Stability of terrestrial ecosystems under the influence of steroid glycoalkaloids

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Abstract. Soil-transmitted helminths are one of the most pressing problems of the urban area. Worm infestations are diseases with a high (more than 50%) mortality rate among both children and adults. Therefore, one of the most pressing safety problems of not only the technosphere, but also the homosphere, is the search for methods of disinfection of the soil cover of urban areas with a minimum load on the biota and ecological risk tending to zero. As a solution to this problem, it is proposed to use secondary plant metabolites (steroid glycoalkaloids) as a means for disinfecting various environmental objects: wastewater and their sediments, soil, sand of playgrounds, etc.

The effect of various concentrations of potato juice (Solanum tuberosum) on the components of terrestrial ecosystems on the shores of water bodies: higher plants (oats (Avenum sativa)) and soil microflora (soil micromycetes Aspergillus niger, Aspergillus terrius, Alternaria alternaria, Fusarium moniliforme) was studied. Revealed moderate phytotoxicity for Avenum sativa, as well as a strong stimulatory effect for Fusarium moniliforme and Alternaria alternaria.

1. Introduction

Soil microorganisms, being the obligatory component of each soil ecosystem, have strong fermentative organs and carry out various functions in the circulation of substances, enabling the constant functioning of the whole ecosystem. The ability of microorganisms to survive under adverse conditions and to regain their normal population under optimal conditions attests to the stability of soil as a biological system. At the same time, negative effects on the ecosystem can hinder the restoration of the stable state, and the system will irreversibly degrade. Evaluation and prediction of alterations taking place in soil as a result of soil contamination by persistent pollutants is an important ecological task [1].

Soil-transmitted helminths (STHs) are parasites involving roundworms (ascarids), hookworms and whipworms which can affect animals and humans [2, 3]. When disinfecting both surface wastewater and bottom sediments of various industrial objects from pathogens (cysts of intestinal pathogenic protozoa, helminth eggs, etc.), it is impossible to completely exclude contact of the disinfection agent with components of terrestrial ecosystems (soil microflora, higher plants, etc.). Despite successful deworming is frequently administered among captive wild carnivores in zoo gardens (lions, lynxes, foxes, wolves), they infected again by helminths because their maintenance in the same parcels enhances that ground is permanently contaminated by eggs passed in the feces [4]. The eggs of ascarids and whipworms are very resistant to chemical and climatic factors, thus can remain infective in the soil for several years [5]. Nevertheless, there is insufficient information regarding measures to reduce the presence of infective stages in the ground. Prior investigations reported that certain saprophytic soil fungi perform an antagonistic activity on eggs of Toxocara canis and Ascaris suum, based on their ability...
to adhere to the eggshell, penetrate and destroy the embryo inside [6]. For the promotion of environment friendly agriculture, the use of organic compounds is now increasingly attempted in controlling weeds and soil borne pathogens [7].

Since the mid-2000s, biological methods of soil deworming have been introduced into widespread use, allowing both to reduce the costs of the disinfestation process of various environmental objects and to reduce the damage to aquatic and terrestrial ecosystems from such activities to a minimum. However, despite the proven efficacy and relative harmlessness, the effect of the components of biogenic preparations has not been studied enough. In particular, there are no comprehensive data on the effect of the active substance of potato juice preparations (steroidal glycoalkaloids (SGA)) on higher plants and soil microflora.

The aim of this work was to study the effect of SGA preparations based on potato *Solanum tuberosum* on the components of terrestrial ecosystems adjacent to the object of disinfection (higher plants and soil microflora).

2. **Materials and methods**

Experimental samples of the preparation were prepared from the juice of potato plants of 5 - 8 cm growth by mechanical grinding, distilled water was added based on a ratio of 1:50 and the most saturated sodium benzoate solution (at room temperature), based on the proportions of 100 μl / liter of the preparation. Investigated: 1) fungicidal properties (soil micromycetes *Aspergillus niger*, *Aspergillus terrius*, *Alternaria alternaria*, *Fusarium moniliforme*); 2) phytotoxicity (seed germination of *Avenum sativa*, mm) [8, 13].

3. **Results and discussion**

When studying the phytotoxicity of SGA in potato juice, it was found that the most significant suppression of the growth of *Avenum sativa* was achieved using a concentration of 10^-4 g / L: the length of the juvenile form of *Avenum sativa* was 52.9 ± 1.9 mm (p <0.05), which is 38.7% lower compared to control. When using a potato juice dilution of 10^-2 g / L, an insignificant stimulating effect was found: the length of the *Avenum sativa* seedling did not differ significantly from the control by 11.5% and amounted to 96.3 ± 7.2 mm (Table 1).

**Table 1. Phytotoxicity of potato juice**

| Concentration (gram per Liter) | L₉₅₀, mm | %     |
|-------------------------------|----------|-------|
| 10^-7                         | 64.6±5.4 | −25.2 |
| 10^-6                         | 63.4±5.8 | −26.6*|
| 10^-5                         | 64.2±4.4 | −25.7 |
| 10^-4                         | 52.9±1.9 | −38.7*|
| 10^-3                         | 62.1±2.3 | −28.1*|
| 10^-2                         | 96.3±7.2 | +11.5 |
| Control                       | 86.4     |       |

Significant differences in relation to the control: * p <0.05, ** p <0.01, *** p <0.001

When studying the effect of SGA of potato juice on test cultures of soil micromycetes, it was found that the most significant change in CFU for all species was observed when the preparation was diluted with 0.1 and 1%. Thus, in the case of a concentration of 0.1%, the CFU value for *Aspergillus niger* was 2.835 ± 0.03 (p <0.05), which is 42% higher than the control; for *Aspergillus terrius* CFU increased by 87% compared to the control and amounted to 3.751 ± 0.08 (p <0.05); for *Alternaria Alternaria* - 12.350 ± 0.03 (p <0.05), which is 59% higher than the control; for *Fusarium moniliforme* - 12.350 ± 0.03.
(p <0.05), which is 517% higher than the control value. When using a concentration of 1% for Aspergillus niger, the CFU increased by 34% compared to the control and amounted to 2.675 ± 0.01 (p <0.05); for Aspergillus terrius - by 69% compared with the control indicator and amounted to 3.388 ± 0.07 (p <0.05); for Alternaria alternaria, the CFU value increased by 85% compared to the control value and amounted to 5.111 ± 0.01 (p <0.05); for Fusarium moniliforme - by 365% compared to control and amounted to 8.720 ± 0.09 (p <0.05).

Also for Alternaria alternaria and Fusarium moniliforme, 10% and 100% juice dilutions had a significant stimulating effect. Thus, in the case of a 10% dilution of potato juice, the CFU value in Alternaria Alternaria increased by 262% in comparison with the control and amounted to 7.242 ± 0.02 (p <0.05); for Fusarium moniliforme - by 115% compared to the control and amounted to 5.136 ± 0.06 (p <0.05).

When using a juice concentration of 100% (undiluted), the CFU value increased most significantly compared to the control values for Alternaria alternaria and Fusarium moniliforme. Thus, for Alternaria alternaria the CFU was 5.333 ± 0.04 (p <0.05), which is 93% higher than the control value; for Fusarium moniliforme the CFU value was 4.157 ± 0.08 (p <0.05), which is 74% higher than the control value (Table 2).

**Table 2. Fungicidal properties of potato juice**

| Set of test cultures       | Concentration,% | The content of mushrooms, 48 hours after the introduction of the drug, 106 CFU / ml |
|----------------------------|------------------|------------------------------------------------------------------|
| Aspergillus niger,         |                  |                                                                  |
| 0,1%                      | 2.835±0.03       | +42*                                                             |
| 1%                        | 2.675±0.01       | +34*                                                             |
| 10%                       | 2.375±0.04       | +19                                                              |
| 100%                      | 2.156±0.03       | +8                                                               |
| Control                   | 1.996            |                                                                  |
| Aspergillus terrius       |                  |                                                                  |
| 0,1%                      | 3.751±0.08       | +87*                                                             |
| 1%                        | 3.388±0.07       | +69*                                                             |
| 10%                       | 2.687±0.09       | +34*                                                             |
| 100%                      | 2.285±0.05       | +14                                                              |
| Control                   | 2.005            |                                                                  |
| Alternaria alternaria     |                  |                                                                  |
| 0,1%                      | 4.392±0.02       | +59*                                                             |
| 1%                        | 5.111±0.01       | +85*                                                             |
| 10%                       | 7.242±0.02       | +262*                                                            |
| 100%                      | 5.333±0.04       | 93*                                                              |
| Control                   | 2.763            |                                                                  |
| Fusarium moniliforme      |                  |                                                                  |
| 0,1%                      | 12,350±0.03      | +517*                                                            |
| 1%                        | 8.720±0.09       | +365*                                                            |
| 10%                       | 5.136±0.06       | +115*                                                            |
| 100%                      | 4.157±0.08       | +74*                                                             |
| Control                   | 2.389            |                                                                  |

Significant differences with respect to control: * p <0.05, ** p <0.01, *** p <0.001
SGA are natural analogs of surfactants, interact with lipid bilayers and the human erythrocyte membrane affecting the cell morphology [9, 10, 14], causing hemolysis of erythrocytes in higher vertebrates at doses of more than $10^{-4}$ gram per Liter. However, when studying the effect on higher plants, one encounters a moderate (less than 50%) phytotoxicity of doses less than $10^{-3}$ gram per Liter, while doses of more than $10^{-3}$ gram per Liter have an insignificant (more than 10%) stimulating effect. The analysis of the effect on the soil microflora revealed the unequal sensitivity of various soil micromycetes. Thus, the most strongly stimulating effect was found for Fusarium moniliforme (over 500%), while for Aspergillus niger and Aspergillus terreus it did not exceed 100%. This nature of the changes confirms the detergent mechanism of the effect of SGA from potato juice [12, 13, 15], on the one hand, and the moderate, and even minimal, effect on the components of the ecosystem of soils adjacent to the disinfected object, on the other.

Thus, the moderate influence of the active substance of the juice of the juvenile form of potato on the components of terrestrial ecosystems of the territories adjacent to the disinfected object has been proved. In this case, the exposure time can be less than 24 hours.

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