Contribuţii Botanice – 2013, XLVIII: 75-82
Grădina Botanică “Alexandru Borza”
Cluj-Napoca

THE ANTIFUNGAL ACTIVITY OF *ALLIUM SCHOENOPRASUM* L. LEAVES

Marcel PÂRVU[1], Ioana RUSU[1], Oana ROŞCA-CASIAN[2]
[1.]Babeş-Bolyai University, Faculty of Biology and Geology, 42, Republicii Street,
RO-400015 Cluj-Napoca, Romania
[2.]Babeş-Bolyai University, „A. Borza” Botanical Garden, 42, Republicii Street, **RO-400015 Cluj-Napoca, Romania**
e-mail: mparvucluj@yahoo.com

Abstract: The antifungal activity of *Allium schoenoprasum* (chives) leaf extract was tested *in vitro* against the following phytopathogenic fungi: *Aspergillus niger*, *Botrytis cinerea*, *B. paeoniae*, *Fusarium oxysporum* f. sp. *tulipae*, *Penicillium gladioli*, and *Sclerotinia sclerotiorum*. The minimum inhibitory concentration (MIC) was 70–120 µl/ml, depending on the fungal species. The results were compared to those obtained for Fluconazole (MIC = 80–300 µl/ml) and synthetic allicin (MIC = 100–160 µl/ml).

Key words: *Allium schoenoprasum*, antifungal activity, allicin, *in vitro*, MIC, phytopathogenic fungi

Introduction

The active trend in plant protection is finding different sources of natural compounds with antimicrobial activity, which can successfully replace the products obtained by chemical synthesis. Therefore, the study of chemical compounds derived from plants is seen as a good source of bioactive molecules. The bioactive fungicides, for example, have proved to be efficient against specific pathogens, while at the same time being biodegradable.

The best alternative method for the control of phytopathogens is provided by the variety of constituents found in medicinal plants. One of the most renowned groups of these plants, used since ancient times for their therapeutic properties, is represented by species of *Allium*.

There is plentiful information in the literature regarding the phytotherapeutic properties of the species *Allium cepa* (onion) and *A. sativum* (garlic) [2, 6, 10, 20, 26, 27, 53, 55].

These *Allium* species have been shown to have mainly antimicrobial activities – antifungal [5, 17, 28, 31, 32, 49, 61] and antibacterial [11, 22, 57] – but also anti-oxidant [7, 9, 50, 52, 60], anti-inflammatory [19, 30, 46], and anti-hypertension properties [3, 4, 15]. There is also information on their anti-allergic [21], anti-diabetic [40], hepato-protective [36], and neuro-protective [18] properties.

Allium includes over 200 components such as volatile oils (allicin, alliin and ajoene) containing sulphur, enzymes (alliinase, peroxidase and miracynase), carbohydrates (sucrose, glucose), minerals (germanium, selenium, zinc), amino acids such as cysteine, glutamine, isoleucine and methionine, bioflavonoids such as quercetin, cyanidin and allistatin I and allistatin II, vitamins C, E and A and niacin, vitamins B_1, B_2 and beta carotene [13]. *Allium*-derived antimicrobial compounds inhibit micro-organisms by reacting with the sulfhydryl (SH) groups of cellular proteins. It used to be thought that allicin reacts only with cysteine and not with non-SH amino acids, but it has been confirmed that allicin and other thiosulfinates also react with non-SH amino acids [25].

There is evidence that *Allium* plant extracts show antifungal activity, but less information is available on *Allium schoenoprasum* (chives). This is why we have attempted to demonstrate the antifungal properties of *A. schoenoprasum*, besides its edible and ornamental values. In this respect, we have assessed the *in vitro* antifungal activity of *A. schoenoprasum* leaves extract against six species of phytopathogenic fungi (*Aspergillus niger*, *Botrytis cinerea*, *B. paeoniae*, *Fusarium oxysporum* f. sp. *tulipae*, *Penicillium gladioli* and *Sclerotinia sclerotiorum*).

Materials and Methods

Leaves of chives were collected from the Agrobotanical Garden of the University of Agricultural Sciences and Veterinary Medicine in Cluj-Napoca. The species was determined by Dr Gheorghe Groza and a plant specimen has been deposited in the Herbarium of the "A. Borza" Botanical Garden (CL 659561).

Small fragments (0.5–1 cm) of *A. schoenoprasum* leaves were put into 70% ethanol. The technique used for obtaining the plant extract was the cold repercolation method [33, 54], at room temperature, for 3 days [54]. 130 g of plant extract was obtained for each 100 g of plant material (chives leaves) from the percolator. The ratio was thus 1:1.3 (w:v).

The chives plant extract was analyzed regarding its allicin content. The method used for the quantification of allicin was LC-CIS-MS/MS (Liquid Chromatography-Coordination Ion Spray-Mass Spectrometry), by means of the Agilent 1100 HPLC Series (Agilent Technologies, Darmstadt, Germany) system [59].

The fungal species were isolated from diseased plants, purified, and cultivated on Czapek-agar nutritive medium (BD Difco, Budapest, Hungary). *Aspergillus niger* was isolated from onion bulbs, *Botrytis cinerea* from rose flowers, *B. paeoniae* from peony flowers, *Fusarium oxysporum* f. sp. *tulipae* from tulip flowering stems, *Penicillium gladioli* from gladiolus corms, and *Sclerotinia sclerotiorum* from carrot roots.

The *in vitro* antifungal activity was assessed by agar-dilution assay and inoculation into the central point. The minimum inhibitory concentration (MIC) was determined for each fungal species, compared to the control (nutritive medium with 70% ethanol), an antimycotic drug – Fluconazole (2 mg/ml) (Krka, Novo Mesto, Spain), and synthetic allicin (Allimed liquid, Allicin International Ltd, UK). Four replicates were carried out for each considered concentration and the percentage of mycelial growth inhibition (P) was calculated according to the formula $P = (C-T) \times 100/C$, where C is the diameter of the control colony and T is the diameter of the treated colony [37].

Results and Discussions

The results concerning the antifungal activity of *A. schoenoprasum* ethanolic extract are presented in detail in Table 1. Briefly, *A. schoenoprasum* leaves extract *in vitro* inhibits all the phytopathogens tested, at MIC depending on the species. The MIC varied between 70–120 µl/ml for chives leaves extract, 80–300 µl/ml for Fluconazole, and 100–160 µl/ml for allicin (Tab. 1).

Similar studies were performed to test the antifungal potential of other *Allium* species (*A. obliquum*, *A. fistulosum*, *A. senescens* subsp. *montanum*, *A. ursinum*) [41, 42, 43, 44]. The results

Table 1: ***In vitro*** **activity of the** ***Allium schoenoprasum*** **leaves extract on mycelial growth of some phytopathogenic fungi compared to the effects of the synthetic fungicide fluconazole and allicin**

Fungal species	*Allium schoenoprasum* extract (µl/ml)	Colony [a] diameter (mm)	P [a] (%)	Fluconazole (µl/ml)	Colony [b] diameter (mm)	P [b] (%)	Allicin (µl/ml)	Colony [c] diameter (mm)	P [c] (%)
Aspergillus niger	C	22	0	C	22	0	C	22	0
	20	30	-	100	11.67	46.97	20	20	9.09
	40	24	-	200	7.67	65.15	40	12	45.45
	50	18	18.18	250	4.33	80.3	60	8	63.63
	80	12	45.45	300	0	100	80	4	81.81
	100	5	72.27				100	0	100
	110	2.5	88.64						
	120	0	100						
Botrytis cinerea	C	65	0	C	65	0	C	65	0
	20	57.25	11.92	20	40.33	37.95	30	61	6.15
	24	31.5	51.53	60	20	69.23	60	44	32.30
	60	11.5	82.3	100	5.33	91.80	80	31	52.30
	70	5.25	91.92	120	0	100	100	19	70.76
	80	0	100				120	5	92.30
							140	0	100
Botrytis paeoniae	C	60	0	C	60	0	C	60	0
	20	57.25	4.58	20	50	16.66	40	58	3.33
	40	41	31.66	60	24	60	60	46	23.33
	60	25	58.33	100	5	91.66	80	28	53.33
	80	4.75	92.08	120	0	100	100	5	91.66
	90	0	100				120	0	100
Fusarium oxysporum f.sp. *tulipae*	C	32	0	C	32	0	C	32	0
	20	30	6.25	20	20	37.5	40	30	6.25
	40	25	21.87	60	8	75	80	24	25
	60	18	43.75	80	2	93.75	120	14	56.25
	80	12	62.5	100	0	100	140	6	81.25
	100	6	81.25				160	0	100
	120	0	100						
Penicillium gladioli	C	15	0	C	15	0	C	15	0
	60	13	13.33	100	11	26.66	30	13	13.33
	80	8	46.66	120	11	26.66	60	10	33.33
	100	3	80	160	10	33.33	80	6	60
	120	0	100	200	10	33.33	100	3	80
							120	0	100
Sclerotinia sclerotiorum	C	64	0	C	64	0	C	64	0
	10	60	6.25	20	30	53.12	40	58	9.37
	20	48	25	40	15	76.56	60	48	25
	30	36	43.75	60	5	92.18	80	28	56.25
	40	24.5	61.71	80	0	100	100	5	92.18
	50	13	79.68				160	0	100
	60	3.5	94.53						
	70	0	100						

Legend: [a] = the effect of *A. schoenoprasum* leaf extract, [b] = the effect of Fluconazole, [c] = the effect of allicin, C = control (70% aq. EtOH), P = mycelial growth inhibition were dependent on the fungal species and the content of bioactive compounds. Therefore, more research was carried out regarding the chemical composition of *Allium* species. Such studies highlighted the presence of sulfur-containing compounds, polyphenolic compounds, and phytosterols [58].

In the case of *A. schoenoprasum*, for example, analyzing its content revealed the presence of polyphenols such as p-coumaric acid, ferulic acid, sinapic acid, quercetol, and kaempferol; phytosterols such as β-sitosterol and campesterol; and sulphur-containing compounds such as allicin, and essential oils [8, 45, 58].

Another phytochemical analysis of the whole plant of *Allium schoenoprasum* led to the isolation of four spirostane-type glycosides and four known steroidal saponins. Their structures were elucidated mainly by spectroscopic analysis and mass spectrometry. Four of the isolated compounds were tested for cytotoxic activity against human colon cancer cell lines [56].

Chive flowers were thoroughly studied regarding their nutritional values, since they are consumed in salads or soups. The analysis revealed fatty acids such as palmitic acid (7.94–16.94%), linoleic acid (7.63–13.45%), and stearic acid (3.13–31.16%), as well as γ-sitosterol (3.41–6.42%), campesterol (0.34–0.66%), fucosterol (0.29–0.51%) and vitamin E (0.16–0.49%) [14].

The flowers also contain anthocyanins which influence their colour [12].

Some of the compounds found in *A. schoenoprasum* were quantified. Thus, a quantity of 25.09 mg β-sitosterol and 7.21 mg campesterol were found per each 100 g vegetal product. A quantity of 320 mg of allicin per 100 g chives vegetal product was also determined [58].

Other studies have been conducted on the properties of these compounds. Such studies were performed on the anti-cancer and anti-oxidant effects of the polyphenols isolated from *A. schoenoprasum* flowers [24, 34]. Moreover, comparisons were made between the enzymes anti-oxidant and scavenging activities in roots, stalks, and leaves, and between the cultivated plants and tissue culture organs [51].

Another study dealt with the anti-diabetic effects of *A. schoenoprasum*. Diabetic rats were fed with plant-mixed pellet food and a hypoglycemic effect was observed, namely the serum triglyceride and LDL-cholesterol level was reduced and the serum HDL-cholesterol increased [48].

Literature data are very scarce regarding the antimicrobial activity of *A. schoenoprasum*. The potential antifungal activity of aqueous and 50% ethanolic extracts was tested against *Fusarium chlamydosporum* [35]. The antibacterial activity of chive oil was assessed against *Escherichia coli* [47].

The *A. schoenoprasum* plant extract contains important antifungal compounds such as allicin [20, 23, 38], polyphenols, etc.

It was observed that antibacterial and antifungal activities of allicin can be attributed to its interaction with the thiol group of proteins and amino acids and that, especially with the latter, allicin forms S-allyl derivatives. By these reactions SH-compounds inhibit the antibiotic properties of extract derived allicin and authentic allicin [39]. Another antifungal mechanism is the allicin-mediated lipoperoxide production in fungal plasma membrane with increased permeability [16].

The mechanisms of action thought to be responsible for phenolic toxicity involve enzyme inhibition by the oxidized compounds, possibly through reaction with sulfhydryl groups or nonspecific interactions with the proteins [1]. In addition, antifungal phenolics from plants with action against the phytopathogenic fungi *Botrytis cinerea*, *Cercospora beticola*, *Colletotrichum circinans*, *Cladosporium herbarum*, *Fusarium oxysporum*, *Phytophthora infestans*, *Venturia inaequalis*, *Verticillium albo-atrum* have been identified [29].

These mechanisms may be involved in *A. schoenoprasum* plant extract effects on tested fungi.

This is why, the present study aimed at reconfirmation of the antifungal properties of *A. schoenoprasum* plant extract and complementing the literature data with valuable information on the biocontrol of plant pathogens.

Conclusions

Allium schoenoprasum leaves extract had inhibitory activity against the plant pathogenic fungi (*Aspergillus niger*, *Botrytis cinerea*, *B. paeoniae*, *Penicillium gladioli*, *Fusarium oxysporum* f.sp. *tulipae*, and *Sclerotinia sclerotiorum*), with minimum inhibitory concentration value (MIC) varying from 70 to 120 µl/ml, depending on the species. By comparison, the MIC for Fluconazole was 80–300 µl/ml, and 100–160 µl/ml for allicin. These data may be useful in the development of new natural antifungal products in the near future.

Acknowledgements: This work was financially supported by the Romanian Ministry of Education and Research, PN II IDEI 2272/2008 project.

REFERENCES

1. Arif, T., Bhosale, J.D., Kumar, N., Mandal, T.K., Bendre, R.S., Lavekar, G.S., Dabur, R., 2009, Natural products – antifungal agents derived from plants, *J Asian Nat Prod Res*, **11**(7): 621-638.
2. Arnault, I., Auger, J., 2006, Seleno-compounds in garlic and onion, *J Chromatogr A*, **1112**(1-2): 23-30.
3. Asdaq, S.M., Inamdar, M.N., 2010, Potential of garlic and its active constituent, S-allyl cysteine, as antihypertensive and cardioprotective in presence of captopril, *Phytomedicine*, **17**(13): 1016-1026.
4. Banerjee, S.K., Maulik, S.K., 2002, Effect of garlic on cardiovascular disorders: a review, *Nutrition Journal*, **1**(1): 1-14.
5. Barile, E., Bonanomi, G., Antignani, V., Zolfaghari, B., Sajjadi, S.E., Scala, F., Lanzotti, V., 2007, Saponins from *Allium minutiflorum* with antifungal activity, *Phytochemistry*, **68**(5): 596-603.
6. Bhandari, P.R., 2012, Garlic (*Allium sativum* L.): a review of potential therapeutic applications, *Int J Green Pharm*, **6**(2): 118-129.
7. Bozin, B., Mimica-Dukic, N., Samojlik, I., Goran, A, Igic, R, 2008, Phenolics as antioxidants in garlic (*Allium sativum* L., Alliaceae), *Food Chem*, **111**(4): 925-929.
8. Buitrago Diaz, A., Rojas Vera, J., Rojas Fermin, L., Morales Mendez, A., Rodriguez Contreras, L., 2011, Composition of the essential oil of leaves and roots of *Allium schoenoprasum* L. (Alliaceae*), Bol Latinoam Caribe Plant Med Aromat*, **10**(3): 218-221.
9. Capasso, A., 2013, Antioxidant action and therapeutic efficacy of *Allium sativum* L., *Molecules*, **18**(1): 690-700.
10. Duke, J.A., Bogenschutz-Godwin, M.J., duCellier, J., Duke, P-A.K., 2002, *Handbook of Medicinal Herbs*, IInd edition, CRC Press.
11. Fani, M.M., Kohanteb, J., Dayaghi, M., 2007, Inhibitory activity of garlic (*Allium sativum*) extract on multidrug-resistant *Streptococcus mutans*, *J Indian Soc Pedod Prev Dent*, **25**(4): 164-168.
12. Fossen, T., Slimestad, R., Ovstedal, D.O., Andersen, O.M., 2000, Covalent anthocyanin–flavonol complexes from flowers of chive, *Allium schoenoprasum*, *Phytochemistry*, **54**(3): 317–323.

13. Goncagul, G., Ayaz, E., 2010, Antimicrobial effect of garlic (*Allium sativum*) and traditional medicine, *J Anim Vet Adv*, **9**(1): 1-4.
14. Grzeszczuk, M., Wesołowska, A., Jadczak, D., Jakubowska, B., 2011, Nutritional value of chive edible flowers, *Acta Sci. Pol., Hortorum Cultus*, **10**(2): 85-94.
15. Han, C.-H, Liu, J.-C., Chen, K.-H., Lin, Y.-S., Chen, C.-T., Fan, C.-T., Lee, H.-L., Liu, D.-Z., Hou, W.-C., 2011, Antihypertensive activities of processed garlic on spontaneously hypertensive rats and hypertensive humans, *Bot Stud*, **52**(3): 277-283.
16. Horev-Azaria, L., Eliav, S., Izigov, N., Pri-Chen, S., Mirelman, D., Miron, T., Rabinkov, A., Wilchek, M., Jacob-Hirsch, J., Amariglio, N., Savion, N., 2009, Allicin up-regulates cellular glutathione level in vascular endothelial cells, *Eur J Nutr*, **48**(2): 67-74.
17. Hughes, B.G., Lawson, L.D., 2006, Antimicrobial effects of *Allium sativum* L. (garlic), *Allium ampeloprasum* L. (elephant garlic), and *Allium cepa* L. (onion), garlic compounds and commercial garlic supplement products, *Phytother Res*, **5**(4): 154-158.
18. Hwang, I.K., Lee, C.H., Yoo, K.-Y., Choi, J.H., Park, O.K., Lim, S.S., Kang, I.-J., Kwon, D.Y., Park, J., Yi, J.-S., Bae, Y.-S., Won, M.-H., 2009, Neuroprotective effects of onion extract and quercetin against ischemic neuronal damage in the gerbil hippocampus, *J Med Food*, **12**(5): 990-995.
19. Jayanthi, M.K., Dhar, M., 2011, Anti-inflammatory effects of *Allium sativum* (garlic) in experimental rats, *Biomedicine*, **31**(1): 84-89.
20. Josling, P., 2003, *Allicin. The heart of garlic*, NWI Publishing Callahan, Florida.
21. Kaiser, P., Youssouf, M.S., Tasduq, S.A., Singh, S., Sharma, S.C., Singh, G.D., Gupta, V.K., Gupta, B.D., Johri, R.K., 2009, Anti-allergic effects of herbal product from *Allium cepa* (bulb), *J Med Food*, **12**(2): 374-382.
22. Karuppiah, P., Rajaram, S., 2012, Antibacterial effect of *Allium sativum* cloves and *Zingiber officinale* rhizomes against multiple-drug resistant clinical pathogens, *Asian Pac J Trop Biomed*, **2**(8): 597-601.
23. Khodavandi, A., Alizadeh, F., Aala, F., Sekawi, Z., Chong, P.P., 2010, In vitro investigation of antifungal activity of allicin alone and in combination with azoles against *Candida* species, *Mycopathologia*, **169**(4): 287-295.
24. Kucekova, Z., Mlcek, J., Humpolicek, P., Rop, O., Valasek, P., Saha, P., 2011, Phenolic compounds from *Allium schoenoprasum*, *Tragopogon pratensis* and *Rumex acetosa* and their antiproliferative effects, *Molecules*, **16**(11): 9207-9217.
25. Kyung, K.H., 2012, Antimicrobial properties of *Allium* species, *Curr Opin Biotech*, **23**(2): 142-147.
26. Lanzotti, V., 2006, The analysis of onion and garlic, *J Chromatogr A*, **1112**(1-2): 3-22.
27. Lanzotti, V., 2012, Bioactive polar natural compounds from garlic and onions, *Phytochem Rev*, **11**(2-3): 179-196.
28. Lanzotti, V., Barile, E., Antignani, V., Bonanomi, G., Scala, F., 2012, Antifungal saponins from bulbs of garlic, *Allium sativum* L. var. Voghiera, *Phytochemistry*, **78**: 126-134.
29. Lattanzio, V., Lattanzio, V.M.T., Cardinali, A., 2006, Role of phenolics in the resistance mechanisms of plants against fungal pathogens and insects. In: Imperato, F., (ed.). *Phytochemistry: advances in research*. Trivandrum, Kerala (India).
30. Lee, D.Y., Li, H., Lim, H.J., Lee, H.J., Jeon, R., Ryu, J.-H., 2012, Anti-inflammatory activity of sulfur-containing compounds from garlic, *J Med Food*, **15**(11): 992-999.
31. Mahmoudabadi, A.Z., Nasery, M.K.G., 2009, Antifungal activity of shallot, *Allium ascalonicum* L. (Liliaceae), *in vitro*, *J. Med. Plants Res.*, **3**(5): 450–453.
32. Meriga, B., Mopuri, R., MuraliKrishna, T., 2012, Insecticidal, antimicrobial and antioxidant activities of bulb extracts of *Allium sativum*, *Asian Pac J Trop Med*, **5**(5): 391-395.
33. Mishra, R., Verma, D.L., 2009, Antifungal activity and flavonoid composition of *Wiesnerella denudata*, *Steph Academia Arena*, **1**(6): 42-45.
34. Moravcikova, D., Kucekova, Z., Mlcek, J., Rop, O., Humpolicek, P., 2012, Compositions of polyphenols in wild chive, meadow salsify, garden sorrel and ag yoncha and their anti-proliferative effect, *Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis*, **60**(3): 125-132.
35. Mudalige, C.P., Jyothi, N.S., Chikabire, U.G., Girisha, S.T., 2011, Biocontrol of root-rot disease of *Coleus forskohlii* and *Coleus amboinicus* by using plant extracts as antifungal agents, *Arch Phytopathology Plant Protect*, **44**(9): 888-893.

36. Nabavi, S.M., Hajizadeh Moghaddam, A., Fazli, M., Bigdellou, R., Mohammadzadeh, S., Nabavi, S.F., Ebrahimzadeh, M.A., 2012, Hepatoprotective activity of *Allium paradoxum*, *Eur Rev Med Pharmacol Sci*, **16**(3): 43-46.
37. Nidiry, E.S.J., Babu, C.S.B., 2005, Antifungal activity of tuberose absolute and some of its constituents, *Phytother Res*, **19**(5): 447-449.
38. Ogita, A., Fujita, K.I., Taniguchi, M., Tanaka, T., 2006, Dependence of synergistic fungicidal activity of Cu^{2+} and allicin, an allyl sulfur compound from garlic, on selective accumulation of the ion in the plasma membrane fraction via allicin-mediated phospholipid peroxidation, *Planta Med*, **72**(10): 875-880.
39. Ogita, A., Nagao, Y., Fujita, K., Tanaka, T., 2007, Amplification of vacuole-targeting fungicidal activity of antibacterial antibiotic polymyxin B by allicin, an allyl sulfur compound from garlic, *J Antibiot (Tokyo)*, **60**(8): 511-518.
40. Ozougwu, J.C., 2011, Anti-diabetic effects of *Allium cepa* (onions) aqueous extracts on alloxan-induced diabetic *Rattus novergicus*, *J Med Plants Res*, **5**(7): 1134-1139.
41. Pârvu, M., Pârvu, A.E., Roşca-Casian, O., Vlase, L., Groza, G., 2010, Antifungal activity of *Allium obliquum*, *J Med Plants Res*, **4**(2): 138–141.
42. Pârvu, M., Pârvu, A.E., Vlase, L., Roşca-Casian, O., Pârvu, O., 2011, Antifungal properties of *Allium ursinum* L. ethanol extract, *J Med Plants Res*, **5**(10): 2041–2046.
43. Pârvu, M., Pârvu, A.E., Vlase, L., Roşca-Casian, O., Pârvu, O., Puşcaş, M., 2011, Allicin and alliin content and antifungal activity of *Allium senescens* L. ssp. *montanum* (F.W.Schmidt) Holub ethanol extract, *J Med Plants Res*, **5**(29): 6544–6549.
44. Pârvu, M., Roşca-Casian, O., Puşcaş, M., Groza, G., 2009, Antifungal activity of *Allium fistulosum* L., *Contrib Bot*, **44**: 125–129.
45. Pârvu, M., Toiu, A., Vlase, L., Pârvu, A.E., 2010, Determination of some polyphenolic compounds from *Allium* species by HPLC-UV-MS, *Nat Prod Res*, **24**(14): 1318-1324.
46. Ranjan, S., Jadon, V.S., Sharma, N., Singh, K., Parcha, V., Gupta, S., Bhatt, J.P., 2010, Anti-inflammatory and analgesic potential of leaf extract of *Allium stracheyi*, *J Appl Sci Res*, **6**(2): 139-143.
47. Rattanachaikunsopon, P., Phumkhachorn, P., 2008, Diallyl sulfide content and antimicrobial activity against food-borne pathogenic bacteria of chives *(Allium schoenoprasum*), *Biosci Biotechnol Biochem*, **72**(11): 2987–2991.
48. Roghani, M., Khalili, M., Baluchnejadmojarad, Aghaie, M., Ansari, F., Sharayeli, M., 2010, Effect of oral feeding of *Allium schoenoprasum* L. on blood glucose and lipid level in diabetic rats, *J Gorgan Uni Med Sci*, **12**(1): 9-14.
49. Shams-Ghahfarokhi, M., Shokoohamiri, M.R., Amirrajab, N., Moghadasi, B., Ghajari, A., Zeini, F., Sadeghi, G., Razzaghi-Abyaneh, M., 2006, *In vitro* antifungal activities of *Allium cepa*, *Allium sativum* and ketoconazole against some pathogenic yeasts and dermatophytes, *Fitoterapia*, **77**(4): 321–323.
50. Singh, B.N., Singh, B.R., Singh, R.L., Prakash, D., Singh, D.P., Sarma, B.K., Upadhyay, G., Singh, H.B., 2009, Polyphenolics from various extracts/fractions of red onion (*Allium cepa*) peel with potent antioxidant and antimutagenic activities, *Food Chem Toxicol*, **47**(6):1161-1167.
51. Stajner, D., Popovic, B.M., Calic-Dragosavac, D., Malencic, D., Zdravkovic-Korac, S., 2011, Comparative study on *Allium schoenoprasum* cultivated plant and *Allium schoenoprasum* tissue culture organs antioxidant status, *Phytoter Res*, **25**(11): 1618-1622.
52. Stajner, D., Popovic, B.M., Canadanovic-Brunet, J., Stajner, M., 2008, Antioxidant and scavenger activities of *Allium ursinum*, *Fitoterapia*, **79**(4): 303-305.
53. Stajner, D., Milic, N., Canadanovic-Brunet, J., Kapor, A., Stajner, M., Popovic, B.M., 2006, Exploring *Allium* species as a source of potential medicinal agents, *Phytother Res*, **20** (7): 581–584.
54. Sundaram, U., Gurumoorthi, P., 2012, Validation of HPTLC method for quantitative estimation of L-Dopa from *Mucuna pruriens*, *Int Res J Pharm*, **3**(4): 300-304.
55. Thangavelu, R., Ganga Devi, P., Gopi, M., Mustaffa, M.M., 2013, Management of Eumusae leaf spot disease of banana caused by *Mycosphaerella eumusae* with Zimmu (*Allium sativum* × *Allium cepa*) leaf extract, *Crop Prot*, **46**: 100-105.
56. Timite, G., Mitaine-Offer, A.-C., Miyamoto, T., Tanaka, C., Mirjolet, J.-F., Duchamp, O., Lacaille-Dubois, M.-A., 2013, Structure and cytotoxicity of steroidal glycosides from *Allium schoenoprasum*, *Phytochemistry*, **88**: 61-66.

57. Ushimaru, P.I., Barbosa, L.N., Fernandes, A.A.H., Di Stasi, L.C., Jnior Fernandes, A., 2012, In vitro antibacterial activity of medicinal plant extracts against *Escherichia coli* strains from human clinical specimens and interactions with antimicrobial drugs, *Nat Prod Res*, **26**(16): 1553-1557.
58. Vlase, L., Pârvu, M., Pârvu, E.A., Toiu, A., 2013, Chemical constituents of three *Allium* species from Romania, *Molecules*, **18**(1): 114-127.
59. Vlase L., Pârvu M., Toiu A., Pârvu A.E., Cobzac, C.S., Puşcaş, M., 2010, Rapid and simple analysis of allicin in *Allium* species by LC-CIS-MS/MS, *Studia UBB Chemia*, **55**(4): 297-304.
60. Ye, C.-L., Dai, D.-H., Hu, W.-L., 2013, Antimicrobial and antioxidant activities of the essential oil from onion (*Allium cepa* L.), *Food Control*, **30**(1**)**: 48-53.
61. Zhang, H., Mallik, A., Zeng, R.S., 2013, Control of Panama disease of banana by rotating and intercropping with Chinese Chive (*Allium tuberosum* Rottler): role of plant volatiles, *J Chem Ecol*, **39**(2): 243-252.

ACŢIUNEA ANTIFUNGICĂ A FRUNZELOR DE *ALLIUM SCHOENOPRASUM* L.

(Rezumat)

Extractul hidroalcoolic obţinut din frunze de *Allium schoenoprasum* a fost testat în ceea ce priveşte acţiunea antifungică *in vitro* asupra a şase specii de ciuperci fitopatogene (*Aspergillus niger*, *Botrytis cinerea*, *B. paeoniae*, *Penicillium gladioli*, *Fusarium oxysporum* f.sp. *tulipae* şi *Sclerotinia sclerotiorum*). Experimentul *in vitro* s-a desfăşurat prin metoda diluţiilor, utilizând mediul de cultură Czapek-agar şi, pentru comparaţie, produsul antimicotic Fluconazol şi allicină sintetică. Rezultatele experimentale au fost exprimate sub forma concentraţiei minime inhibitoare (CMI), care a variat, în funcţie de specia patogenă, între 70-120 µl/ml pentru extractul vegetal de *A. schoenoprasum*, 80-300 µl/ml pentru Fluconazol şi 100-160 µl/ml pentru allicină.

Acţiunea antifungică mai pronunţată a extractului vegetal poate fi explicată de compoziţia în principii active. Rezultatele obţinute completează puţinele date din literatură cu privire la acţiunea antifungică a extractului de *A. schoenoprasum* şi recomandă utilizarea acestuia cel puţin pentru tratarea bolilor produse de speciile fitopatogene studiate.