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## THE BIOLOGICAL ACTIVITY OF COLLOIDAL COPPER PARTICLES OBTAINED BY “GREEN SYNTHESIS” BASED ON THE EXTRACT OF THE ALCHEMILLA VULGARIS

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*The effect of colloidal copper particles on the germination energy and biometric parameters of wheat seedlings was studied.*

**Keywords:** *colloidal copper particles; growth regulators; germination energy.*

## БИОЛОГИЧЕСКАЯ АКТИВНОСТЬ КОЛЛОИДНЫХ ЧАСТИЦ МЕДИ, ПОЛУЧЕННЫХ ПУТЕМ «ЗЕЛЕННОГО СИНТЕЗА» НА ОСНОВЕ ЭКСТРАКТА МАНЖЕТКИ ОБЫКНОВЕННОЙ

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*Изучено влияние коллоидных частиц меди на энергию прорастания и биометрические показатели проростков пшеницы.*

**Ключевые слова:** *коллоидные частицы меди; регуляторы роста; энергия прорастания.*

The materials presented in the article describe the effect of colloidal copper particles synthesized on the basis of the *Alchemilla vulgaris* extract on the germination energy and biometric parameters of wheat seedlings. It is known that colloidal copper particles exhibit pronounced biological activity, including bacteriostatic and bactericidal action [1]. Copper nanoparticles were obtained by the method of “green synthesis” by reducing copper nitrate to metal. Extracts from the *Alchemilla vulgaris* were used as reducing agents. The recovery involves biologically active substances contained in plants, namely tannins, flavonoids, anthracene derivatives, coumarins, terpenoids, polysaccharides.

The starting aqueous plant extract was prepared in a Soxhlet extractor. The weight of a sample of plant material was 50 g, the volume of water was 250 ml.

Further, on the basis of the initial solution by dilution, three extracts of different degrees of dilution were obtained (table 1).

Table 1.

**Preparation of aqueous extracts of ordinary cuffs of varying degrees of dilution**

№ plant extracts	Power dilution
1	Source extract
2	10-fold dilution
3	100-fold dilution

To obtain a colloidal solution, 8.5 ml of the filtered initial extract was added dropwise to 50 ml of a solution of copper nitrate ( $C = 0.001 \text{ mol / L}$ ) at room temperature, with constant stirring. The color of the solution became darker after 10 minutes of reaction, which indicated the development of copper nanoparticles. To study the effect of concentration on the biological activity of colloidal copper, three solutions were prepared by dilution: the initial solution (**1**), dilution 10 times (**2**), dilution 100 times (**3**), and dilution 1000 times.

The effect on seed germination energy is one of the indicators of the stimulating activity of any drug. Wheat seeds were chosen as the object of study because of their optimal size, short germination time, and high stress resistance. Data on the study of germination energy are presented in table 2.

Table 2.

**Wheat germination energy**

Seed treatment	Germination energy, %		
	3 days after soaking	6 days after soaking	9 days after soaking
Colloid № 1	76,7	93,3	93,3
Colloid № 2	76,7	76,7	93,3
Colloid № 3	83,3	83,3	83,3
H <sub>2</sub> O	93,3	93,3	100
Cu(NO <sub>3</sub> ) <sub>2</sub>	66,7	73,3	96,7
Extract № 1	73,3	73,3	83,3
Extract № 2	80,0	93,3	93,3
Extract № 3	73,3	83,3	93,3

The data presented in table 2 show that neither the original extracts nor the synthesized colloids show a significant ability to stimulate the processes of seed germination. The highest rates of germination energy are observed in the experiment with water.

Biometric indicators recorded on the 9th day after the start of treatment allow us to evaluate the biological activity of the tested drugs in relation to the

growth processes that occur in plants at the initial stage of development. The sizes of wheat shoots treated with different compositions are presented in table 3.

Table 3.

### Biometry of wheat plants

	Colloid № 1	Colloid № 2	Colloid № 3	H <sub>2</sub> O	Cu(NO <sub>3</sub> ) <sub>2</sub>	Extract № 1	Extract № 2	Extract № 3
Shoot height, cm	11,3±0,9	12,0±1,6	15,6±1,3	21,4±4,5	14,2±1,3	14,3±1,4	14,3±1,4	14,35±1,1

The data in table 3 show that the extracts of the *Alchemilla vulgaris*, as well as colloidal solutions of copper obtained on the basis of these extracts, inhibit the growth processes in the shoots of wheat in the early stages.

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