NANODISPERSION BASED ON LIGNIN AS A GROWTH REGULATORS

NANODISPERSII PE BAZĂ DE LIGNINĂ FOLOSITE CA BIOREGULATORI DE CREŞTERE

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Abstract. *The paper present the results concerning obtaining nanodispersions based on lignin and their use as maize seedlings bioregulators. Thus, two commercial lignins, wheat straw (L1) and Sarkanda grass (L2) from Granite Company, Switzerland were used. Nanodispersions based on lignin, were obtained by physical methods (cavitation) and were characterized in terms of average dimensional distribution. Using germination tests, the maize seedling bioregulators effect was evaluated. Compared with the control sample, a reduction in biomass accumulation in all vegetative organs has been found. These results are correlated with a elongation reduction for vegetative organs and photoassimilating pigments decreasing, in leaves.*
Key words*: nanodispersions, bioregulators, lignin, maize.*

Rezumat. *In lucrare sunt prezentate rezultatele cu privire la obtinerea de nanodispersii pe baza de lignina si utilizarea lor ca bioregulatori ai metabolismului din plantulele de porumb. Astfel, s-au folosit lignine comerciale din paie de grau (L1) si iarba Sarkanda (L2), provenite de la firma Granit, Elvetia. Nanodispersiile pe baza de lignina au fost obtinute prin metode fizice (cavitatie) si au fost caracterizate din punct de vedere al distributiei medii dimensionale. Prin teste de germinare s-a evaluat efectul bioregulator asupra plantulelor de porumb. Comparativ cu martorul, s-a constatat o reducere a acumularii de biomasa in toate organele vegetative. Aceste rezultate se coreleaza si cu o reducere in alungirea organelor vegetative si scaderea cantitatii de pigmenti fotoasimilatori.*
Cuvinte cheie*: nanodispersii, bioregulatori, lignina, porumb.*

INTRODUCTION

Lignin is a biopolymer with aromatic structure, which play an important role in fixing of polysaccharides in the cell walls of higher plants. That confers mechanical resistance and at the action of microorganisms and enzymes, stability (Popa et al., 2001). Also, lignin structure is unknown, its contain combination of macromolecular amorphous systems (Rozmarin, 1984). Lignin abundance in nature and importance from economic point of view is the reason why its biosynthesis and structure intensely studied has been (Popa, 1983). The big part of lignin resulted from chemical pulping is converted to energy by concentration of black liquor followed by combustion. Environmental compatibility, accessibility and abundance of this biopolymer, motivates the development of superior

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technologies. In recent years, using chemical biochemical and physical modify was possible enlarge the range of potential applications in different field for lignin products. Constitutive units of lignocellulosic biomass at fundamental level have nano dimensions, its confers unique properties for wood and wood derivatives. Water insoluble nanodispersions based on organic substances can substitute inorganic nanodispersions which have a negative impact on the environment. Some researchers have been used these nanodispersions in the treatment of textile fibers and in the production of water based-ink (Zimniewska et al, 2008, Peter Schilling and Charleston, 1993). Nanoparticles were synthesized using cavitations phenomena from Sarkanda grass and wheat straw lignin.

The paper present studies concerning possibility to use nanoparticles based on lignin, wich were obtained by psihical modification, as plant grouth regulators.

Biovegetal regulatory are natural or synthetic organic, who exercise on plant growth and development, an similar action like that phytohormones.

Polyphenols, applied to the plants in very small amounts in some phases of development, may modify growth, nutrition or body or organs resistance at different stress conditions by inducing changes in vital processes. So that crops quality and quantity can increase and also at a more convenient and rapid mechanical harvesting (Gergen, 1988). In the same time are also known lignin applications in agriculture which work as a soil former and in the bioremediation processes.

MATERIAL AND METHOD

For nanodispersion obtaining wheat straw (L1) and Sarkanda grass L2) lignin, from Granit Recherche Developement Company, was used. A suspension was prepared (0.7%) in distilled water, then it was ultrasonated with ultrasonic horn. (600 W power, 20 kHz frequency). Dimensional analysis was performed with SALD 7001 (Gîlcă et al., 2011).

The germination tests were carried out according to a standard method. It was used 10 Petri dishes for each experimental variant (distilled water – control, nanodispersion based on lignins obtained from wheat - L1 and grass Sarkand - L2). On a filter paper it sat to 5 corn seeds, carefully chosen order not present a major deterioration. The plant material was subjected to a presterilization proces. This consisted in seed submersion in absolute ethanol for 10 seconds, followed by sterilization itself in the presence of Na-hypochlorite 10% for 20 to 30 minutes (Cachita et al., 2004). The volume of solution added was 10 mL / plate. Petri dishes were incubated in the dark in a thermostat set at 27 ° C. After a 7 day period, the Petri dishes was kept in day light for 3 days to allow the seedlings to synthesize the photoassmilating pigments. Biometric measurements, quantitative components of seedling (roots, stems, leaves) and spectrophotometry to determine the concentration of photoassmilating pigments were performed at finaly.

Quantification of assimilating pigments - 0.05 g fresh vegetal material was extracted in 80% acetone by grinding with a spatula tip of quartz sand. Chlorophyll extract was analyzed spectrophotometrically by reading absorbance at various specific wavelengths: 470, 646, and 663 nm. In order to determine the concentration of chlorophyll pigments (chlorophyll a and b) and carotenoid pigments were used formula proposed by Lichtenthaler and Welburn (1983):

Clorophyll a (µg/mL) = 12, 21 (A $_{663}$) – 2, 81 (A $_{646}$)
Clorophyll b (µg/mL) = 20, 31 (A $_{646}$) 5, 03 (A $_{663}$)
Carotenoids (µg/mL) = (100· A 470 – 3,27 [chl a] – 104 [chl b])/22

Our results are expressed as mean ± standard error where n = 3. Comparison of the means was performed by the Fisher least significant difference (LSD) test (PB ≤ 0.05) after ANOVA analysis using program PAST 2.14. Sampling and chemical analyses were examined in triplicate in order to decrease the experimental errors and to increase the experimental reproductibility.

RESULTS AND DISCUSSIONS

Analysis of distribution particle size is presented in Figure 1, the mean values recorded were between 20-130 nm.

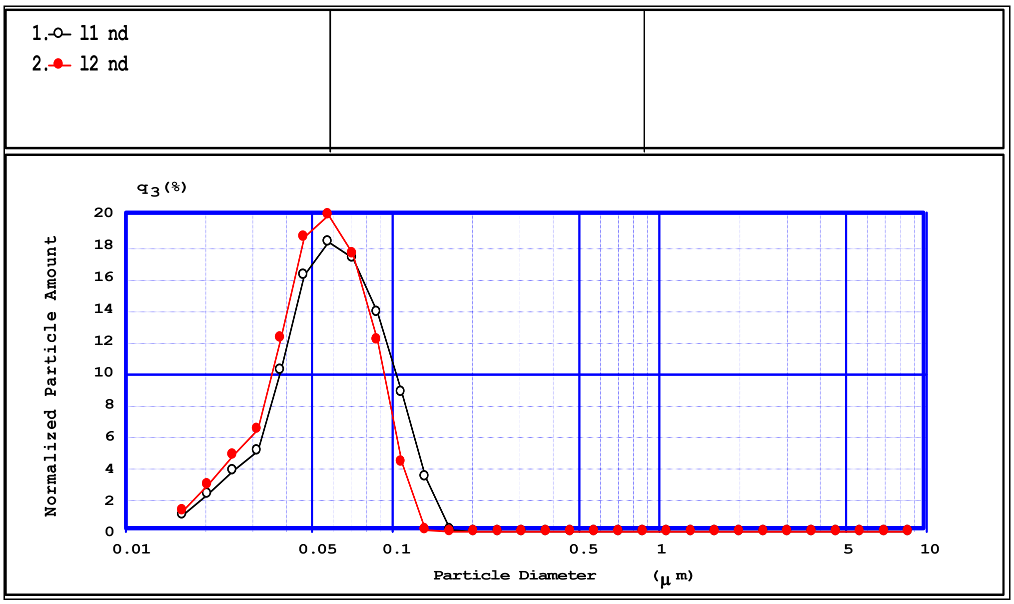

Fig. 1 - Dimensional average distribution of synthesized nanodispersions (L1 nd -wheat straw, L2 nd - Sarkanda grass)

After germination tests, it can be seen that the presence of nanodispersions based on lignin to wheat and Sarkanda grass has inhibitory effects on energy (4.5% - L1, 31.8% - L2) and capacity germination (20, 8% - L1, 34.4% - L2) (Fig. 2). Nanodispersions present in the growth medium leads to inhibition growth of all vegetative organs (Fig. 3). For the roots, the percentage inhibition of growth was 16.2% - L1, and 28.95% for the solution L2. Increasing in length of the stem is negatively influenced with a percentage of 24.1% for L1 version, and 40.03% for L2 version. The leaves growth was also negatively influenced by the nanodispersions presence in the growth medium (24.3% - L1 and 43.3% - L2).

In terms of biomass accumulation in vegetative organs, there is an inhibitory effect (Fig. 4). The percentage of biomass accumulation inhibition at the root, compared to the control, is 11, 11% for L1solution and 26.14% for L2 solution. Biomass accumulated in stem of corn seedlings that have been developed in the presence of L1 and L2 was with 13% (L1) and 20% (L2) lower comapring with control. For biomass accumulated in leavs results are similar. Thus the percentage of inhibition of wet biomass accumulation in leaves is 13.04% to L1 variant and 16.34% for L2 variant.

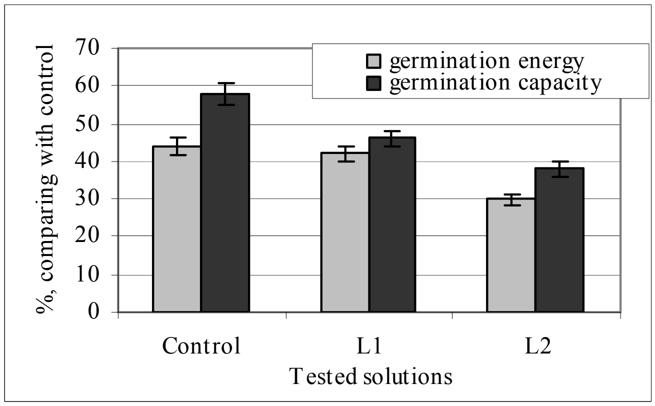

Fig. 2 - Influence of nanodispersions used on maize seed germination

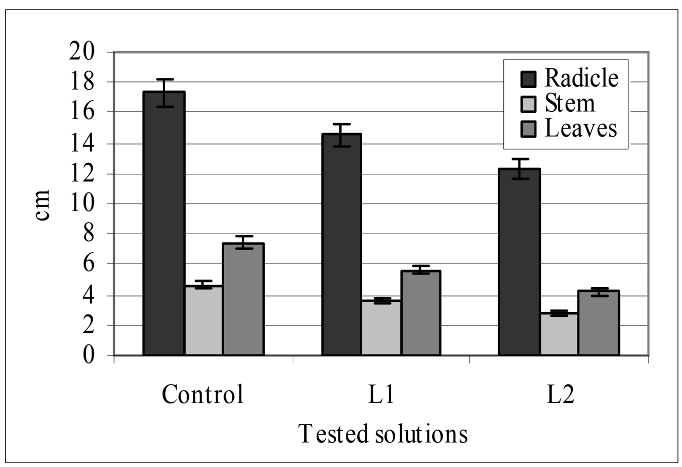

Fig. 3 - Influence of nanodispersions used on maize seedling elongation

Concerning of synthesis of photoassimilating pigments it is found that nanodispersions bazed on lignin inhibit this process with a percentage of 24% (L1) respectively 50.1% (L2) for chlorophyll a, 63% (L2) and chlorophyll b 36.62% (L1) or 48.2% (L2) for carotenoid pigments.

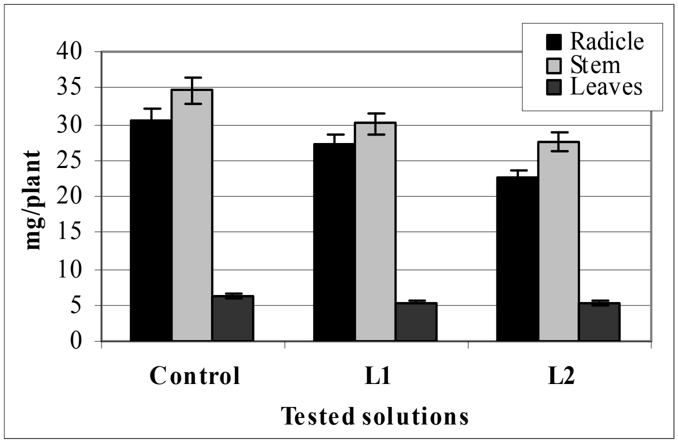

Fig. 4 - Influence of nanodispersions on biomass accumulation of maize plants

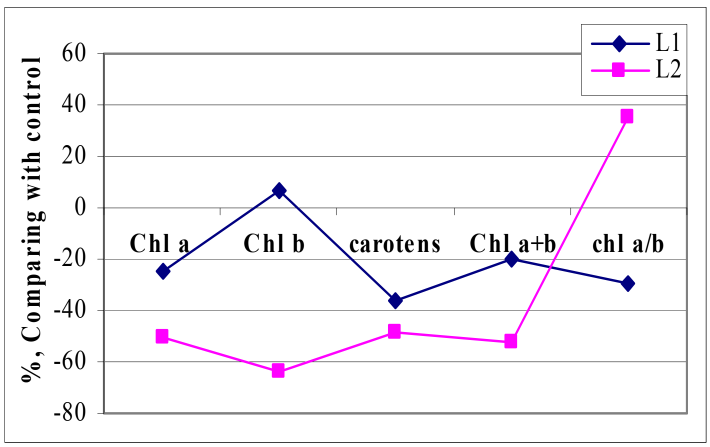

Fig. 5 - Influence of nanodispersions on photoassimilating pigment in maize leaves

The percentage of inhibition of the synthesis of the photoassimilating pigments will be greatly reduced or even positive if we refer to the percentage for chlorophyll b, when applied nanodispersion based on lignin obtained from L1 (Fig. 5).

CONCLUSIONS

1. Following experiments were synthesized nanodispersions based on lignin which were dimensional characterized and used in vegetal systems.

Nanodispersions studied have shown an inhibitory effect of the germination process, both the the germination energy and germination capacity.

2. Growth and development of maize seedling, in the presence of two types of nanodispersion, was significantly reduced. Also the same for plant biomass accumulation in all vegetative organs. Concerning to the photoassimilating pigments synthesis it is found that nanodispersions used inhibit this process.

3.Thus for first time was highlighted the fact that nanodispersions bazed on lignin from wheat straw an Sarkanda grass manifest inhibitory effects on growth and development maize seedling, properties who can be studied for the herbicides creation.

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