CHEMICAL CHARACTERIZATION OF CELLULOSE - LIGNIN WASTE AND THEIR CAPITALIZATION AS NUTRITIOUS SUBSTRATE FOR VEGETABLE SEEDLINGS

CARACTERIZAREA CHIMICĂ A UNOR DEȘEURI CELOLIGNINICE ȘI VALORIFICAREA ACESTORA CA SUBSTRAT NUTRITIV PENTRU RĂSADURI DE LEGUME

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***Abstract**. Soil fertility and plants mineral nutrition are primarily conditioned by the nutritive elements released into the biological cycle through organic remains mineralization. Plants' different evolution is the result of the effect, generally stimulating, of the aromatic structure products, expressed on plants growth, development and fructification and also on the metabolism of microorganisms accumulated in the culture medium. Lignin can have multiple applications, as mentioned its use in animal nutrition, soil fertilization and bioremediation processes. The aim is enhancing the cellulose lignin waste through composting and the use of added lignin extracted from wheat straw (L 1) and grass (L 2) as possible nutritive mixture for seedlings. The paper comprises the determination of chemical parameters for the components used in the preparation of compost, the parameters of the resulted substrate and the effect of additional concentration of lignin on the development of cucumber seedlings (Cucumis sativus L.).*
***Key words**: lignin, compost, seedlings, nutritious substrate*

***Rezumat**. Fertilitatea solurilor şi nutriția minerală a plantelor sunt condiționate în primul rând de fondul de elemente nutritive eliberate în cadrul circuitului biologic prin procesul de mineralizare a resturilor organice. Evoluția diferită a plantelor este rezultatul efectului, în general stimulator, al produselor cu structură aromatică, manifestat asupra creşterii, dezvoltării şi fructificării plantelor, cât şi asupra metabolismului microorganismelor care se acumulează în mediul de cultură. Lignina poate avea aplicații multiple, fiind menționată utilizarea sa în hrana animalelor, în fertilizarea solului, în procese de bioremediere etc. Se urmăreşte revalorificarea deșeurilor celolignince prin compostare și folosirea unor adaosuri de lignină extrasă din paie de grâu (L 1) și iarbă (L 2), ca posibil amestec nutritiv pentru obținerea de răsaduri. Lucrarea cuprinde determinarea parametrilor chimici pentru componentele utilizate la prepararea compostului, ai celor pentru substratul rezultat și efectul concentrațiilor suplimentare de lignine asupra dezvoltării răsadurilor de castraveți cornichon (Cucumis sativus L.).*
***Cuvinte cheie**: lignina, compost, răsaduri, substrat nutritiv*

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INTRODUCTION

Due to the provided energy for microorganisms and to the nutrients reserve provided for the plants nutrition, the organic matter accumulated in the soil's surface layer has an extremely important role.

Although organic matter has a reduced contribution to the soil's solid phase, its role in the fertility stage is decisive. Thus, well-formed hummus participates in proportion of 30-40% to the soil's total cationic – change capacity, registering a value of 150-300 mL/100 g, compared to 8-150 mL/100 g, established for clay. Hummus promotes the increase of water retaining capacity, in an equivalent of up to 80-90% of its mass, while clay retains only 15-20% of its own mass. (Totolin et al., 2010).

The organic matter is subjected to a continuous process of biochemical transformation from low nitrogen content organic substances to ones rich in carbon and nitrogen, characterized by the presence of many carboxyl and carbonyl groups, this process being named ***humification*** (Ungureanu et al., 2007)**.**

Lignin is the main substance involved in hummus formation, which takes place as a result of extracellular enzyme activity of the microorganisms, conducting to intermediary products such as vanilin, vanilic acid, ferulic acid etc., which are subjected to oxidation, hydroxylation, decarboxylation processes and form phenolic radicals and hydroquinone. Thus, following these products complex formation with substances resulted from sugars and proteins initial decay, humic substances are formed (Trofin and Ungureanu, 2012).

Under actual conditions when the environment preservation is a priority, it is expected that more and more biological and biochemical processes to be used for the transformation of the polyphenol and lignin products. Through slow microbiological action, lignin from plant debris turns in the soil into organic micro molecular products, which show a physiological action on plants, thus contributing to the improvement of soil fertility (Dumitru et al., 2005).

MATERIAL AND METHOD

The following raw materials were used to prepare the compost:

- sawdust – added in weighed quantities, according to the experimental scheme presented in table 2;
- spruce bark – also added in weighed quantities;
- quartz sand – sieved and added in each variant three times as much as the rest of the mixture, in order to obtain a compost able to retain water for a longer period of time and also for an increased homogeneity;
- vegetable seeds – the tested specie was *Cucumis sativus*, seeds of cornichon cucumbers, in number of five for each blank or treated variant;
- lignin L_1 from wheat straws (100WA-140);
- lignin L_2 from grass (Sarkanda -100SA-140), both provided by the company Granit Recherché Developpement S.A. from Lausanne, with the following characteristics (table 1) (Ungureanu E., 2011):

Table 1

The characteristics of lignin from wheat straws (L1) and grass (L2)

Characteristic	L1	L2
Solubility in acid, (%)	1	2
- COOH , mmolls/g	3.8	3.3
- OH aromatic, mmolls/g	1.7-1.8	1.8-1.9
Polydispersity	10.5	10.8
Nitrogen (%)	1	1.2
pH (10% water suspension)	2.7	3.2
Tsoaking, ^{0}C	170	163
Solubility in furfuryl alcohol (%)	88.5	84.0
Solubility in alkalis, pH=12 (%)	98.5	98.5
Ash, (%)	2.5	4.1
Relative humidity, %	5.00	5.60

The chemical parameters were determined as follows: ash content was calculated by the calcination method in the oven at 550^{0}C, and calculating the difference there was determined the volatile matter and the carbon contents; the total nitrogen was determined by Kjeldahl method.

Compost was prepared after experimental scheme shown in table 2 and wetted continuously for 30 days to obtain a nutrient substrate to allow seed germination and seedling development.

Table 2

Composting mixtures experimental scheme

Crt.no.	Variant	Sawdust %	Spruce bark %	Lignin %
1	Blank	80	20	-
2	L 1 - 2%	78	20	2
3	L 1 - 3%	77	20	3
4	L 1 - 4%	76	20	4
5	L 1 - 5%	75	20	5
6	L 2 - 2%	78	20	2
7	L 2 - 3%	77	20	3
8	L 2 - 4%	76	20	4
9	L 2 - 5%	75	20	5

RESULTS AND DISCUSSIONS

Analyses were performed to determine the ash content, the volatile matter, carbon, total nitrogen contents, as well as C / N ratio for the studied variants where the percentage of added lignin varied between 2 and 5% for both products used. The obtained values for the raw materials used for compost are presented in table 3 and the values for the control without added lignin and studied variants, in table 4:

Table 3

Chemical parameters values for wood waste and used lignins

Parameter	Sawdust	Spruce bark	L1	L2
U%	5.023	5.71	5	5.6
DS%	94.97	94.28	95	94.4
Ash%	2.2047	2.693	2.3	3.05
VS%	97.7653	97.3066	97.69	96.949
C%	54.31	54.0567	54.2722	53.8606
N_t%	5.1167	5.168	1	1.2
P%	31.9791	32.2997	6.25	7.5
C / N	10.6157	10.4603	54.2594	44.8833

Table 4

Chemical parameters values for control and studied variants

Param.	Blank	L1 2%	L1 3%	L1 4%	L1 5%	L2 2%	L2 3%	L2 4%	L2 5%
U%	5.1604	5.15971	5.15971	5.15948	5.15925	5.17194	5.17771	5.18348	5.18925
SU%	94.832	94.8326	94.8329	94.8332	94.8335	94.8206	94.8149	94.8092	94.8035
Cen%	2.30236	2.304266	2.305219	2.306172	2.307125	2.319266	2.327719	2.336172	2.344625
SV%	97.67356	97.67205	97.6713	97.67055	97.6698	97.65723	97.64907	97.64091	97.63275
C%	54.25934	54.25858	54.25821	54.25783	54.25745	54.25035	54.24586	54.24136	54.23687
Nt%	5.12696	5.044626	5.003459	4.962292	4.921125	5.048626	5.009459	4.970292	4.931125
Pb%	32.04322	31.52864	31.27135	31.01406	30.75677	31.55364	31.30885	31.06406	30.81927
C / N	10.582	10.7527	10.8460	10.9409	11.0253	10.7527	10.8342	10.9170	11.0011

After 30 days, variants were seeded with cornichon cucumber seeds that have germinated starting with the third day, having, over the next seven days, the distributions shown in the graphs in figures 1 and 2.

Compared to the blank variants used where soil or compost without lignin added were used as nutritive substrate, it is noticed that even in such short period of time, in some of the variants the height of the seedlings levelled or exceeded the values obtained for the soil control variant.

The obtained compost proved to be able to work as a substitute for soil as a nutritive substrate and in the meantime, to capitalize an important waste source, the sawdust, wood chips and bark.

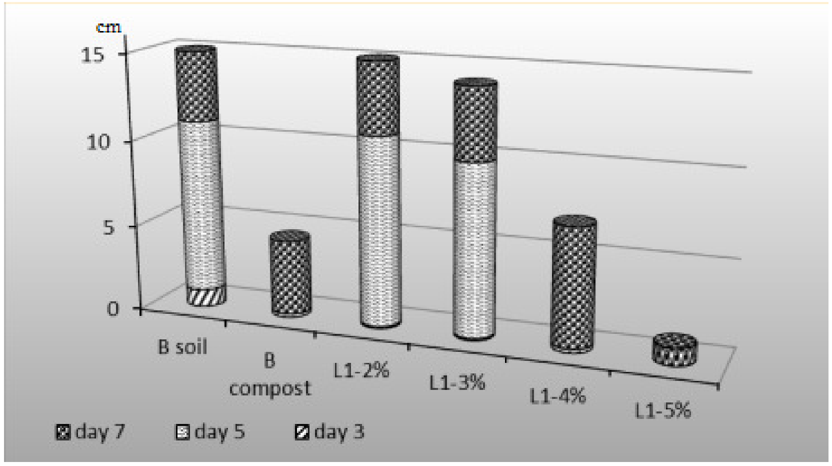

Fig. 1 - Development of L_1 variants' seedlings

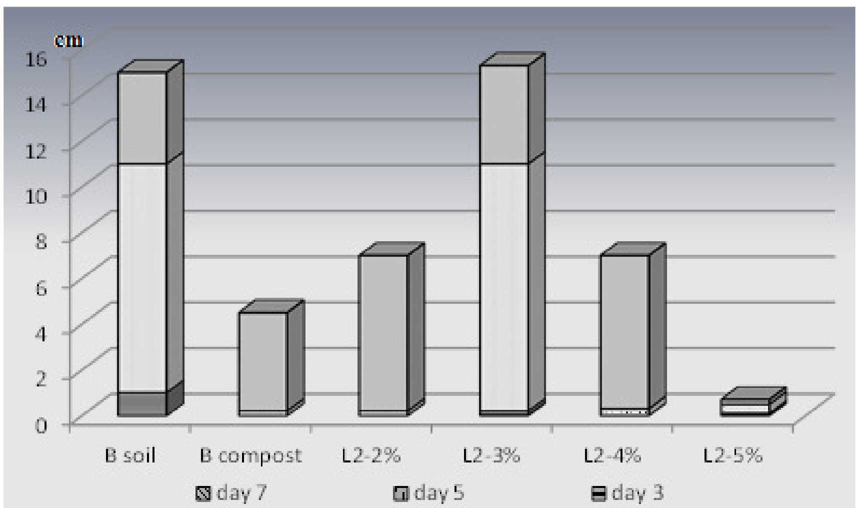

Fig. 2 - Development of L_2 variants' seedlings

CONCLUSIONS

1. From the study of C / N ratio for the variants considered it is noted that they are placed below the maximum of 30, what allows for the composting mixture to be used as germination and development substrate;

2. Following the observations about seed germination, it was found that the addition of lignin had a stimulating effect, especially on seedling height;

3. Spruce sawdust and bark, mixed with quartz sand or plain, may become, in compost, a substitute for soil used as germinating substrate in the seedbeds;

4. Thus, there can be capitalized large quantities of waste from forestry, by reintroducing them into the biological cycle as growth substrate.

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