ISSN 2075-5457 (print), ISSN 2220-9697 (online)

••• ПРИКЛАДНІ АСПЕКТИ РЕГУЛЯЦІЇ РОСТУ, РОЗВИТКУ ТА ПРОДУКТИВНОСТІ РОСЛИН •••
••• PRACTICAL ASPECTS OF PLANTS GROWTH REGULATION, DEVELOPMENT AND PRODUCTIVITY •••

DOI: https://doi.org/10.26565/2075-5457-2026-46-4
UDC: 631.46:579.64

Effect of aqueous extracts from natural sweetener-producing plants on the growth and antagonistic and phytotoxic activity of soil microorganisms

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This study assessed the effect of aqueous extracts from natural sweetener-producing plants — *Stevia rebaudiana* (stevia) leaves, *Glycyrrhiza glabra* (licorice) roots/rhizomes, and *Helianthus tuberosus* (Jerusalem artichoke) tubers — on the growth, antagonistic, and phytotoxic activities of soil microorganisms, including several bacterial species, micromycetes, and the green alga *Tetracystis* sp. The addition of aqueous extracts to the nutrient medium stimulated colony growth in all tested micromycetes and the bacterium *Azotobacter chroococcum*. The highest stimulatory effect was observed for extracts from stevia leaves and Jerusalem artichoke tubers. The antagonistic activity of the micromycete *Trichoderma viride* against potentially phytopathogenic fungi was enhanced during co-cultivation with aqueous extracts from all studied plants. The strongest phytotoxic effect was exerted by *Aspergillus niger* when grown on a medium supplemented with licorice root extract. Conversely, the lowest level of phytotoxicity was observed for *Fusarium oxysporum* cultivated with the addition of Jerusalem artichoke tuber extract. These findings indicate the selective and species-specific influence of aqueous extracts of the studied plants on the functional activity of the soil microbiome. This effect could be leveraged to develop biological agents aimed at optimizing cultivation conditions for natural sweetener-producing crops.

Key words: *natural sweetener-producing plants, soil microorganisms, colony growth rate, antagonism, phytotoxicity*

Cite this article: *Vinnikova O. I. Effect of aqueous extracts from natural sweetener-producing plants on the growth and antagonistic and phytotoxic activity of soil microorganisms. The Journal of V. N. Karazin Kharkiv National University. Series Biology, 2026, 46, 43–53. https://doi.org/10.26565/2075-5457-2026-46-4*

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Подано до редакції: 09.01.2026 / Прорецензовано: 26.02.2026 / Прийнято до друку: 25.05.2026 / Оприлюднено: 31.05.2026

Introduction

In recent years, there has been a growing interest in plants that produce natural sweeteners. This is driven by the increasing prevalence of metabolic diseases, particularly diabetes mellitus, necessitating the search for safe sugar substitutes. The use of natural plant-derived sweeteners is especially relevant in the production of dietary food for individuals with impaired carbohydrate metabolism, as such products are characterized by low caloric value and do not cause a significant increase in blood glucose levels (Peteliuk et al., 2021; Muñoz-Labrador et al., 2024; Patel & Navale, 2024). The most widely cultivated plants for obtaining sugar substitutes comprise various species of *Glycyrrhiza* L.**,** *Stevia rebaudiana* Bertoni, and *Helianthus tuberosus* L. Cultivation technologies for these plants usually do not include regular crop rotations, with particularly long periods of cultivation in the same location in case of *G. glabra* — up to 6 or more years. In continuous cropping systems, active plant compounds can enter the soil environment through volatilization, root exudation, decomposition, and leaching throughout the plant growth period. The accumulation of such substances can lead to soil depletion, reduced soil fertility, and also significantly affect the soil microbiome (Yadav et al., 2011; Ren et al., 2017; Zhou et al., 2018; Xu et al., 2022; Xu et al., 2024; Wang et al., 2025; Madeo et al., 2026).

The overall chemical profile of the roots and the entire plant is, to some extent, reflected by the composition of root exudates. It is well known that root exudates are a mixture of primary metabolites — sugars, amino acids, organic acids, and secondary metabolites — flavonoids, terpenoids, phenolic

compounds, etc. According to published reports, during the cultivation of licorice, secondary metabolites such as glycyrrhizin, liquiritin, flavonoids, and triterpene saponins may accumulate in the soil. These compounds can enter the soil through root exudation and plant residues (Chen et al., 2022). Stevia plant material contains stevioside (steviol glycosides), rebaudiosides, phenolic compounds, and flavonoids, which may also be components of root exudates and plant residues (Peteliuk et al., 2021). A number of flavonoids as well as phenolic compounds have been identified in Jerusalem artichoke tubers, including chlorogenic acid, caffeoylquinic acid and its derivatives, and ethers of caffeic and quinic acids (Showkat et al., 2019). These particular biologically active compounds comprise one of the factors which cause changes in the structure of the rhizosphere microbiome and contribute to the development of monoculture effects.

In the plant–microorganism system, plants provide the formation of habitats for microorganisms and nutrient supply to the associated microbiome. In turn, plant growth and productivity are determined by the integrated activity of soil microorganisms. Specialized studies have demonstrated that metabolites present in the root exudates of medicinal and sweetener plants shape the rhizosphere microbiome (Liu et al., 2022; Qu et al., 2024). It has also been established that in the rhizosphere of perennial monocultures, the abundance of microorganisms either remains unchanged or may even increase compared to soil not cultivated with these plants. However, conversely, the species diversity and activity of the microbiome may decline and undergo substantial shifts. The microorganisms typically present in a given soil may be replaced by phytopathogens or species capable of producing compounds with phytotoxic or antibiotic effects (Zhou et al., 2017; Zhou et al., 2018; Yue et al., 2020; Liu et al., 2022; Xu et al.,2022). Disruptions to the soil microbial community structure may also lead to adverse environmental consequences, including an increased proportion of toxigenic, opportunistic pathogenic, or allergenic species able to contaminate plant raw materials. Therefore, the relevance of our study is determined by the expanding cultivation of plants that produce natural sweeteners and their widespread use in the food and pharmaceutical industries. At the same time, the specific effects of the biologically active compounds of these plants on the soil microbiome remain insufficiently understood, particularly in regard of microbial growth responses, antagonistic interactions, and phytotoxic properties.

This issue is important for assessing the ecological consequences of cultivating such plants and for the development of stable agroecosystems. In view of the above, the aim of this study was to determine the effects of aqueous extracts of natural sweetener-producing plants on the growth, antagonistic activity, and phytotoxic properties of selected soil microorganisms.

Materials and Methods

Biological material. Commercially available dried plant material of *Glycyrrhiza glabra* L. (dried roots and rhizomes) and of *Stevia rebaudiana* Bertoni. (dried leaves) was purchased from a local pharmacy and used for further analysis. Commercially available tubers of *Helianthus tuberosus* L. were purchased from a local market. Before using the Jerusalem artichoke tubers for the preparation of aqueous plant extracts, they were washed under running water, rinsed with sterile distilled water, chopped, and dried at +45°C until constant weight was achieved. In the subsequent work, aqueous extracts of the plant material were used. For this purpose, a weighed portion of the ground plant material (10 g) was extracted with 100 mL of distilled water at 80°C and shaken on a shaker for 60 minutes. The resulting aqueous extract was first filtered through paper filters and then sterilized using Millipore syringe filters with a pore diameter 0.22 μm. For the phytotoxicity study, commercial seeds of garden cress (*Lepidium sativum* L.) were used as the test culture.

Isolates of soil microorganisms used in the study were obtained from the collection of the Department of Plant and Microorganism Physiology and Biochemistry of V.N. Karazin Kharkiv National University. These included micromycetes (*Mucor hiemalis* Wehmer, *Alternaria alternata* (Fr.) Keissl., *Penicillium chrysogenum* Thom, *Trichoderma viride* Pers., *Aspergillus niger* Tiegh., and *Fusarium oxysporum* Schltdl.); bacteria (*Azotobacter chroococcum*, *Bacillus subtilis*, *Pseudomonas putida*), and the microscopic alga *Tetracystis sp.* All microorganisms were isolated from soils of agrocenoses located within the Kharkiv district. Micromycetes were cultivated on liquid or agarized nutrient medium based on unhopped wort with a reduced sugar concentration of 2.5% (experimental variant) and 5% sugar according to Balling (control). *B. subtilis* and *P. putida* were cultivated on meat-peptone agar, *A. chroococcum* — on Ashby's medium, and Tetracystis sp. — on solid Bold's medium (Bischoff &Bold, 1963; Atlas, 2010). Fungi were grown in a thermostat at 22±1°C, azotobacter — at 28°C, other bacteria — at 36°C, algae — in a vegetation chamber at 23±2°C under natural illumination.

Study design. To explore the effect of aqueous extracts of plants producing natural sweeteners on the growth and antagonistic properties of individual representatives of soil microorganisms, the obtained aqueous extract from the plant material was cooled to 40°C and 1 ml was added to sterile Petri dishes. In the control variant, the extracts were replaced with an equal volume of sterile distilled water. Then, 20 ml of molten nutrient media were poured into the Petri dishes.

Microscopic fungi were inoculated into Petri dishes using the stab method, while in experiments with bacteria and algae, cell suspensions at concentration about 10^6 CFU/ml were prepared. Bacteria and algae were inoculated onto agar plates using a Drigalski spatula. The inoculated Petri dishes were placed in thermostats or a vegetation chamber.

Observations of microorganism development were carried out over 2–10 days, with recording of the number of colonies during 2–3 days (bacteria) and 2–3–8 days (algae). The diameter of micromycete colonies was also measured over 10 days, starting from the day of growth initiation, and the day of sporulation onset was noted.

The linear growth rate of micromycete colonies was calculated using the formula:

$$K_r = \frac{R_t - R_0}{t - t_0},$$

where R_t — colony radius at time t, R_0 — colony radius at time t_0.

The study of the antagonistic activity of micromycetes was carried out using the double agar plate method, with the following pairs of micromycetes: *T. viride* and *A. alternata*; *T. viride* and *A. niger*; *T. viride* and *F. oxysporum*. The Petri dishes were incubated in a thermostat at 22±1°C for 4 days. The assessment of culture reactions of fungal interactions was performed visually using the Jackson and Carl scale (Flanagan, 1978).

The study of the phytotoxicity of potentially phytopathogenic isolates of micromycetes *A. niger*, *A. alternata*, and *F. oxysporum* was conducted using the bioassay method with *L. sativum* seeds (Modern methods in allelopathic research, 2021). For this purpose, the micromycetes were cultivated on liquid nutrient medium supplemented with aqueous plant extracts in 10% of the medium volume. The phytotoxic effect was determined using the formula:

$$F_e = \frac{L_c - L_x}{L_c} \times 100\ \%,$$

where L_c — length of the control plant seedling, L_x — length of the seedling of the tested plant.

Statistical analysis. The parameters were measured in three parallel replicates of each series; the results were combined and averaged. The entire experiment was repeated twice. The means obtained in two experiments were pooled, and their overall mean and its standard error (SE) were calculated using the built-in option of the Microsoft Excel™ software package. Mean values were compared between experimental series using the Tukey test, considering the difference to be significant at $p \leq 0{,}05$.

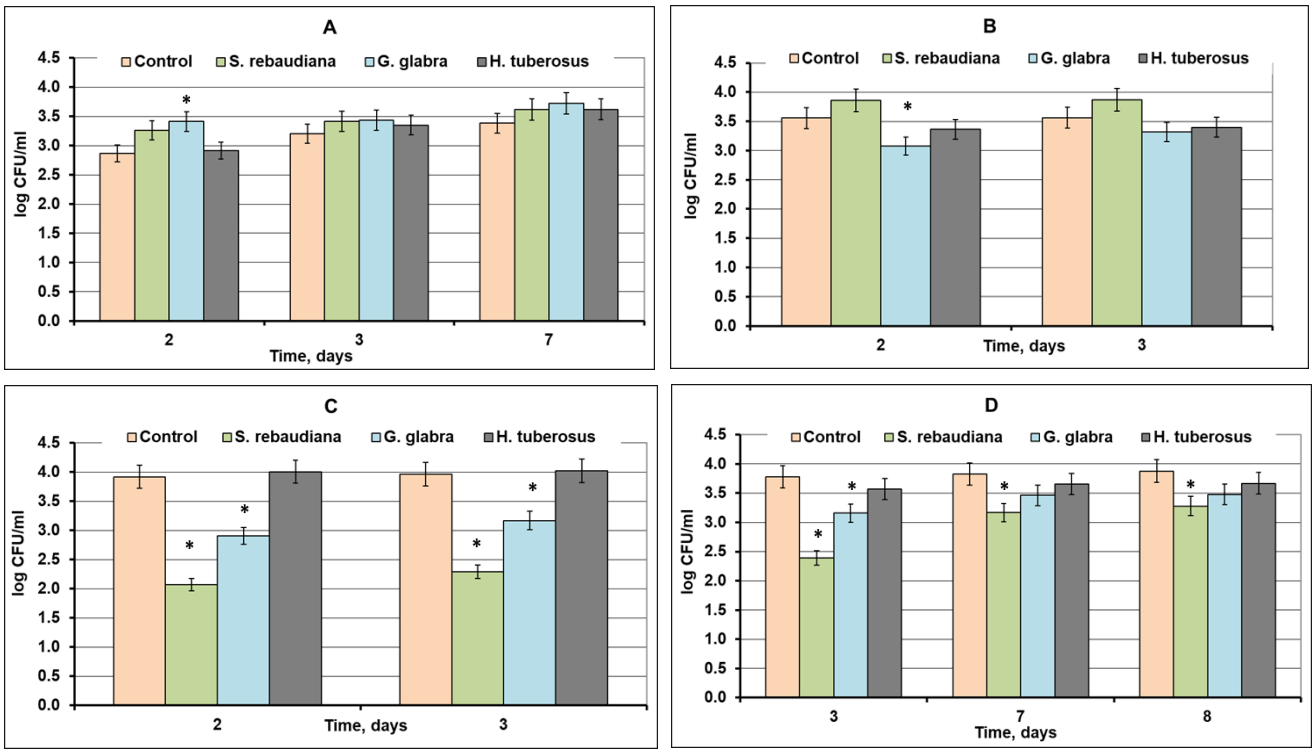
Results and Discussion

Today, natural sweeteners are widely used in dietary nutrition and medicine. Their sources are metabolites with a sweet taste that accumulate in various parts of plants. In terms of chemical composition, these metabolites include either sugar-rich primary metabolites other than glucose or, more commonly, secondary metabolites such as glycosides. These compounds may be released as exometabolites and accumulate in the soil in the form of «rhizodeposits».

The use of monoculture practices and the incorporation of post–harvest residues during the cultivation of such plants lead to the accumulation of substantial amounts of sugar-rich metabolites in the soil. Under these conditions, significant changes may occur in the composition of the soil microbiome, accompanied by a decline in plant productivity. Numerous studies have demonstrated the effects of sweetener plant monocultures on soil microorganisms, as well as the role of microorganisms in enhancing plant tolerance to stress (Chen et al., 2022; Sun et al., 2022; Shao et al., 2025; Ullah et al., 2025). Investigating the effects of sweetener plant metabolites on the components of biogeocenoses is also important, since plants and their microbiome form an interconnected system with reciprocal interactions.

ISSN 2075-5457 (print), ISSN 2220-9697 (online)

Moreover, the interactions bentween plants, microbiome and soil, being mediated through plant rhizodeposits, constitute the basis for the restoration of soil structure and maintening of soil fertility.



*Note: * — difference is significant in compare to the control, p≤ 0.05*

Fig. 1. The effect of aqueous extracts of sweetener-producing plants on the abundance of soil bacteria and algae: A — *Azotobacter chroococcum*, B — *Bacillus subtilis*, C — *Pseudomonas putida*, D — *Tetracystis sp.*

In the framework of current study, the effect of aqueous extracts from the aboveground (herb) or underground parts of sweetener-producing plants on the growth, antagonistic, and phytotoxic properties of common representatives of biogeocenoses — namely, microorganisms of the auto- and heterotrophic blocks — was investigated. The effects of aqueous extracts from plant raw materials on the population dynamics of bacteria and algae grown on the corresponding nutrient media supplemented with aqueous extracts of sweetener plants are presented in Fig. 1A–1D. The addition of aqueous extracts from stevia and licorice plant material to the nutrient medium stimulated the development of the nitrogen-fixing bacterium *A. chroococcum* only on the second day of observation. Subsequently, this effect was not sustained, and the bacterial counts in the experimental variants were slightly, but not significantly, higher than in the control (Fig. 1A).

In the experiment with the spore-forming bacterium *B. subtilis*, no stimulation effect was observed after the addition of aqueous extracts from any of three plant species to the nutrient medium. Instead, a significant decrease in the number of CFU/ml was recorded on the second day in the variant with the licorice extract (Fig. 1B).

A different effect occurred in the experiment with the non-spore-forming soil bacterium *P. putida*. The addition of aqueous extracts from stevia herb and licorice rhizomes caused a significant decrease in the number of CFU/ml compared to the control. However, no such effect was observed when the Jerusalem artichoke tuber extract was added (Fig. 1C).

Regarding the influence of metabolites from sweetener plants on the development of the autotrophic representative of the soil microbiome — the green alga *Tetracystis* sp. — a significant decrease in CFU/ml compared to the control took place throughout the entire observation period in the variants with stevia and licorice extracts. A less pronounced, but still noticeable, decrease in the number of colonies was caused

ISSN 2075-5457 (print), ISSN 2220-9697 (online)

by the Jerusalem artichoke extract (Fig. 1D). However, it was noted that the algae colonies grown on nutrient media supplemented with aqueous extracts had a larger diameter compared to the control. This suggests that there may have been an increase in biomass rather than in the number of cells.

Thus, a certain antibacterial effect from the addition of aqueous extracts of sweetener–producing plants was observed when using stevia herb and licorice rhizomes in the variants with *B. subtilis*, *P. putida*, and the green alga *Tetracystis* sp. The antibacterial effect of extracts from stevia herb, licorice roots, and rhizomes has also been demonstrated by other authors (Wahab et al., 2021; Chakma et al., 2023; Chen et al., 2024). The antifungal and antibacterial efficacy of the active components of Jerusalem artichoke tubers has also been noted (Showkat et al., 2019; Tapera et al., 2024). However, no such effect was observed in our study. This may be explained by the fact that the antibiotic and antifungal activity depends on the concentration of active compounds in the tubers. In turn, the content and concentration of these substances are influenced by the cultivar, agronomic cultivation conditions, soil chemical composition, microbiome activity, and storage conditions of the plant material itself.

The *A. chroococcum* isolate used in this study proved to be insensitive to the antibiotic effects of the active components present in aqueous extracts of sweetener-producing plants (Fig. 1A). The resistance of *Azotobacter* species to various environmental factors, including plant-derived antibiotic compounds, has also been reported in other studies. The insensitivity of these bacteria to plant-derived antibacterial substances (phytoncides and phenolic compounds) may be associated with a combination of evolutionary defense mechanisms, specific metabolic features, and their adaptive capacity within the rhizosphere. These mechanisms include cyst formation, high metabolic activity, synthesis of antioxidants and enzymes, and siderophore production (Nongthombam et al., 2021; Shahid & Khan, 2022).

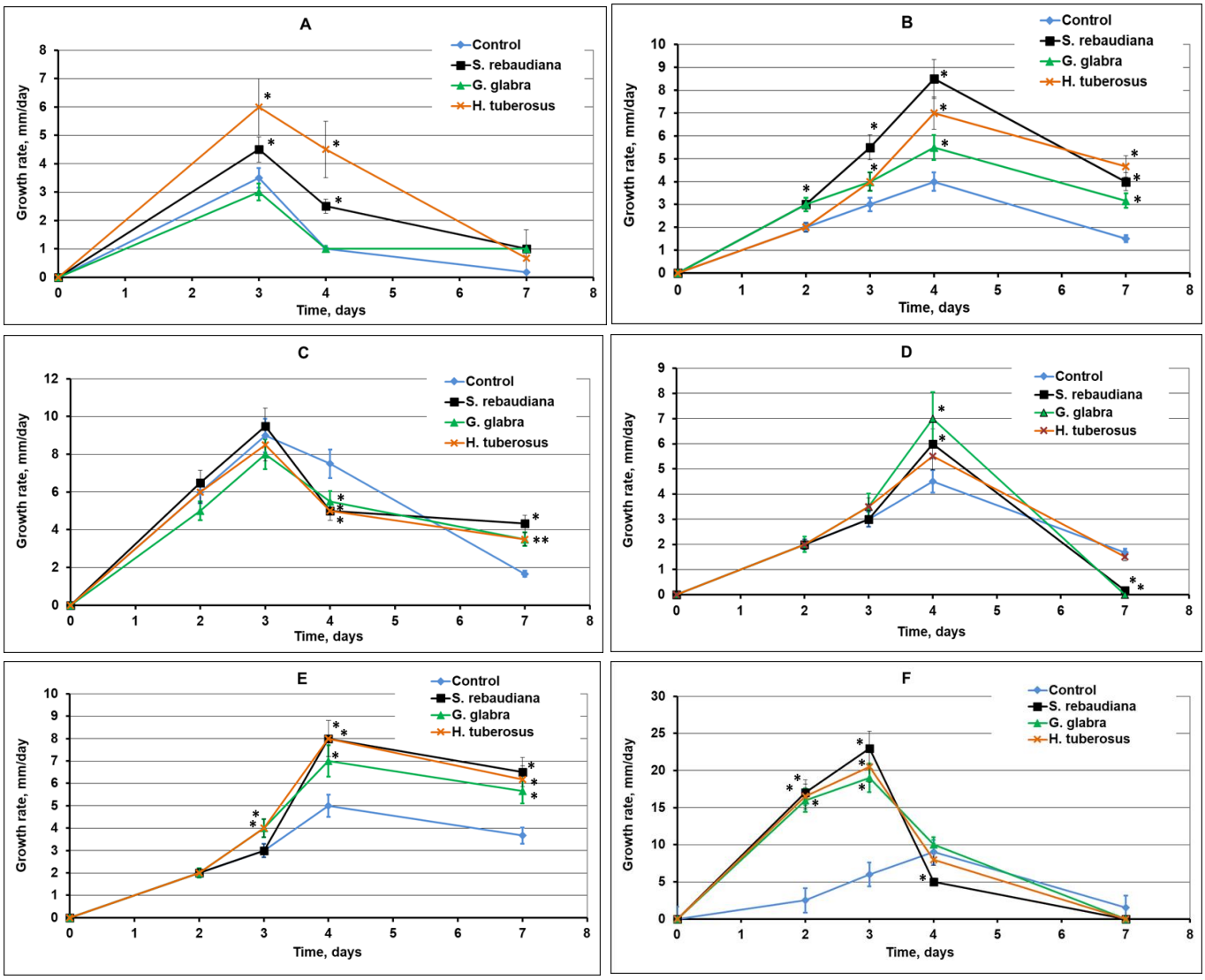
Thus, diverse microbial responses to the addition of aqueous extracts of sweetener-producing plants to the cultivation medium were observed. Such effects may be associated both with the physiological characteristics of representatives of the heterotrophic (bacteria) and autotrophic (algae) components of the soil microbiome, as well as with differences in the metabolite composition of aqueous extracts obtained from different plant species. Indeed, apart from their “sugar” component, metabolites of sweetener-producing plants may also contain a variety of other biologically active compounds.

Another type of response to the added sugar in the culture medium was expected in experiments with soil micromycetes. It is well known that the availability of accessible sugars in sufficient amounts is a factor that significantly affects both the growth rate and the qualitative composition of micromycetes in the environment (Reischke et al., 2014). The dynamics of the growth rate of micromycete colonies under the influence of plant extracts added to the nutrient medium are presented in Fig. 2A–2F.

Compared to the control, a significant decrease in the growth rate of micromycetes under the influence of plant extracts was observed in the following experimental variants: with *A. niger* on the 4th day, if any extract was added (Fig. 2C), *M. hiemalis* on the 7th day, in the presence of stevia and licorice extracts (Fig. 2D), and *T. viride* on the 4th day, when stevia extract was added (Fig. 2F). The expected increase in the growth rate of micromycete colonies in the presence of aqueous extracts of plant material was observed in all series of the experiment. Moreover, the growth rate of the fungi increased mainly on days 2–4, while on day 7 the stimulation effect slightly decreased. This can be explained by the depletion of the added sugars contained in the plant extracts. However, in case of potentially phytopathogenic micromycete species (*A. alternata*, *A. niger*, and *F. oxysporum*), the growth rate in the presence of plant extracts remained significantly higher than in the control even on the 7th day (Fig. 2B, 2C, 2E). In contrast, the micromycete *T. viride*, which is a known antagonist of phytopathogens, showed a decrease in growth rate to the control level by the 7th day of cultivation in presence of plant extracts.

The representative of fast-growing sugar–utilizing zygomycetes, *M. hiemalis*, demonstrated a significant increase in colony growth rate on the 4th day of cultivation compared to the control in the presence of stevia and licorice extracts. The addition of the aqueous extract from Jerusalem artichoke tubers had no significant effect on the development of colonies of this micromycete throughout the entire observation period (Fig. 2D).

Thus, the results of the study showed that the addition of aqueous extracts of sweetener-producing plants to the nutrient medium predominantly stimulated the growth of micromycete colonies, but at different times and to varying degrees. The decrease in growth rate observed in some cases may be associated with the presence of phenolic compounds in the plant extracts, which can have antimicrobial properties. In contrast to other reports (Showkat et al., 2019), no antimycotic effect of the Jerusalem artichoke extract was observed in our study. A possible explanation for these results is presented above.



*Note: * — difference is significant in compare to the control, p≤ 0.05*

Fig. 2. The growth rate of micromycete colonies under the influence of extracts from sweetener-producing plants: A — *Penicillium chrysogenum*, B — *Alternaria alternata*, C — *Aspergillus niger*, D — *Mucor hiemalis*, E — *Fusarium oxysporum*, F — *Trichoderma viride*.

At the next stage, the extracts obtained from sweetener-producing plants were tested against the phytotoxicity of potentially phytopathogenic micromycetes — *A. alternata, A. niger,* and *F. oxysporum*. The effects of the culture liquid from these micromycetes grown in media supplemented with aforementioned extracts on the germination and seedling length of the test plant are presented in Figs. 3 and 4. The addition of sweetener plant extracts to the cultivation medium enhanced the phytotoxic properties of *A. niger* and *A. alternata*, while no effect on the phytotoxicity of *F. oxysporum* was observed.

By the garden cress seed germination test, the most pronounced phytotoxic effect was exerted by the culture liquid of *A. niger* cultivated in the presence of stevia leaves extract, with a 1.3–fold difference compared to the control. The phytotoxicity of *A. alternata* was also enhanced under the influence of licorice and Jerusalem artichoke extracts, likewise by 1.3–fold (Fig. 3).

ISSN 2075-5457 (print), ISSN 2220-9697 (online)

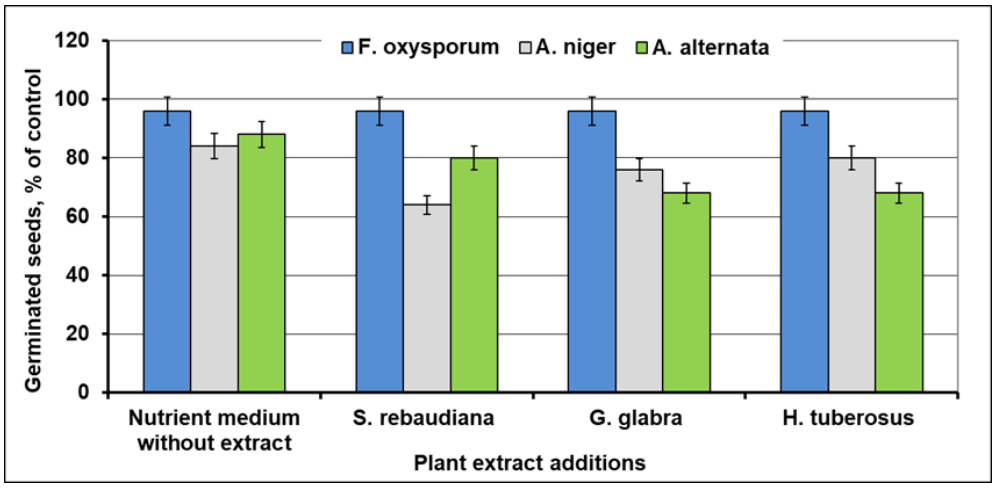


Fig. 3. The effect of extracts from sweetener-producing plants on the phytotoxicity of *Alternaria alternata*, *Aspergillus niger* and *Fusarium oxysporum* by the garden cress seeds germination test.

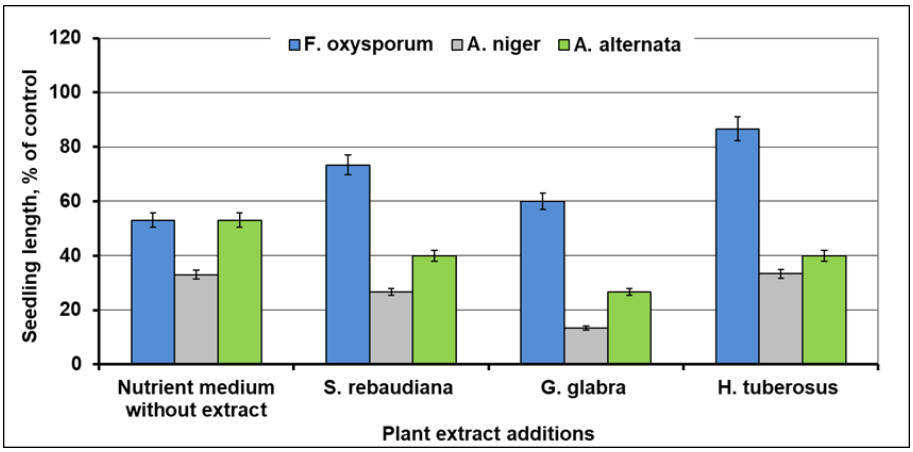


Fig. 4. The influence of extracts from sweetener-producing plants on the phytotoxicity of *Alternaria alternata*, *Aspergillus niger* and *Fusarium oxysporum* by the garden cress seedlings length test

Measurements of the length of garden cress seedlings exposed to the culture liquids of micromycetes cultivated with the addition of sweetener plant extracts revealed no phytotoxic effect in the *F. oxysporum* treatment. In experiments involving other micromycetes, the average seedling length of the test plants was lower in nearly all experimental series compared with the control variants in which the fungi were cultivated without the addition of extracts (Fig. 4). Notably, the addition of licorice extract to the cultivation medium resulted in the strongest phytotoxic effect for all three micromycetes tested, as evidenced by the shortest mean length of seedlings. Thus, licorice metabolites may enhance the phytotoxic properties of the potentially phytopathogenic micromycetes. Accordingly, the accumulation of such metabolites in the soil may increase the activity of phytopathogens, thereby negatively affecting plant growth and development.

The use of fungi of the genus *Trichoderma* as biocontrol agents against phytopathogens in agrocenoses is a widespread practice worldwide (Guzmán-Guzmán et al., 2023). Biopreparations based on monocultures of various strains are used, or they are applied as part of complex preparations. When this micromycete is introduced into the soil, it enters a complex multicomponent environment. This environment contains a large variety of organic substances (products of plant, soil animal, and microorganism metabolism), and diverse interactions occurs between the participants of the biogeocenosis. Therefore, the activity of a particular strain can be modified by environmental factors.

In this regard, studying the beneficial properties of microorganisms under conditions simulating various forms of interaction between participants of biogeocenosis has certain practical value. Table 1

ISSN 2075-5457 (print), ISSN 2220-9697 (online)

presents the results of the assessment of the antagonistic activity of the *T. viride* isolate against potentially phytopathogenic fungi under co-cultivation of colonies on media supplemented with extracts of sweetener-producing plants. A certain effect of the added sugars and other metabolites from aqueous plant extracts on the antagonistic properties of these micromycete isolates is apparent.

Table 1. Antagonistic properties of micromycetes when cultivated on media supplemented with extracts of sweetener-producing plant material: scores according to the Jackson and Carl scale*

Name of micromycetes	Source of the extract			
	Control (no extract in nutrient medium)	*Stevia rebaudiana*	*Glycyrrhiza glabra*	*Helianthus tuberosus*
Trichoderma viride	4-5	5	4.5	4.5
Fusarium oxysporum	2	4	3	3
Aspergillus niger	3	2.5	1.5	3.5
Alternaria alternata	2.5	1	1	1

*Note: * — 1 point is the minimum value, 5 points is the maximum*

In general, the addition of extract from any of the plants to the culture medium enhanced the activity of *Trichoderma* against *A. alternata*. In the experiment with *F. oxysporum*, the opposite effect was observed, particularly if stevia extract was added. The isolate of *A. niger* demonstrated the most diverse antagonistic activity: its activity increased in presence of Jerusalem artichoke extract, but decreased under the influence of the licorice extract.

Among micromicetes used in the study, *A. alternata* cosistentlly showed the slowest growth. Such a growth strategy explains the most significant decrease in the antagonistic activity of *Alternaria* compared to the fast-growing *T. viride*. The addition of readily available sugars to the medium stimulated the growth of *Trichoderma*, thereby creating conditions of readily available carbon deficiency for the other species. This assumption may also be valid for another potential phytopathogen — *F. oxysporum*, since this species, like *T. viride*, is fast-growing.

Table 2. Phytotoxic effect of micromycetes (potential phytopathogens) under cultivation on medium supplemented with extracts of sweetener-producing plants, %

Name of micromycetes	Source of the extract			
	Control (no extract in nutrient medium)	*Stevia rebaudiana*	*Glycyrrhiza glabra*	*Helianthus tuberosus*
Fusarium oxysporum	47	27	40	13
Aspergillus niger	67	73	87	67
Alternaria alternata	47	60	73	60

Therefore, the different effects of plant extracts observed in the study may be associated both with the physiological and biochemical characteristics of the particular micromycete species, as well as with the varying content of sugars, phenolic compounds, and flavonoids in the extracts.

The estimates of the phytotoxic effect of micromycetes cultivated on media supplemented with extracts of sweetener plant material is presented in Table 2. The isolate *A. niger* appeared to be the most phytotoxic, especially when cultivated with the addition of licorice extract. Meanwhile, the *F. oxysporum* isolate demonstrated the lowest phytotoxic properties, particularly when cultivated on medium supplemented with Jerusalem artichoke tuber extract.

Conclusions

Aqueous extracts from the raw materials of three sweetener-producing plant species — stevia, licorice, and Jerusalem artichoke — exhibited variable, object-specific effects on the growth of soil bacteria, algae, and micromycetes.

In bacterial cultures, the most pronounced effect was the modification of *A. chroococcum* abundance, which was initially stimulated by licorice and stevia extracts. Conversely, none of the extracts stimulated *B.*

subtilis or *P. putida*; instead, licorice extract significantly suppressed *B. subtilis* growth, and both stevia and licorice extracts inhibited *P. putida*.

For the green alga *Tetracystis* sp., the extracts suppressed overall colony counts but induced an increase in individual colony diameter, suggesting a shift toward biomass accumulation rather than cell division.

Micromycetes colony growth rates were predominantly accelerated by Jerusalem artichoke and stevia extracts during the initial stages (days 2–4), whereas licorice extract inhibited the growth of *A. niger* and *P. chrysogenum*. The dynamics of *T. viride* growth on all sweeteners showed the highest increase in colonies already on the third day, whereas in the control (without sweeteners) this occurred only on the fourth day of cultivation.

In bioassays, the culture liquid of *A. niger* grown with licorice extract displayed the highest phytotoxicity (reducing garden cress seedling length), while the lowest phytotoxicity was observed for *F. oxysporum* cultivated with Jerusalem artichoke extract. Furthermore, the addition of plant extracts enhanced the antagonistic potential of *T. viride* against *A. alternata* but reduced its efficacy against *F. oxysporum*.

Therefore, the growing demand for natural sweeteners highlights the importance of studying interactions between these plants and soil microorganisms. Investigating the effects of their aqueous extracts on bacteria and micromycetes allows assessment of their potential role in shaping microbial communities, regulating soil microbiological activity, and influencing the phytosanitary condition of agroecosystems. Consequently, the selective modulation of soil microbial activity by compounds from sweetener-producing plants should be taken into account when designing continuous cropping systems and developing targeted bioformulations to optimize crop performance.

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Вплив водних екстрактів рослин-продуцентів натуральних підсолоджувачів на ріст, антагоністичну та фітотоксичну активність ґрунтових мікроорганізмів

О.І. Віннікова

Досліджено вплив водних екстрактів рослин-продуцентів натуральних підсолоджувачів — *Stevia rebaudiana* (стевія), *Glycyrrhiza glabra* (солодка) та *Helianthus tuberosus* (топінамбур) на ріст, антагоністичну і фітотоксичну активність ґрунтових мікроорганізмів (окремих представників бактерій, мікроміцетів та зеленої водорості *Tetracystis sp.*). Встановлено, що внесення водних екстрактів у поживне середовище стимулювало ріст колоній усіх досліджуваних мікроміцетів та бактерії *Azotobacter chroococcum*. Найвищий стимулюючий ефект спостерігався за додавання екстрактів з листків стевії та бульб топінамбуру. Антагоністична активність мікроміцета *Trichoderma viride* щодо потенційно фітопатогенних грибів була більш вираженою за умови культивування з водними екстрактами всіх досліджуваних рослин. Найсильніший фітотоксичний ефект проявляв *Aspergillus niger* за культивування на середовищі з екстрактом листя солодки. Водночас найнижчий рівень фітотоксичності зафіксовано у *Fusarium oxysporum* за вирощування із додаванням екстракту бульб топінамбуру. Отримані результати свідчать про селективний і видоспецифічний характер впливу водних екстрактів досліджуваних рослин на функціональну активність ґрунтового мікробіому, що може бути використано для розробки біологічних засобів, які покращать умови вирощування рослин-продуцентів натуральних підсолоджувачів.

Ключові слова: *рослини-продуценти підсолоджувачів, ґрунтові мікроорганізми, швидкість росту колоній, антагонізм, фітотоксичність*

Цитування: *Vinnikova O. I. Effect of aqueous extracts from natural sweetener-producing plants on the growth and antagonistic and phytotoxic activity of soil microorganisms. Вісник Харківського національного університету імені В.Н. Каразіна. Серія «Біологія», 2026, 46, 43–53. https://doi.org/10.26565/2075-5457-2026-46-4*

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Use of Artificial Intelligence: The authors certify that no generative artificial intelligence tools were used in the conduct of the research or in the preparation of this manuscript. / **Використання штучного інтелекту:** Автори засвідчують, що під час проведення дослідження та підготовки цього рукопису генеративний штучний інтелект не використовувався.

Received: 09.01.2026 / Revised: 26.02.2026 / Accepted: 25.05.2026 / Published: 31.05.2026