STUDIES ON PLANT BIOMASS IN VARIOUS STAGES OF DEGRADATION

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Abstract: *Lignocellulosic residues from wood, grass, agricultural, forestry wastes and municipal solid wastes are particularly abundant in nature and have a potential for bioconversion. Due to their abundance and renewability, there has been a great deal of interest in utilizing this biomass for the production and recovery of many value-added products. Accumulation of lignocellulosic materials in large quantities in places where agricultural residues present a disposal problem results not only in deterioration of the environment but also in loss of potentially valuable material that can be used in paper manufacture, biomass fuel production, composting, human and animal feed among others. Several novel markets for lignocellulosic residues have been identified recently. The use of fungi in low cost bioremediation projects might be attractive given their lignocelluloses hydrolysis enzyme machinery.*
This paper presents the evolution of the lignocelluloses degradation from vegetal residues (sawdust, rose leaves, rushes leaves and corn leaves) during five months, in aerobic and anaerobic conditions. The degradation process gives small molecules like polyphenols. We used Folin-Cicâlteu method for evaluation of lignine amount that is transformed in corresponding polyphenols. It was observed a growth of transformed amount along this period. Therefore, we can conclude that the lignocellulosic degradation occurred. This increase in degradability could have important implications in the evaluation of the composting process.

Keywords: *lignocelluloses, biodegradation, polyphenol.*

Introduction

Lignin has great importance for plants. It has evolutionary significance as it has played a major role in the emergence of land plants from the aquatic plants. It forms a major integral cell wall component encrusting cellulose in all vascular plants including herbaceous species. It plays an important role in conferring rigidity, strength, resistance to pathogen ingress and water impermeability to the polysaccharide-protein matrix of the cell wall[1,2].

Lignin, present in all vascular plants, represents on an average 25% of the terrestrial plant biomass. It is a complex phenolic heteropolymer resulting from the oxidative polymerization of three types of hydroxy cinnamyl alcohols termed monolignols[3].

The notion of lignin does not reflect a substance with well defined chemical structure similar to the other macromolecular natural products as cellulose, starch or protein, but rather refers to a group of chemically related polymer combinations between them.

The elemental chemical composition of lignin has been determined yet by Gay Lussac and T. Thenard[4,5].

The research on the breakdown products of lignin has established that its

basic structural unit is phenylpropane group, C6-C3.

Phenyl propane structural(Fig.1) unit contains a hydroxyphenol group in para position and one or two methoxy groups in 3.5 positions of the core benzene.

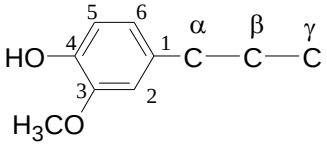

Figure1.**Phenyl propane structure**

Biodegradation is the phenomenon which a substance is decomposed naturally by means of microorganisms.

The biodegradation is the key feature that allows organic substances both natural cleansing process and biological treatment, and refers to the ability of organic matter to chemically change from the action of micro-organisms[6].

The biochemical degradation of polymeric compounds in plant biomass composition is achieved through the action of many enzymes including amylase, cellulase, protease, keratinase, lipase, etc.

These compounds with complex structure must be available for enzymes biodegradation to achieve a degree of conversion of biomass into biogas as high.

The chemical changes produced in the biodegradation of lignin is complicated, first because the action of each individual organism, and secondly because most of the links in lignin are not hydrolysable.

Difficult biodegradability of lignin in comparison with the most other biological molecules depends on molecular dense texture, which prevents entry of large enzyme molecule and that this polymer is formed by polyaddition, not by polycondensation[7,8].

The most important biological degradation process is aerobic degradation of organic matter, degradation which uses the microorganism in a rich oxygen and nutrients environment.

The removal of organic substances is performed through abiotic degradation under the action of photo-chemical processes in the atmosphere or under the processes of hydrolysis; biological degradation in the absence of oxygen is known as anaerobic degradation.

Polyphenols are organic compounds which contain two or more hydroxyl groups linked to an aromatic radical. In this category of substances are: pigments (coloring matter) and tannins.

A lot of studies of natural phenolic compounds are of particular interest[9].

These substances, which for centuries are used as active principles of medicinal plant remedies, are used in technical textiles as natural dyes, the preparation of inks, leather tanning[10].

They are widespread in nature, especially flora.

This group of natural compounds, plant pigments, tannins, lignin, requires a complex investigation as in terms of their physiological functions in plants, and for their structure, biosynthesis, various properties and usability.

Materials and methods

The knowledge of quantitative and qualitative structure of the main polyphenolic compounds found in plant debris as a first stage requires developing working methodology for decomposing plant debris and concentrates the main polyphenolic fractions.

The works began by collecting plant material and necessary preconditioning dilutions made for the separation of polyphenolic compounds.

Plant material

Biological materials so taken were leaves of corn, leaves of rushes, leaves of rose and sawdust.

Sample preparation

After being harvest the leaves were dried and then weighed.

The plants were put at degradation:10 g in 300 mL distilled water.

It were placed two parallel samples of the same biological material: a sample container to degrade in aerobic conditions and the other in anaerobic conditions.

The prepared samples were left at room temperature 20 ° C for 30 days to degrade before making the first analysis.

Analysis of total phenolic content

The total polyphenol content (TPC) of the extracts was determined by spectrophotometry, using gallic acid as standard, according to the method described by the International Organization for Standardization (ISO) 14502-1[9,10,11]. Briefly, 1.0 mL of the diluted sample extract was transferred in duplicate to separate tubes containing 5.0 mL of a 1/10 dilution of Folin-Ciocalteu's reagent in water. Then, 4.0 mL of a sodium carbonate solution (7.5% w/v) was added. The tubes were then allowed to stand at room temperature for 60 min before absorbance at 765 nm (in a UV–Vis spectrophotometer) was measured against water. The TPC was expressed as gallic acid equivalents (GAE) in g/100 g material. The concentration of polyphenols in samples was derived from a standard curve of gallic acid ranging from 10 to 50 µg/mL (Pearson's correlation coefficient: r^2 0.9986).

All measurements were carried out in for replicates.

Using the standard curve for gallic acid it were determined concentrations expressed in mg polyphenols and polyphenols calculation was done using the formula:

$$\%\text{polyphenols} = \frac{Vs(mL)x10^{-3}}{m(g)} xFxC(mg/l)x10^{-3}x100$$

Vs-volume solution prepared from the product;

m- mass produced vegetable;

F-dilution factor;

C- sample concentration from standard curve

Results and Discussion

The temperature solutions were kept constant around 20°C unregistered sudden changes during experiments.

A. pH determinations

The degree of acidity or alkalinity is one of the most important indices of solutions that occur in nature chemical degradation processes, being given by the concentration of hydrogen ions.

The pH solutions were measured by multiparameter Consort C 862.

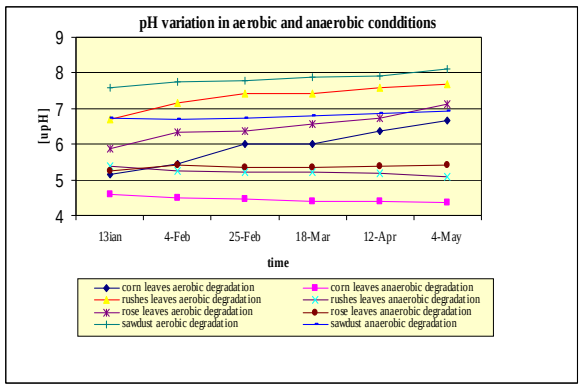

Figure 2. pH determination of studied plants

From figure 2 is evident that all solutions obtained by anaerobic degradation have a pH acid lower than pH of the solutions obtained from aerobic degradation.

It is also evident that the pH of the solutions increases steadily with the advancing of biodegradation process.

B. Total polyphenols contents

This part of the study proposed to investigate the dynamics of the phenolic compounds in a sawdust, rose leaves, rushes leaves and corn leaves.

The determination of polyphenol content was made by colorimetric method with Folin-Ciocâlteau reagent. In the following figure we represented the

concentration of polyphenols for all the investigated samples during the five months in aerobic and anaerobic conditions.

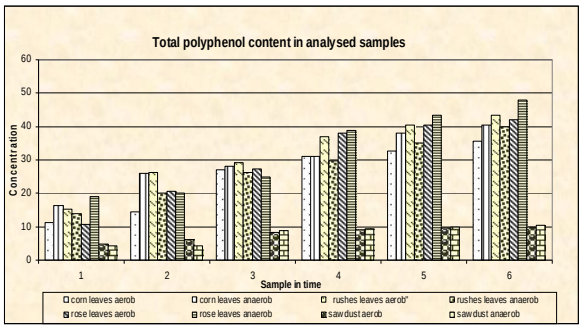

Figure 3. TPC during five month
Legend: 1-January, 13th, 2-February, 4th, 3-February, 25th, 4-March, 18th, 5-April,12th 6-May, 4th

All the experiments shows a steady growth in concentrations of polyphenols degradation both aerobic and anaerobic degradation of analysed plants. The concentration of polyphenols in solutions resulting from aerobic degradation is higher than the concentrations of solutions resulting from anaerobic degradation.

Conclusions

Lignocellulosic biomass has the potential to become a key element in future growth of the quantity of bioenergy generated.

Its universal availability in large quantities and that is little used at present are reasons for lignocellulosic biomass is regarded as one of the most promising resources for future production of bioenergy.

Our experiments have shown that the pH of the solutions degraded anaerobically, is under acid range varying with the stage of decomposition and degradation from 4.452 to 6.692 upH.

Also, the pH of aerobically degraded solutions is higher than the solutions degraded anaerobically.

The total polyphenol content varies according to species and depending on type of biodegradation : aerobic or anaerobic.

The solutions maintained in anaerobic conditions have a lower content of polyphenols than those under aerobic process.

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