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A Review

The Potential Phytoncide Effect of *Allium cepa* L. Extracts

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Abstract

It is well known that phytoncides are represented by a series volatile organic substances, produced by plants, and they are characterized by special antimicrobial properties. The chemical nature of phytoncides is very diverse. Usually, they belong to groups of compounds included in the classes of: glycosides, terpenes, pigments, etc. Antimicrobial capacity is species specific. Research on the antibacterial, antifungal and antioxidant properties of *Allium cepa* L. has revealed a number of peculiarities, but these are carried out, especially *in vitro*, in field experiments related to the above mentioned properties of the plant being little addressed.

Keywords: biomolecules, glycosides, onion, plant diseases

1. Introduction

The word phytotoncide (it means "exterminated by plants") was introduced in the scientific vocabulary in the year 1937, by the Russian biochemist Boris Tokin, from the University of Leningrad. The researcher discovered that some plants possess in their composition biomolecules characterized of intense activity, which have properties that prevent their decay, or give them natural resistance against some insects and animals [7]. In the category of the compounds class he called generically phytotoncide, are included various plants. Among these, we mention the Allium genus [3, 9].

The phytoncides are represented by a series volatile organic substances, produced by plants, and they are characterized by special antimicrobial properties [14].

The capacity to produce substances characterized by special antimicrobial properties is a characteristic of all plants. It is a feature of the natural immunity of plants, which means that they can be protected against the attacks of fungi, pathogens, or insects, by certain classes of biomolecules produced by the plant itself. The release of active biomolecules with phytoncide properties increases when the plant is "attacked" by an "enemy".

This rewiew was compiled using specific methodology destined to bibliographical reserch. Several databases were consulted, and articles important for research were analyzed.

The aim of our study is to elaborate a synthesis on article subject, taking into account the bibliographic study methodologies, and by consulting data from different sources.

2. A chemical approach

The chemical nature of phytoncides is very diverse. Usually, they belong to groups of compounds included in the classes of: glycosides,

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terpenes, pigments, etc. Antimicrobial capacity is species specific.

The chemical nature of phytoncides is very diversified. Usually, they belong to groups of compounds, which frames in the category of glycosides, pigments, terpenes, and secondary metabolites. Their antifungal and antibacterial powers are species specific. E.g. some specific phytochemicals produced by garlic, onion, and horseradish are able to anihilate various bacteria and fungi even within seconds.

Phytoncides fulfill their role as plant defenders not only by destroying pathogens and pests, but they can also prevent their spread, and in some cases, stimulate the activity of high importance, specific to other microorganisms, to fight against harmful mites and pathogens [15, 23]. Diseases caused by fungi and bacteria, in plants, are still a serious problem worldwide. In this context, it should be mentioned that Allium species contain a number of active biomolecules, which belong to the category of organosulfur compounds, which have antifungal and antibacterial properties [10].

Allium cepa L., for example, produces phytochemicals able to destroy different species of fungi and bacteria within seconds. Phytoncides act not only as plant defenders by destroying pests and pathogens, but they also have a prevention role in pests and pathogens spreading, and stimulating activity of fighting against pathogenic agents. According to a series of theoretical and practical studies, *Allium cepa* L. (onion) is a species also analyzed from the point of view of its antioxidant, antibacterial, antifungal and insecticide potential. Onion has an average content of 89% water, 7.1%, carbohydrates, 2.1% fiber, 1.3% protein and 0.2% lipids [9]. Flavonoids (predominantly quercetin and kaempferol), organosulfur compounds (different types of alkyl thiosulfinates) and/or peptides (e.g. allicepin), are considered responsible for above mentioned onion properties [1, 2, 11, 13, 17].

Different efficacy degrees are reported for water or organic solvents extracts of active principles extracted from onion. Reviewing literature concerning the antibacterial, antifungal and insecticide potential of *Allium cepa* L., in order to implement a practical study on this issue is the aim of our research. These aspects could bring a real contribution to diversifying the organic agriculture inpunts, issue which has real importance mainly in the present national context, favorable for attracting European funds for developing organic agriculture.

3. General considerations on *Allium cepa* L.

Allium cepa L. (onion), belongs to the Order Asaparagales, Family Alliaceae, genus Allium. Thus, a series of authors [6, 16, 20, 21, 24] performed studies on antimicrobial extracts from *Allium cepa* L.

Flavonoids are abundant in onions, being present as glycosides, meaning quercetin and kaempferol, in a higher concentration (280-400 mg/kg) than in other fruits or vegetables, as in apple - 50 mg/kg, or in broccoli 100 m/kg. According to Reuter et al. (1996), the antimicrobial effect of *Allium cepa* L. is primarily due to its content in different types of alkyl thiosulfines [19].

Literature considers, however, that their metabolization products also play the same role [4, 5, 12, 24]. Also, according to literature, antibacterial, antifungal and insecticide action, could be the result other active biomolecules from the structure of *Allium cepa* L., but to a lesser extent. They include: flavonoids, phenols with antioxidant properties [8, 20], peptides [25], and alkaloids [22]. In *Allium cepa* L., sulfur compounds are responsible for the typical odor and aroma and are also active antimicrobial agents, property on which the onion has the potential to be used as a natural preservative [18].

Wang et al. (2003) isolated from the bulbs of the *Allium cepa* L., a new antifungal peptide, distinct from the antimicrobial peptides literature mentions as being obtained from the onion seeds [25]. The antifungal peptide, called allicepin, was purified by a procedure that involved aqueous extraction, ion exchange chromatography on DEAE cellulose, affinity chromatography on Affi-gel blue gel, and FPLC gel filtration on Superdex 75. Allicepin was not absorbed on DEAE cellulose and adsorbed on Affi-gel blue gel. The molecular weight of allicepin was estimated to be 10 K by sodium dodecyl sulfate-polyacrylamide gel electrophoresis and gel filtration on Superdex 75. Allicepin exerted inhibitory activity on micellar growth in several fungal species, including: *Fusarium oxysporum*, *Botrytis cinerea*, *Physalospola*, or *Mycosphaerella arachidicola*.

Research on the antibacterial, antifungal and antioxidant properties of *Allium cepa* L. has revealed a number of peculiarities, but these are carried out, especially *in vitro*, in field experiments related to the above mentioned properties of the plant being little addressed. An exception is the study by Liguori et al. (2017) regarding the antioxidant activity of *Allium cepa* L. cultivars, highlighting the importance of the culture maintenance conditions on it. Santas et al. (2010) analyzing the antioxidant and antimicrobial activities of the extracts of three varieties of *Allium cepa* L. in various media, namely esters (ethyl acetate), alcohols (methanol) and aqueous on some gram-positive and gram-negative bacteria, obtained differentiated results [14].

Thus, it was found that flavonoids were present mainly in the etheric extract (in ethyl acetate). The flavonoid extracts in ether represented by quercetin and kaempferol exhibited inhibitory activity on gram-positive bacteria (*Staphylococcus aureus*, *Bacillus cereus*, *Listeria monocytogenes*, and *Microcroccus luteus*) while gram-negative bacteria as *Pseudomonas aeruginosa* or *Escherichia coli* had and increased resistance against flavonoids extracts in ether, while *Candida albicans* was completely resistant against etheric flavonoid extracts.

When study of the antomicrobial action of the aqueous and alcoholic extracts was performed, their inefficiency was found. In a similar study, Cornago et al. (2013) studied the antifungal activity of the extracts of *Allium cepa* L. bulbs in different media: etheric medium (ethyl acetate), alcoholic medium (methanol) and aqueous media, on fungi belonging to Colletotrichum sp., and also on *Fusarium oxysporum* [6].The etheric medium extract showed significant activity against both fungi even at very low concentrations. The activity of etheric medium extract was not significantly different ($p> 0.05$) compared to that of captan, a known fungicide against Colletotrichum sp., and *Fusarium oxysporum*.

The etheric medium extract was fractionated using normal phase vacuum liquid chromatography, resulting in ten fractions.Six of the ten factions showed activity against both fungi.

These results showed that the *Allium cepa* L. bulb extracts can be a source of compounds that can serve as templates for future fungicides with role in fight against Colletotrichum sp., and *Fusarium oxysporum*. Studies also show that *Allium cepa* L. roots extracts in n-butanol and found antifungal activity against pathogenic fungi of plants.

The purified compounds from the extract were examined for antifungal activity to determine the predominant antifungal compounds in the extract [8, 23].Two major purified antifungal compounds were determined to be Alliospiroside and Alliospiroside B. Alliospiroside had prominent antifungal activity against a wide range of fungi.

The acid hydrolysis products of Alliospiroside showed reduced antifungal activity, which suggests that the sugar chain of the compound is essential for its antifungal activity. Fungal cells treated with Alliospiroside showed rapid production of reactive oxygen species.

The funcicide action of Alliospiroside was partially inhibited by a superoxide purification, Tiron, which suggests that the generation of superoxide anion in fungal cells may be linked to the action of the compound. Inoculation experiments have shown that Alliospiroside protects strawberry plants against *Colletotrichum gloeosporioides*, indicating that Alliospiroside has the potential to control the anthracnose of the plant.

4. Conclusions

Phytoncides are represented by a series volatile organic substances, produced by plants, and they are characterized by special antimicrobial properties. The chemical nature of phytoncides is very diverse. Usually, they belong to groups of compounds included in the classes of: glycosides, terpenes, pigments, etc. Antimicrobial capacity is species specific. Research on the antibacterial, antifungal and antioxidant properties of *Allium cepa* L. has revealed a number of peculiarities, but these are carried out, especially *in vitro*, in field experiments related to the above mentioned properties of the plant being little addressed.

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