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SYNTHESIS OF COPPER PHYTOCOMPOUND AND POLYFUNCTIONAL DRUG BASED ON DICALCIUM PHOSPHATE

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ABSTRACT

This article gives information on the synthesis of phytocompounds of copper with the subsequent production of a multifunctional biological product based on dicalcium phosphate for use as fertilizers for application to the soil in order to increase the activity of soil microorganisms and the yield of agricultural crops.

Keywords: Synthesis, Fertilizer, Dicalcium Phosphate, Phytocompounds, Soil, Herbal Remedies.

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INTRODUCTION

Today, one of the important environmental problems in agriculture is the increased content of phosphorus in the soil, which arose as a result of the annual change in the soil under the crop with a large amount of phosphorus-containing fertilizers.[1,2.] Soil is a chemically and biologically diverse, active environment. The level of its fertility is determined to a large extent by the intensity and direction of biological processes, the regulation of which is quite difficult.[3,4] Determining the microbiological processes that have a significant impact on crop yields, as well as the content of individual nutrients in the soil, is an important task.[5,6] In combination with traditional agrotechnical methods, the use of growth stimulants, immuno-regulators, activators of beneficial microflora, biofertilizers, etc., applied in small or ultra-low doses, provides stimulation of plant immunity, acceleration of metabolism, and activation of protein synthesis, improves the quality of finished products with increased yields. The work shows the positive effect of phosphorus bacterial and organomineral fertilizers on the biomass and enzymatic activity of the soil, ultimately on obtaining high-quality crop yields.[7,8,9,10] In the work, the authors state that the activity of phosphorus-containing fertilizers occurs under the effect of phytocompounds. High-quality crop yields are achieved by reducing the norms of phosphorus-containing components by 1.5-3 times.[11,12] Dicalcium phosphate is one of the main components of the phosphorus nutrition of amorphous and other phosphorus-containing fertilizers. However, there is no information in the literature on its chemical interaction with phytocompounds of transition metals. The scientific novelty of the article lies in the synthesis of phytocompounds of copper with the subsequent production of a multifunctional biological product based on dicalcium phosphate for use as fertilizers for application to the soil in order to increase the activity of soil microorganisms and the yield of agricultural crops.

EXPERIMENTAL

Material and Methods

To determine the elemental composition and study the structural features of the mixture under experimental conditions, testing methods were chosen using a scanning SEM Jeol JSM-6490lV, X-ray diffractometer D878-PC75-17.0, IR Fourier spectrometer, and other instrumental methods.

General Procedure

Obtaining a phytocompound of copper in a mass ratio of 1:1. To do this, 2.0g of copper sulfate and 2.0g of phytocompound are dissolved in 100 ml of water at a temperature of 45-50°C and kept with stirring for 2 hours. The product was dried at 25-30°C. Next, 1.0g of copper phytocompound and 1.0g of dicalcium phosphate were dissolved in 200 ml of water and kept under stirring for 25-30 minutes. Temperature 45-

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50°C. The preparation was dried at a temperature of 25-30°C. The result is a copper phytocompound preparation.

RESULTS AND DISCUSSION

To study the elemental and mineralogical composition of the mixture obtained on the basis of phytocompounds and copper sulfate, microscopic analysis was carried out using a scanning SEM. The elemental chemical composition of raw materials and products was determined. The results are shown in Fig.-1 and Table-1.

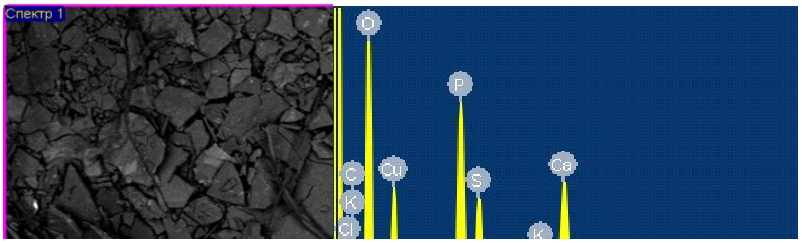

Fig.-1: Microstructure of Copper Phytocompound

It follows from Fig.-1 that the results of the research determine the chemical composition of copper phytocompounds. The content of the useful component of copper (Cu) reaches up to 10%.

Table-1: Elemental Composition of Copper Phytocompounds

Element	Weight,%	Oxides	Interms of oxides, %	Element	Weight,%	Oxides	Interms of oxides, %
C	47.00	-	-	Ca	0.65	CaO	0.91
O	34.22	-	-	Cu	10.00	CuO	12.5
Mg	0.38	MgO	0.63	S	3.95	-	-
P	0.27	P_2O_5	0.61	Cl	0.81	-	-
K	2.72	K_2O	3.33	-	-	-	-

From Table-1 it follows that the mixture contains useful components such as phosphorus (P), magnesium (Mg), potassium (K), copper (Cu), etc. The presence of such useful components makes it possible to use copper phytocompounds as raw materials for the synthesis and a multifunctional drug. To determine the phase composition of the copper phytocompound, X-ray phase analysis was carried out using an X-ray diffractometer D878-PC75-17.0. The research results are presented in Fig.-2. From Fig.-2 it follows that in a mixture of phytocompounds with copper sulfate, distinctive reference lines are observed, indicating the formation of compounds in the composition of the semi-product (theta(deg)): 6.52; 11.698; 20.753; 21.29; 29.091; 30.61.

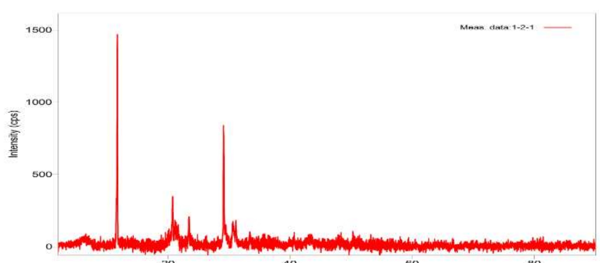

Fig.-2**:** X-ray Phase of Copper Phytocompounds

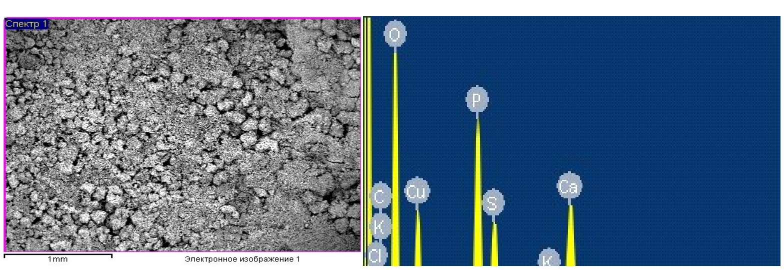

Fig.-3: Microstructure of Phytocompound of Copper with Dicalcium Phosphate

Table-2: Elemental Composition of Phytocompound of Copper with Dicalcium Phosphate

Element	Weight,%	Oxides	Interms of oxides, %	Element	Weight,%	Oxides	Interms of oxides, %
C	17.74	-	-	Cl	0.374	-	
O	41.78	-	-	K	2.245	K_2O	2.705
Mg	0.191	MgO	0.318	Ca	7.191	CaO	10.06
P	8.62	P_2O_5	14.54	Cu	17.67	CuO	22.08
S	4.189	-	-	-	-	-	-

From Table-2 it follows that the phytocompound of copper with dicalcium phosphate contains useful components, the phosphorus (P) content reached up to 8.62%, and copper (Cu) up to 17.67%. This content of macro and microelements allows them to be used as phosphorus-containing mineral fertilizers to increase the yield of agricultural crops.[13,14]

Table-3: IR Spectral Data of Phytocompound of Copper with Dicalcium Phosphate

No	Peak	Intensity	Corr. intensity	Base (H)	Base (L)	Area	Corr. Area
1	478.35	97.484	8.374	493.78	466.77	0.006	0.606
2	551.64	94.414	4.358	574.79	540.07	0.592	0.383
3	601.78	94.606	2.542	609.51	578.64	0.565	0.192
4	644.22	96.105	0.600	655.80	613.36	0.659	0.080
5	663.51	96.236	0.412	698.23	659.66	0.503	0.017
6	748.38	97.403	0.115	752.24	725.23	0.277	0.006
7	864.11	97.084	0.258	871.82	856.39	0.188	0.008
8	968.27	92.496	0.265	1006.84	883.40	2.834	0.768
9	1053.13	92.302	2.519	1087.85	1010.70	2.185	0.416
10	1095.57	94.513	0.256	1215.15	1091.71	1.648	0.035
11	1222.87	99.103	0.211	1234.44	1215.15	0.064	0.007
12	1288.45	99.156	0.164	1296.16	1269.16	0.079	0.007
13	1442.75	99.025	0.188	1458.16	1431.18	0.100	0.009
14	1620.21	99.143	0.268	1631.78	1589.34	0.118	0.022

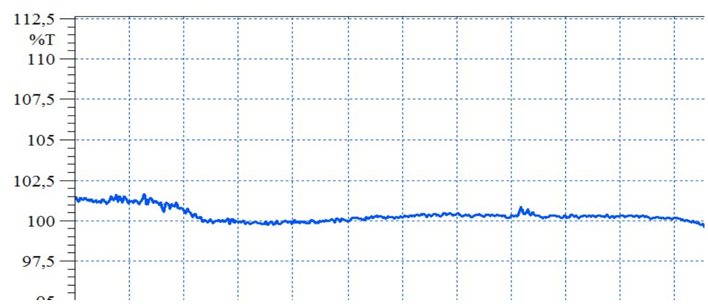

Fig.-4: IR-spectrum of Phytocompound of Copper with Dicalcium Phosphate

From Fig.-4 it follows that the IR spectrum of the phytocompound of copper with dicalcium phosphate implies that:

- Spectra 1620.21–1442.75 cm^{-1}, obtained in the presence of carbon compounds, indicate C-O-C chemical bonds in the copper phytocompound;
- Spectra 1288.45–1053.13 cm^{-1} indicate phosphorus compounds;
- Spectra 968.27 cm^{-1}, which indicates phosphorus-containing phosphorus-potassium compounds.;
- Spectra 864.11–663.51 cm^{-1}, which are proved by potassium and sulfur;
- Spectra in the range 644.22–478.35 cm^{-1} refer to compounds of aluminum, iron, and magnesium.

From Fig.-5 it follows that the phytocompound of copper with dicalcium phosphate has new distinctive reference lines, indicating the formation of new compounds in the complex composition of the final product (theta(deg)): 11.791; 21.077; 21.664; 23.903; 30.224; 34.471; 37.06; 42.141.

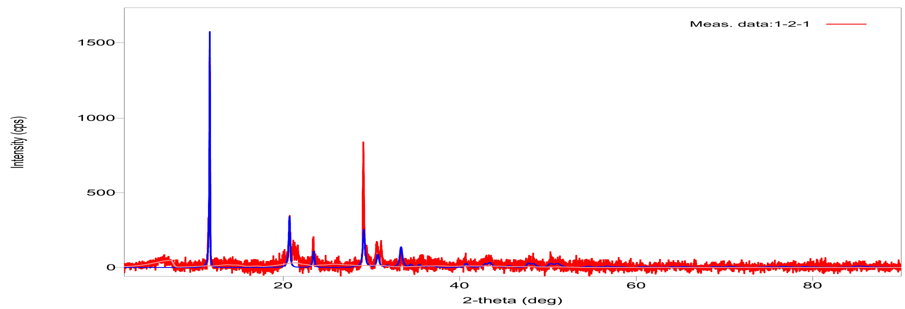

Fig.-5: X-Ray Phase of Phytocompound of Copper With Dicalcium Phosphate

CONCLUSION

Based on the analytical review, it was revealed that the efficiency of phosphorus-containing fertilizers does not exceed 20-22%, due to the retrogradation of phosphorus oxide with the formation of salts that are not absorbed by the plant. It is also certain that biological preparations and phytocompounds increase the activity of soil microorganisms, as a result of which the efficiency of the fertilizer increases. This helps to obtain high and high-quality crop yields while reducing the rates of phosphorus-containing fertilizers by 1.5-3 times. The chemical, physicochemical, and commercial characteristics of the main components of phosphorus-containing fertilizers - dicalcium phosphate and phytocompounds of copper - have been studied. Based on X-ray phase, IR spectral, and microscopic analysis, a chemical interaction in the system of phytocompounds with dicalcium phosphate with the formation of new compounds has been established. The resulting copper phytocompounds, when applied together with phosphorus-containing fertilizers, have a positive effect on plant growth and increase productivity.[15]

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CONFLICT OF INTERESTS

The authors declare that there is no conflict of interest.

AUTHOR CONTRIBUTIONS

All the authors contributed significantly to this manuscript, participated in reviewing/editing, and approved the final draft for publication. The research profile of the authors can be verified from their ORCID IDs, given below:

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