

BIOMASS BIOCHEMICAL DATA IN PHYLLIS DATABASE

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ABSTRACT: The existing Phyllis database (www.ecn.nl/phyllis) contained biomass data that are relevant mainly to thermal conversion of biomass into energy, like ash and moisture content, heating value and chemical composition. Over 1000 times each month users from all over the world visit the internet site and retrieve information. The extension of the database with biochemical data is aimed at users interested in biomass use as base material or feedstock in biochemical processes. The extension consists of new data parameters, new categories of materials and options to narrow the selection procedure for retrieval of biochemical information. The total number of materials in the database increased to 2250. The present article explains the changes in the database structure and contents, and illustrates user options.

Keywords: biomass characteristics, data bases, chemicals from biomass

1 INTRODUCTION

ECN collects information on various biomass materials, with emphasis on data relevant to thermal conversion of biomass into energy. Sources of information are literature, research performed at ECN and results made available by other research institutes, biomass suppliers and users. The information is stored in a database named Phyllis and made available to users via the internet site www.ecn.nl/phyllis. Information on the contents and use of Phyllis can be found in a contribution to the previous conference [1]. Here, recent additions and new options are described.

Until recently, a very limited amount of information on biochemical properties was collected. However, there are several initiatives that would profit from a broader scope of the database:

- Biomass cultivation for energy usually is not price-competitive with fossil fuel. A cascade approach, in which valuable feedstock or base material is gained first and the remainder used for energy, may improve the economy substantially. Common examples are grain and straw, paper fibres and black liquor, sugar and bagasse, olive oil and olive cake. We perform research to explore the potential of the production of protein from grass or fine chemicals from microalgae [2, 3].
- The GAVE program in the Netherlands surveyed routes to produce gaseous and liquid fuels from biomass. Biological processes like digestion and fermentation, using enzymes and microorganisms, have been identified as valuable options for methane and hydrogen, acetone, butanol, ethanol and derived products [4, 5].
- The draft EU fuel directive aims at an ambitious growth of biofuels for transportation, from 2% of all petrol and diesel sold in 2005 to 5.75% in 2010. At present, main candidate biofuels are biodiesel (derived from seed oil), bioethanol and ETBE produced from bioethanol [6].

The extension of the Phyllis database has been realized in a joint effort of ECN and Agrotechnology and Food Innovations B.V. with financial support from the DEN programme. A group of potential users has served as advisory committee.

2 NEW DEVELOPMENTS

2.1 Biochemical parameters

The database already contained limited data on cellulose, hemicellulose, lignin, lipids and protein. In addition to the total lignin content, the new database version also specifies the "acid soluble" and "acid insoluble" fractions. A number of other parameters has been added. Table I shows all biochemical parameters for which information is stored in the Phyllis database.

Table I: Biochemical parameters on which information is collected and stored in the Phyllis database. (Information usually is not complete.)

Main parameter	Subdivision (if any)
Cellulose	
Hemicellulose	
Lignin	Acid soluble /insoluble (ASL/AIL)
Protein	
Lipids	
Starch	
Pectin	
Extractives	Ethanol/toluene (50/50), Ethanol 95%, Hot water
C5 sugars	Arabinan, Xylan
C6 sugars	Galactan, Glucan, Mannan, Rhamnan
TNC	Total Non-structural Hydrocarbons

Members of the advisory committee proposed to add information on oxygen demand (COD or BOD) and on components that hinder or block biochemical processes. Sparsity of available information has made us decide not to add another parameter to the list. However, the presence of sulfates, nitrates and ammonia, which may act as inhibitors, can be derived from the sulphur and nitrogen content that will be shown even when only biochemical information is requested (see next section). Any additional information is collected under "remarks" that are shown when the database is consulted for information on a specific material.

2.2 Selection options

The option "preferences" allows users to limit the information shown to either biochemical or chemical data. Even if biochemical information only is selected, some thermal and chemical data are still shown. User preferences are stored and retrieved automatically on future visits to the Phyllis website. Some available choices are shown in Figure 1 and described below.

Your preferences are stored on your computer.

- Show me the element composition.
 Show me the biochemical composition.

set preference

Your preferences are stored on your computer.

- Show me the element composition.
 Show me the biochemical composition.

Do not show records without biochemical information.

set preference

Your preferences are stored on your computer.

- Show me the element composition.
 Show me the biochemical composition.

Limited to data obtained by *Van Soest method and/or*
 sugar analysis

set preference

Figure 1: Three Phyllis preference options.

A user interested in the chemical composition and thermal data only, should set the preference as shown in the top section of Figure 1. The middle section of Figure 1 shows the additional choice that becomes visible when biochemical information is required (either separately or combined with chemical data). The user may select to neglect data records without biochemical information.

For users interested in biochemical data only, the selection may be narrowed even further to data obtained by one or two standard methods (Van Soest and sugar analysis) that are used to determine the cellulose and hemicellulose content. If one or both of these methods is selected (as in the lower part of Figure 1), the option to neglect records without biochemical information is activated automatically and not shown.

2.3 Biomass categories

Phyllis uses two systems for classification of biomass materials: a scheme developed by ECN and a Dutch standard designated NTA 8003 [7]. Both systems have been revised. Changes mainly consist of new subgroups, either as new item or by subdivision of an existing one, and some rearrangement of materials over subgroups.

Changes in the ECN classification have been made to prevent crowding of materials in rest groups or to accommodate materials that are much more common in

sources of biochemical data than in sources of thermal and chemical data.

Changes in the NTA scheme mainly reflect the result of discussions between the Dutch government and electricity producers on the eligibility of specific biomass materials for subsidies or exemption of levies on "green" electricity. Still, some biomass materials, like meat and bone meal (MBM) and charcoal, considered or used as secondary fuels have not received a fitting place in the December 2003 revision of the NTA scheme and are gathered in main groups without specification (like FDI waste) or in the most unspecific rest group "other other".

2.4 Biomass materials

The co-operation of ECN with Agrotechnology and Food Innovations B.V. has disclosed new sources of information. Many products or residues derived from plants grown for animal fodder or for fibres have been added to the database. The total number of materials (i.e. separate samples or results published for averages of samples) has grown by these additions and by a steady stream of data from ECN research to a total of 2250.

3 EXAMPLES OF RESULTS

3.1 Average for a group of materials

The subgroup "hemp" in the group "grass/plant" contains 36 materials in total. Table II shows part of the result obtained if the average biochemical composition is requested from all available records on hemp.

Table II: Part of the biochemical data of hemp shown by Phyllis for the selection "average of a group of materials" using all available records. Most concentrations in % dry.

Component	Mean	Min	Max	Ref.
Water content	5.8	1.5	9.8	10
Volatiles	80.5	79.6	83	10
Ash	5	0	8.7	19
HHV	19627	18879	21465	13
LHV calc	18283	17546	20080	13
N	0.9	0.45	1.51	13
S	0.13	0.07	0.21	13
Cellulose	63.8	37.5	83.8	23
Hemicellulose	13.9	4.2	31	22
Lignine	9	2.5	22.7	23
AIL	4	3	7	6
ASL	0	0	0	6
Lipids	-	-	-	0
Protein	-	-	-	0
Extr Eth/toluene	1.6	1.2	2	5
Extr Eth 95%	0.5	0.2	1	6
Extr hot water	6	3.1	8.6	5
Starch	-	-	-	0
Pectin	3.7	3	5.6	6
Xylan C5	0.7	0.3	1.3	10
Arabinan C5	2.8	0.8	17.1	10
Mannan C6	3.7	1.9	4.9	10
Galactan C6	1.8	0.7	2.4	10
Glucan C6	70.4	41.5	83.8	10
Rhamnan C6	0.3	0.2	0.8	10
TNC	-	-	-	0

The last column in Table II (References) shows the number of data records providing information on each parameter. Clearly, information in separate data records is usually far from complete. For instance, only 10 out of 36 records contain data on the water content, volatiles and separate sugars. If the selection is restricted to the 23 records that contain any biochemical information at all, no records are left with data on water content, volatiles, heating value (HHV and LHV), nitrogen and sulphur, and only 6 out of 19 records remain that contain ash data. The average ash content changes from 5% to 2.4%.

The loss of information is a significant drawback of the choice to restrict the selection to data records containing biochemical information, certainly if average values are required. However, if the user intends to browse individual records on biochemical data, using preferences to skip irrelevant records saves valuable time. If e.g. the user would only consider data obtained by sugar analysis to be of interest, the proper setting of preferences would skip 26 of the 36 records on hemp.

3.2 Single material

Results for a single material can be obtained in three ways: by following the selection tree from group, subgroup to material, by a (keyword) search for materials and by viewing the information in a record that has been removed from the calculation of the average composition because of an extreme value it contained. For an explanation how to use the latter option see [1].

The result for a single material starts with general information on the sample. If the ID number is followed by the symbol _ (as in Figure 2), more than one material in the database answers the same description. The user may call the other record(s) by clicking the triangle and selecting a number from the list shown.

Sample information	
Group	grass/plant
Subgroup	hemp
Material	hemp, bast fibre
ID-number	2469 ▾
Reference:	ATO laboratories
Remarks:	analysis ATO 168

Figure 2: Part of the information shown for a single sample. (Instead of ATO, please read Wageningen UR).

The result for the biochemical composition of a single sample contains some features not present in the result for average values (c.f. Table II). At the top of the list the method of analysis is given. The term "Measured" is used to indicate a specific method other than Van Soest or Sugar Analysis. "Unknown" means the method has not been specified or described in the reference.

Next in the list follows the Total Ash + Biochemical, the sum of the ash content and of all biological fractions. It is shown to draw the users' attention to differences in normalization used by

various authors. Some put the total of hemicellulose, cellulose and lignin equal to 100, others meticulously normalize each fraction to the original dry weight of the sample, either with or without ash.

The texts Lignin acid insoluble (AIL) and soluble (ASL) are displaced to the right to indicate that they represent fractions of the lignin content and should not be counted separately in the Total Ash + Biochemical. The same rule applies to the separate C5 and C6 sugars, for which the totals have been calculated to the users' convenience.

4 CONCLUSION

Data on a specific biomass sample are usually restricted to part of the chemical or biochemical information users would like to know. The strength of the Phyllis database is the possibility to combine data about 2250 materials from different sources to obtain a more complete picture, while maintaining the option to retrieve specialist information on single samples. The still growing number of requests for information at the website, now well over 1000 each month, testifies to Phyllis' value.

ECN aims at continuous improvement of the quality and usefulness of the Phyllis database. ECN welcomes additional data and values comments.

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For a description in English of a preliminary version of NTA 8003 see: L. Dinkelbach (editor) *Standardisation of solid biofuels in the Netherlands*. Report EWAB 9923, Novem, Utrecht, the Netherlands, 1999.

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