

## **New Formulation for Prevention of Diseases and Pests in the Process of Growing Seedlings from Plant Cuttings and their Acute Toxicity to Chick Embryos**

**Archil Chirakadze<sup>\*</sup>, Nino Lomidze<sup>\*\*</sup>, Jemal Dzlierishvili<sup>\*\*</sup>,  
Marina Devdariani<sup>§</sup>, Ia Kvachakidze<sup>§</sup>, Nodar Mitagvaria<sup>#,§</sup>**

*<sup>\*</sup>Department of Engineering Physics, Georgian Technical University, Tbilisi, Georgia*

*<sup>\*\*</sup>Faculty of Agricultural Sciences and Biosystems Engineering, Georgian Technical University, Tbilisi, Georgia*

*<sup>§</sup>Department of Cerebral Circulation and Metabolism, Ivane Beritashvili Center for Experimental Biomedicine, Tbilisi, Georgia*

*<sup>#</sup>Academy Member, Georgian National Academy of Sciences, Ivane Beritashvili Center for Experimental Biomedicine, Tbilisi, Georgia*

**One of the main tasks in plant propagation is the sanitation of the “parent” material and prevention of its contamination by various pathogens. This problem is equally important for the two leading branches of agriculture in Georgia - viticulture and the cultivation of hazelnuts, pistachios and walnuts. One of the most common ways to prevent contamination of seedlings is to treat them with hot water, which requires a lot of energy and, at the same time, is not effective enough. This article proposes to apply a new energy-efficient method of processing the source material using various combinations of electrochemically activated aqueous solutions and water dispersions of nano-materials with high antiviral, antimicrobial, fungicidal and insecticidal efficacy. Another important property of the means and methods used in agriculture is their low acute toxicity against living organisms, which in this study was tested using visible light ovoscopy of chick embryos. The research results allow us to conclude that combinations of electrochemically activated aqueous solutions and water dispersions of nano-materials with high antiviral, antimicrobial, fungicidal and insecticidal efficacy can be regarded as very promising formulations for preventing contamination of the source planting material with pathogens. © 2022 Bull. Georg. Natl. Acad. Sci.**

plant propagation, electrochemically activated, pathogens, prevention, viticulture, pistachio, walnuts, hazelnuts

Plant cultivation is the propagation of "parent" plants from the material taken from them, and it is widely used for the cultivation and propagation of agricultural plantations, gardens and forest parks [1]. There are two main types of propagation - asexual, when propagation occurs from an already well-developed plant part (cuttings), and sexual,

when development takes place from a plant seed. In the first case, the seedling has only one type of genetic material, just like the "mother" plant. In the second case, the new plants have two types of genetic material, and they can be markedly different from the "parents" and from each other. Today, when winemaking and horticulture is no

longer an industry based mainly on family and regional small and medium enterprises, but is mainly represented in the form of large national and international corporations, the importance of compliance with the established standards of nursery material and final product is paramount. It is important to note that strict adherence to the standards is possible in the case of asexual reproduction and practically impossible in the case of sexual reproduction [1]. Around the world (especially in viticulture and horticulture) it is widely used to propagate plants by growing seedlings from cuttings in various traditional and newly designed containers. At this time, great attention is paid to the protection of the propagating material from contamination by pathogens, which is highly relevant in the case of vines and pistachio plantations (more than 70 major main pathogens in vines and more than 10 major pathogens of pistachios).

Network, founded in 2010 in the United States, provides to consumers a pathogen-free nursery material [2].

**Purpose and object of the research.** Both of the above sanitation methods are respectively highly energy- and time-consuming, and significantly increase the cost of planting vineyards and pistachio, hazelnut and walnut plantations, as well as orchards or forest parks. However, it is impossible to use the first method in the case of softwood cuttings. Therefore, our choice was to enhance and reduce the time and costs processing of plant material using an electrochemically activated water-based preparation (namely, "elixir for nuts, walnuts and pistachios"). This drug is an innovative and high-tech product, made in Georgia with European technology. It is used for prevention of plant diseases caused by harmful microorganisms, for prevention of fungal, viral and bacterial diseases, is

**Table. Composition of the developed combinations**

Number of combination \ Share of components in combinations	Distilled water	Elixir for nuts, walnuts and pistachios	Al <sub>2</sub> O <sub>3</sub> water dispersion	Fe <sub>3</sub> O <sub>4</sub> water dispersion	Lanspers BIO-868 surfactant
1 (room temperature water)	100	-	-	-	-
2	96	1.0	-	-	-
3	96	0.9	0.1	-	3
4	96	0.9	-	0.1	3
5	95.6	0.9	0.5	-	3
6	95.6	0.9	-	0.5	3
7 (56 °C) temperature water	100	-	-	-	-

If the starting material for plant cultivation is taken from a plant that is infected with a viral pathogen, it will inevitably show itself in the new plant as well. Therefore, it is a common practice to treat the starting material with 0.1% aqueous solution of hydrogen peroxide or hot water at a temperature of (56±1)<sup>0</sup>C [1]. The second, more effective and valuable method is to thoroughly test the infection of the raw material with pathogens and to create collections of pathogen-free nursery material. For example, the National Clean Plant

registered by the Georgian National Food Agency and complies with the latest EU regulations. Importantly, this drug also has a strong insecticidal action [3] and it is an environmentally safe highly effective stimulant of plant growth [4].

At the present stage, it is considered that a joint use of antiviral drugs water dispersions of insecticidal metal (ZnO, CuO, Al<sub>2</sub>O<sub>3</sub>) nanoparticles has a high protective potential [5, 6]. Therefore, it is expected that if their environmental safety is confirmed, they can be successfully used both for

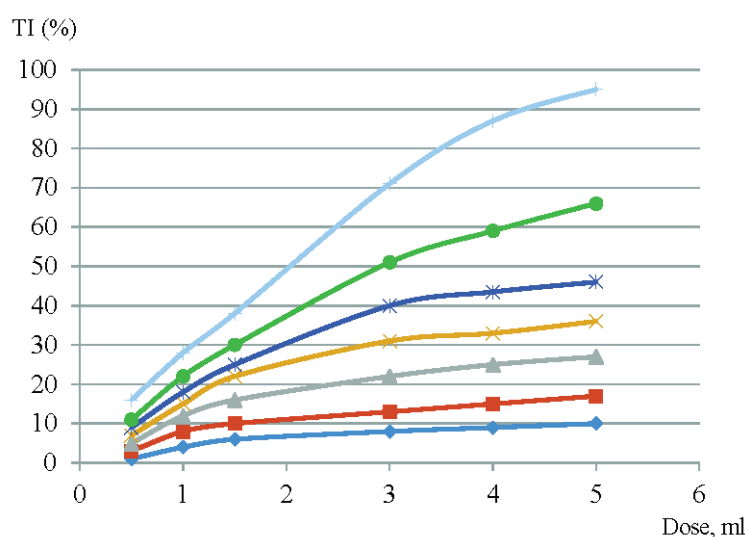


Fig. Acute toxicity index of tested combinations by increasing number of combinations (bottom to top).

disinfection of nursery materials and to protect the propagated plants from pests. The aim of this study was to evaluate the environmental safety of combined preparations containing  $\text{Al}_2\text{O}_3$  nanoparticles compared to preparations containing  $\text{Fe}_3\text{O}_4$  iron oxide nanoparticles using visible spectroscopy of chicken embryos [3].

**Experimental research.** Water dispersions of 28 nm sized  $\text{Al}_2\text{O}_3$  nanoparticles (22 wt%) and water dispersions of 18 nm sized  $\text{Fe}_3\text{O}_4$  nanoparticles (22 wt%) provided by “Nanografi” (Jena, Germany) were used to make the test combinations. 100% biodegradable surfactant Lansperse BIO-868 supplied by “Lanskem” (Cheshire, UK), 0.5 wt% solution of “Elixir for nuts, walnuts and pistachios” supplied by Elixir Georgia (Tbilisi, Georgia) and standard distilled water were used as components of seven different combined formulations. Combinations were made using high-frequency mechanical and ultrasonic dispersers [3].

The content of composed combinations is given in Table. Combinations were injected (using a small needle) into chicken eggs with confirmed normally developed 7-day embryos tested using visible light ovoscopy. 0.5, 1, 1.5, 3, 4 and 5 ml doses were applied. The needle-shaped holes were

immediately covered with melted natural wax. Distilled water was introduced both cold (room temperature) and hot ( $56\text{-}60^\circ\text{C}$ ). Ovoscopic control of embryonic development was performed every 3 days. The acute toxicity of the combination was determined by the number of hatched normally developed chickens by the formula:

$$TI = (1 - N1 / N0) \times 100(\%), \quad (1)$$

where TI is the so called acute toxicity index, N1 is the number of hatched and normally developed chickens, and N0 is the initial number of tested eggs put into the incubator. Meanwhile, embryonic developmental abnormalities were observed during the incubation period. The dose dependence of the toxicity index for each combination is given in Figure.

#### The brief analysis of the results and conclusion.

The results of the study clearly show that hot water treatment, depending on the dose of dermatology, is 6-10 times more toxic to chick embryos than a combination of aluminum nanoxide and electrochemically activated water-based elixir. Meanwhile, a combination containing aluminum nanoxide is about twice as toxic as combinations containing iron nanoxide. Taking into account the

high insecticidal properties of the new combinations, their high biological effectiveness, high energy efficiency and low cost of their production and use, the high environmental and economic potential for their wide application in agriculture become clear. It is also clear that greenhouse and field trials are necessary to provide more data on the real sanitation, insecticidal and environmental potential of the developed and

preliminarily tested combinations. Various nanomaterials having high antiviral, antimicrobial, fungicidal and insecticidal properties (like zinc and copper oxides and hydroxides), as well as essential oils (clove oil, rosemary oil, etc.) and minerals (diatomaceous earth, kaolin) should be tested as promising additives to the dual use (anti-pathogen and insecticidal) combinations for agricultural use.

### ბიოფიზიკა

## მცენარეთა კალმებიდან ნერგების გაზრდის პროცესში დაავადებების და მავნე ორგანიზმების პრევენციის ახალი კომბინირებული პრეპარატი და მისი მწვავე ტოქსიკურობა ქათმის ემბრიონების მიმართ

ა. ჭირაქაძე\*, ნ. ლომიძე\*\*, ჯ. ძლიერიშვილი\*\*, მ. დევდარიანი#,  
 ი. ქვაჩაკიძე#, ნ. მითაგვარია#§

\*საქართველოს ტექნიკური უნივერსიტეტი, საინჟინრო ფიზიკის დეპარტამენტი, თბილისი, საქართველო

\*\*საქართველოს ტექნიკური უნივერსიტეტი, აგრარული მეცნიერებების და ბიოსისტემების ინჟინერინგის ფაკულტეტი, თბილისი, საქართველო

#ბერეტაშვილის ექსპერიმენტული ბიომედიცინის ცენტრი, თავის ტვინის სისხლის მიმოქცევის და მეტაბოლიზმის განყოფილება, თბილისი, საქართველო

#აკადემიის წევრი, საქართველოს მეცნიერებათა ეროვნული აკადემია, თბილისი, საქართველო

მცენარის გამრავლების ერთ-ერთი მთავარი ამოცანაა „მშობელი“ მასალის სანიტაცია და სხვადასხვა პათოგენებით მისი დაბინძურების პრევენცია. ეს პრობლემა ერთნაირად მნიშვნელოვანია საქართველოში სოფლის მეურნეობის ორი წამყვანი დარგისთვის – მევენახეობის, თბილისა და კაკლის მოშენებისთვის. ნერგების დაბინძურების თავიდან აცილების ერთ-ერთი ყველაზე გავრცელებული გზაა მათი ცხელი წყლით დამუშავება, რაც დიდ ენერჯიას მოითხოვს და, ამავდროულად, არასაკმარისად ეფექტურია. ნაშრომში წარმოდგენილია „საწყისი“ მასალის დამუშავების ახალი ენერგოეფექტური მეთოდი ელექტროქიმიურად აქტივირებული წყალხსნარებისა და მაღალი ანტივირუსული, ანტიბიკრობული, ფუნგიციდური და ინსექტიციდური ეფექტურობის მქონე ნანო-მასალების წყლის დისპერსიების კომბინაციების გამოყენებით. სოფლის მეურნეობაში გამოყენებული საშუალებებისა და მეთოდების კიდევ ერთი

მნიშვნელოვანი მახასიათებელია მათი დაბალი მწვავე ტოქსიკურობა ცოცხალი ორგანიზმების მიმართ, რაც ამ კვლევაში გამოიყენა ქათმის ემბრიონების ხილული სინათლის ოვოსკოპის მეშვეობით. კვლევის შედეგები საშუალებას გვაძლევს დავასკვნათ, რომ ელექტროქიმიურად აქტივირებული წყალხსნარების და ნანო-მასალების წყლის დისპერსიების კომბინაცია მაღალი ანტივირუსული, ანტიმიკრობული, ფუნგიციდური და ინსექტიციდური ეფექტურობით შეიძლება ჩაითვალოს ძალზე პერსპექტიულ საშუალებად „საწყისი“ გასამრავლებელი მასალის პათოგენებით დაბინძურების თავიდან ასაცილებლად.

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Received June, 2022