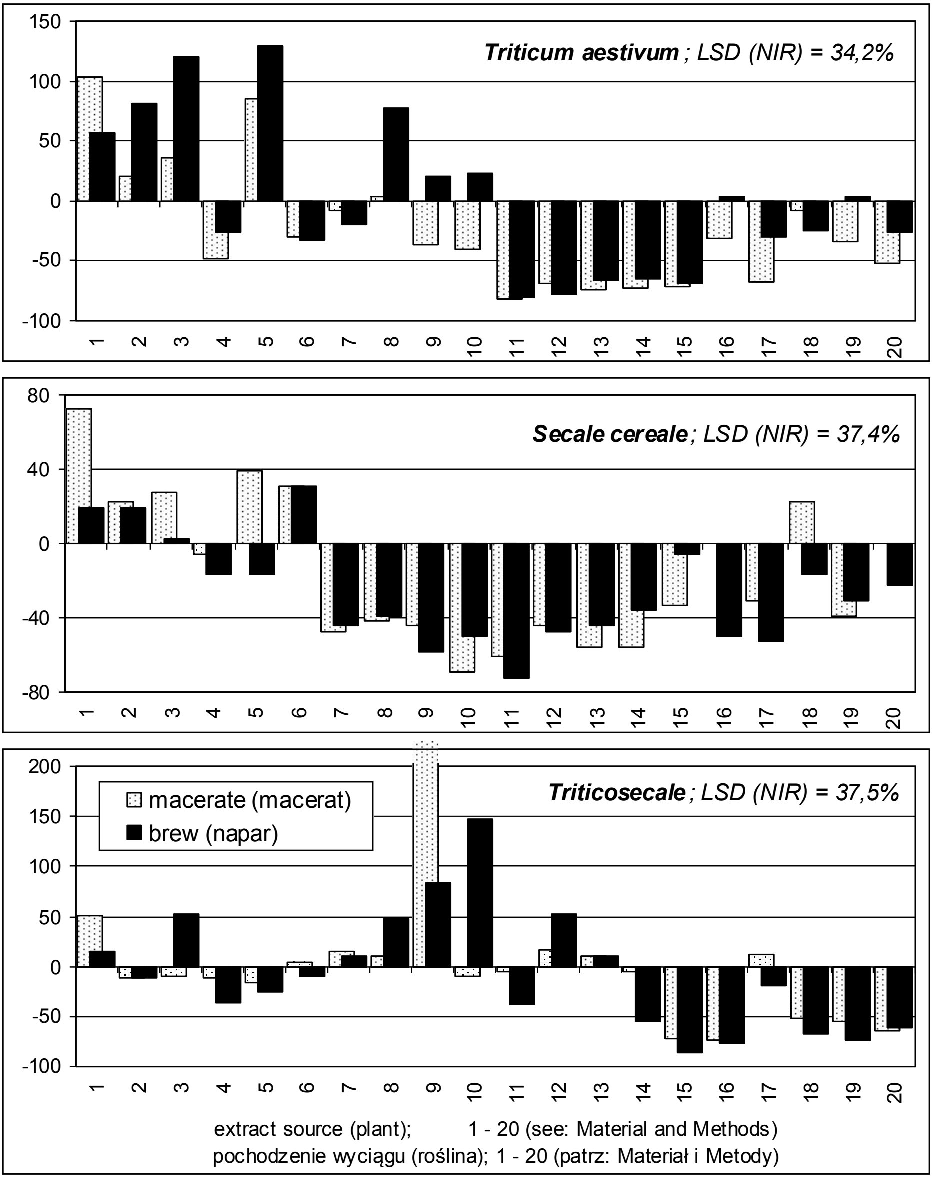



**Fig. 4.** A seeds healthiness depending on a source and a preparation mode of the extracts (number of infested seeds – deviation from control in %)

**Rys. 4.** Zdrowotność nasion w zależności od pochodzenia i sposobu przygotowania wyciągów (liczba nasion porażonych - odchylenie od kontroli w %)

## 4. Discussion

The subject literature contains many contributions on the use of bioactive substances contained in herbal plants in management of insect pests (Achremowicz, Cież 1992, Kmitowa et al. 1997, Banaszak, Jagusz 1999, Dankowska, Robak 2006, Pisarek 2006, Górski, Piątek 2008, Tomczyk et al. 2008).The contributions on use of these substances to control of plant pathogens are not so numerous. Moreover, they are focused mainly on *in vitro* researches and carried out on a small number of herbal plants and plant pathogens.

The functioning and activity of the bioactive substances differ depending on their origin i.e. species of herbal plant, a preparation mode as well as on a protected crop and the plant pathogen. In a case of seed dressing formulations made from plant extracts there is essential not only a healthiness of seeds and sprouts but also their vitality i.e. – the germination viability and capacity.

Stompor-Chrzan (2002) has revealed that a dried fruits of *Coriandrum sativum* and green parts of *Satureja hortensis* given to a substratum stimulated as regard to a control the seed germination of *Cucumis sativus*. It was on a level of 83.3% and 79.2 %. The plant healthiness was also higher. The similar results were obtained by the same author (2003) by seed dressing of *Pisum sativum* with extracts from leaves of *Ribes nigrum* and from bark of *Aesculus hippocastanum*. These extracts stimulated seed germination and reduced fungal root rot infection.

The extracts made from some plants may however restrict the vitality of treated seeds. For instance Panasiewicz et al. (2007) have proved that seeds of *Avena sativa, Triticale* and *Secale cereale* treated with Vitavax 200 FS and *Triticale* and *Zea mays* treated with Bioczos BR did not meet a minimal germination capacity. In turn the seed germination capacity of *Daucus carota* was restricted by 0.1 % solution of oils from basil and thyme (Dorna et al. 2008).

The similar different effect of some extracts on vitality of cereal seeds were observed in our earlier researches. For instance the seed longevity of Akt variety of *Avena sativa* was stimulated by extracts from *Melissa officinalis* and *Satureja hortensis* and inhibited by extracts from *Urtica dioica* and *Lavandula vera*. The seed longevity of Bajka variety was stimulated however by extracts from *Taraxacum officinale* and *Matricaria chamomilla*, and inhibited by extracts from *Melissa officinalis* and *Levisticum officinale* (Sas-Piotrowska et al. 2005).

However a vitality of seeds of *Triticum aestivum* was stimulated by infusions from *Aesculus hippocastanum, Saponaria officinalis, Allium sativum* and *Mentha piperita*, of *Secale cereale* – by infusions from *Crataegus oxycantha* and *Zea mays* and macerations from *Taraxacum officinale* and *Frangula alnus* and of *Triticosecale* – by infusions from *Zea mays, Melissa officinalis* and *Frangula alnus* (Sas-Piotrowska et al. 2004). Negatively on a vitality and healthiness of seeds of investigated cereal plants influenced macerations from *Sambucus nigra* and *Rosa canina.*

In the presented own researches there was observed that: a germination viability and capacity of *Triticum aestivum* was stimulated by extracts from leaves of *Ribes nigrum* and green parts of *Origanum majorana*; of *Secale cereale* – by extracts from bark of *Quercus robur* and leaves of *Juglans regia* and of *Triticosecale* – by extracts from bark of *Quercus robur* and green parts of *Artemisia absinthium*. A vitality of cereal plants was also stimulated by macerations: from a bark of *Salix alba* and *S.purpurea*, and sprouts of *Pinus sylvestris*. Germination vitality of *T.aestivum* was reduced by macerations and infusions from roots of *Levisticum officinale*; *S.cereale* – maceration from bark of *Salix alba* and *S.purpurea*; *Triticosecale* – macerations and infusions from green parts of *Satureja hortensis*, roots of *Levisticum officinale*, fruits of *Coriandrum sativum*, sprouts of *Pinus sylvestris*, flovers of *Lavandula vera* and seeds of *Linum usitatissimum*.

Piotrowski et al. (1995) assessing *in vitro* the bioactivity of 106 plant extracts in relation to 5 fungi species have revealed that their fungistatic activity depended on a extract source and a fungus species being tested. None of the tested extracts had restricted in 100 % the spores germination although the modifications of infection hyphae were visible.

On the other hand Stompor-Chrzan (2003) found that from among 22 plant extracts about 33 % revealed *in vitro* fungistatic properties in relation to *Alternaria alternata*. There were first of all the extracts from *Satureja hortensis*, *Levisticum officinale*, *Archangelica officinalis*, *Coriandrum sativum*, *Ribes nigrum*, *Populus tremula* and *Pinus sylvestris*. Masny et al. (2006) observed however that from among 16 plant extracts germination of conidia spores of *Venturia inequalis* was hampered by extracts from *Rubus sp.*, *Lavandula vera*, *Ribes nigrum*, *Artemisia absinthium* and *Hypericum perforatum*.

Also in the own researches it was proved that the healthiness of the seeds of different cereal species or their cultivars treated with the extracts from different herbal plants may be diverse. The seed infection of Akt variety of *Avena sativa* L. was most strongly reduced by infusions from *Mentha piperita* and *Melissa officinalis* as well by macerations from *Mentha piperita* and *Levisticum officinale* while for Bajka variety those were infusions from *Lavandula vera* and *Coriandrum sativum* as well as macerations from *Satureja hortensis* and *Linum usitatissimum* (Sas-Piotrowska et al. 2005). However the seed infection of Akt variety was stimulated by infusions from *Artemisia vulgaris* and *Crataegus oxyacantha* and macerations from *Urtica dioica* and *Rosa canina*, and of Bajka variety by infusions from *Rosa canina* and *Matricaria chamomilla* as well as macerations from *Urtica dioica* and *Artemisia vulgaris*.

A healthiness of seeds another plants of wheat was improved in general by the same extracts which influenced positively on vitality of the seeds. There were in a case of *T. aestivum* infusions from *Aesculus hippocastanum* and *Saponaria officinalis*, maceration from *Betula verrucosa*; of *S. cereale* – maceration from *Taraxacum officinale*, infusion from *Crataegus oxyacantha and Frangula alnus*; and of *Triticosecale* – macerations from *Taraxacum officinale*, *Inula helenium* and *Crataegus oxyacantha* (Sas-Piotrowska et al. 2004).

Regardless of a preparation mode an increase of a number of infected seeds of *T. aestivum* was caused by extracts from fruits of *Rosa canina* and from flowers of *Sambucus nigra*. In a case of *S. cereale* it was extracts from roots of *Saponaria officinalis* and from fruits of *Rosa canina*, and of *Triticosecale* – from roots of *Saponaria officinalis* and from leaves of *Urtica dioica*.

Kaczmarek-Cichosz and Sas-Piotrowska (2008) had proved however that seed infection of *Hordeum vulgare* was most strongly restricted by extracts from roots of *Arctium lappa*, seeds of *Linum usitatissimum*, green parts of *Hyssopus officinalis* and *Origanum majorana*.

In the presented researches a number of infested seeds of *T. aestivum* was increased by extracts from a bark of *Salix alba* and *S. purpurea*; green parts of *Origanum majorana*, leaves of *Camellia sinensis* and leaves of *Ribes nigrum*; *S. cereale* – extracts from a bark of *Salix alba* and *S. purpurea*, leaves of *Juglans regia*; bark of *Quercus robur* and parts of *Origanum majorana*: *Triticosecale* – extracts from leaves of *Camellia sinensis*, green parts of *Artemisia absinthium* and leaves of *Ribes nigrum*.

Significantly negatively healthiness of seeds influenced: *T. aestivum* – macerations and infusions from flowers of *Lavandula vera*, roots of *Levisticum officinale*, sprouts of *Pinus sylvestris*; *S. cereale* – macerations from roots of *Levisticum officinale*; *Triticosecale* – maceration and infusion from flowers of *Calendula officinalis*, as well as infusions from leaves of *Juglans regia* and sprouts of *Pinus sylvestris*.

As it results from literature and from experiments carried out the effect of plant extracts is differentiated and depends on abiotic and biotic environmental factors; their preparation is very laborious, the assessment is not always reliable and their bioactivity is often insufficient. All this is a cause of still very restricted use of the bioformulations based on plant extracts in plant protection practice, what was earlier reported by Orlikowski et al.(2002).

## 5. Conclusions

1. A vitality and a healthiness of the seeds depended both from a species of a cereal plant and from an extract source (plant species) and the way of its preparation.
2. A germination viability and capacity of *T.aestivum* was stimulated by extracts from leaves of *Ribes nigrum* and green parts of *Origanum majorana*; of *S. cereale* – by extracts from bark of *Quercus robur* and leaves of *Juglans regia* and of *Triticosecale* – by extracts from bark of *Quercus robur* and green parts of *Artemisia absinthium*. A vitality of cereal plants was also stimulated by macerations: from a bark of *Salix alba* and *S.purpurea*, and sprouts of *Pinus sylvestris*.
3. A number of infested seeds and emerging cereal plants were improved in general by the same extracts which influenced positively on vitality of the seeds. There were in a case of *T. aestivum* extracts from a bark of *Salix alba* and *S.purpurea*; green parts of *Origanum majorana*, leaves of *Camellia sinensis* and leaves of *Ribes nigrum*; *S.cereale* – extracts from a bark of *Salix alba* and *S.purpurea*, leaves of *Juglans regia*; bark of *Quercus robur* and parts of *Origanum majorana*; *Triticosecale* – extracts from leaves of *Camellia sinensis*, green parts of *Artemisia absinthium* and leaves of *Ribes nigrum*.

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# Żywotność i zdrowotność nasion roślin zbożowych traktowanych wyciągami roślinnymi


## Streszczenie

Celem prezentowanych doświadczeń było określenie wpływu wyciągów roślinnych na żywotność i zdrowotność nasion ***Triticum aestivum*** L., ***Secale cereale*** L., ***Triticosecale*** Wittm. Wyciągi wodne (maceraty i napary) sporządzano z różnych części morfologicznych 20 gatunków roślin: ***Levisticum officinale*** L., ***Coriandrum sativum*** L., ***Pinus sylvestris*** L., ***Satureja hortensis*** L., ***Lavandula vera*** L., ***Linum usitatissimum*** L., ***Quercus robur*** L., ***Arctium lappa*** L., ***Calendula officinalis*** L., ***Juglans regia*** L., ***Salix alba*** L i ***S.purpurea*** L., ***Origanum majorana*** L., ***Archangelica officinalis*** Hoffm., ***Ribes nigrum*** L., ***Camellia sinensis*** L., ***Artemisia absinthium*** L., ***Verbascum thapsiforme*** L., ***Hyssopus officinalis*** L., ***Juniperus communis*** L., ***Carum carvi*** L. W doświadczeniu założonym wg wymogów PN-94R-6595 określano energię i zdolność kiełkowania nasion oraz ich zdrowotność (porażenie przez grzyby i bakterie).

Wyniki badań opracowano statystycznie za pomocą analizy wariancji i korelacji liniowej. Wykazano, że w zależności od pochodzenia (rośliny) i sposobu przygotowania wyciągi różniły się istotnie między sobą oddziaływaniem na energie i zdolność kiełkowania oraz zdrowotność nasion *Triticum aestivum, Secale cereale, Triticosecale*.

Energię kiełkowania nasion poszczególnych roślin zbożowych stymulowały: ***T. aestivum*** – napar z ziela *A. absinthium* i macerat z liści *R. nigrum*; ***S. cereale*** – macerat i napar z kory *Q. robur* a także wyciągi z liści *J. regia* i pędów *P. sylvestris*; ***Triticosecale*** – maceraty i napary z z kory *Q. robur*, liści *R. nigrum* oraz maceraty z korzeni *A. lappa*, ziela *H. officinalis* i *A. absinthium*.

Na zdolność kiełkowania wpływały najkorzystniej: ***T. aestivum*** – maceraty i napary z kory *S. alba* i *S. purpurea* L, liści *C. sinensis*, maceraty z liści *R. nigrum* i kwiatów *V. thapsiforme* oraz napar z ziela *O. majorana*; ***S. cereale*** – macerat i napar z kory *Q. robur* i macerat z liści *J. regia*; ***Triticosecale*** – macerat z owoców *C. carvi*, kory *Q. robur* i ziela *A. absinthium*.

Mikrobiologiczne skażenie nasion ograniczały natomiast: ***T. aestivum*** – maceraty i napary z kory *S. alba* i *S. purpurea*, ziela *O. majorana*, korzeni *A. officinalis*, liści *C. sinensis* i *R. nigrum* oraz maceraty z kwiatów *V. thapsiforme* i owoców *C. carvi*; ***S. cereale*** – maceraty i napary z kory *S. alba* i *S. purpurea*, liści *J. regia*, kwiatów *C. officinalis*, korzeni *A. officinalis*, kory *Q. robur*, ziela *O. majorana* oraz napar z kwiatów *V. thapsiforme*; ***Triticosecale*** – maceraty i napary z liści *C. sinensis*, ziela *A. absinthium*, owoców *J. communis* i *C. carvi*, ziela *H. officinalis* oraz napar z liści *R. nigrum*.