Biomass Analysis Services

FROM A LAB DEDICATED TO ADVANCING THE BIOECONOMY

CELIGNIS ANALYTICAL

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Celignis Analytical

We are a dedicated service provider for the bioeconomy. We provide our clients with the most precise compositional data and highly-informed process expertise in order to allow them to make the best use of their biomass feedstocks and optimise their biomass conversion processes.

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We can help to determine the value of your feedstock for the production of advanced biofuels. We determine sugars in cellulose and hemicellulose, as well as lignin, extractives, and ash. We provide data in one day with our unique rapid analysis models.

The Renewable Identification Numbers are a major component of the biofuels industry in the USA. They can be complex and credits can vary according to feedstock and technology. Our analytical expertise can be of assistance in RINs applications.

We provide valued analytical services to industrial and academic clients across the globe. We also have a top-class multidisciplinary team that can work with our clients on optimising their biomass valorisation technologies.

"We believe that when people have accurate and comprehensive data the opportunities are limitless"

Our Philosophy

Celignis was born from research that targeted replacing fossil-fuels with sustainable biofuels. We found that feedstock composition was crucial, but that literature data could be highly misleading. There was a critical need for accurate analysis. We are driven to provide the best possible data and want to play our part in the development of the bioeconomy.

Dr Dan Hayes, CEO of Celignis Analytical.

ANALYSIS OF PROCESS LIQUIDS

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We can analyse liquids for their sugars, differentiating as to whether they are in the monomeric or oligomeric forms, and for their sugar degradation products. Our methods are often used to characterise the liquids from biomass pre-treatments.

ANAEROBIC DIGESTION

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14-15

We determine many properties relevant to the anaerobic digestion of biomass. These include the biomethane potential and the composition of the digestate. We also provide bioprocess consultation services to improve digestion efficiency.

BIOENERGY PARAMETERS

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If you are considering producing heat or electricity from biomass, then we also have you covered! We can determine a range of important properties including calorific value, ash melting behaviour, ash composition, chlorine, and ultimate analysis.

BIOMASS FEEDSTOCK ANALYSIS

1. Advanced Biofuels Feedstocks

RELEVANT ANALYSIS PACKAGES:

P4 - Ethanol Extractives

P5 - Water Extractives

P6 - Full Extractives

P7 – Lignocellulosic Sugars: Total Sugars, Glucose, Xylose, Mannose, Arabinose, Galactose, Rhamnose

P8 – Lignin Content: Klason Lignin, Acid Soluble Lignin, Acid Insoluble Residue, Acid Insoluble Ash

P9 – Lignocellulosic Sugars and Lignin

P10 – Sugars, Lignin, Extractives, and Ash

P11 – NIR Prediction Package: Lignocellulosic Sugars, Lignin, Ethanol Extractives, Ash

P14 – Starch Content

P15 – Uronic Acids: Glucuronic, Galacturonic, Mannuronic, Guluronic, 4-O-Methyl-D-Glucuronic

P16 – Acetyl Content

P17 – Biomass Amino Acids: Alanine, Arginine, Aspartic Acid, Cystine, Glutamic Acid, Glycine, Histidine, Isoleucine, Leucine, Lysine, Methionine, Phenylalanine, Proline, Serine, Threonine, Tyrosine, Valine

We can determine all the important parameters for the production of chemicals and advanced biofuels from cellulosic biomass.

Second-generation biofuels, such as cellulosic ethanol, offer huge potential in substituting for fossil-derived transport fuels. Similarly, biorefineries could produce a range of sustainable chemicals and bio-products from low-cost lignocellulosic biomass. The number of suitable feedstocks is massive and includes energy crops, agricultural residues, and municipal wastes. There can be huge variations in composition between different feedstocks and also within the same feedstock grown in different locations and under different conditions. Thus, it is crucial to use a laboratory experienced in the detailed and complex methods of analysis required to fully characterise these materials.

We provide all lignocellulosic analytical data in duplicate so you can see the precision of our work

EXTRACTIVES

These are non-cell-wall components that can be removed using various solvents. Extractives can vary greatly in their compositions and amounts according to the feedstock and its stage of life. We recommend that extractives are removed prior to undertaking the lignocellulosic analysis of samples. We can use water, ethanol, or other solvents for extraction and can determine 14 different water-soluble carbohydrates present in the liquid extract. We also offer detailed analysis of the constituents in ethanol extractives.

STRUCTURAL SUGARS

In lignocellulosic biomass the main structural polysaccharides are cellulose and hemicellulose. These are often the most important constituents when estimating potential cellulosic ethanol yields from the biological conversion of biomass.

We can determine the glucan content of biomass, a good estimate for the cellulose content, and we can also analyse for five other sugars present in hemicellulose (xylose, mannose, arabinose, galactose, and rhamnose) as well as uronic acids (galacturonic, glucuronic, mannuronic, guluronic, 4-O-Methyl-D-Glucuronic) and acetyl content.

LIGNIN

This is a structurally important polymer in biomass and is often the solid residual output of biorefineries after the polysaccharides have been hydrolysed. It can be combusted or used as a feedstock for the production of chemicals and biofuels. In our acid hydrolysis process for liberating the structural sugars, we obtain Klason lignin as a solid residue and also acid soluble lignin which we determine using ultraviolet spectroscopy. We also determine the amount of acid insoluble ash in the sample.

STARCH

Starch is a glucan polymer so we recommend, for relevant samples, that starch content is analysed to differentiate between lignocellulosic and starch-derived glucose.

PRE-TREATED BIOMASS

Biomass pre-treatment is a crucial step in producing advanced biofuels and chemicals. There are a large number of different processes that can be used and a wide spectrum of potential products. We have a suite of analysis packages designed to fully evaluate the efficiency of pre-treatment so that conditions can be appropriately engineered for the particular feedstock and desired end products.

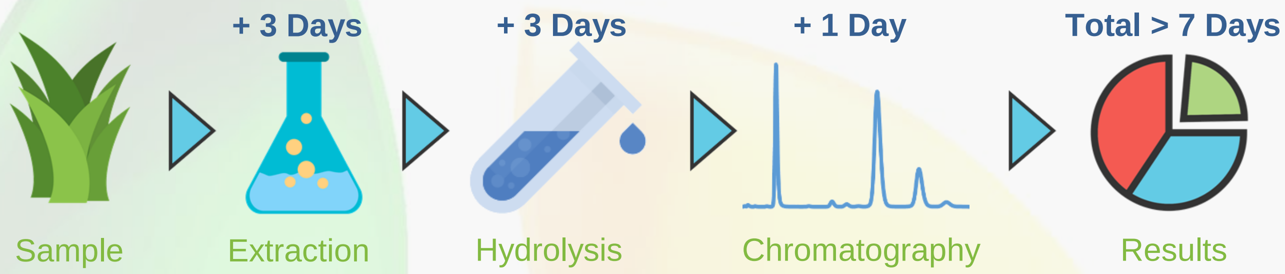
In particular, the starting feedstock should be characterised in detail so that the different sources (e.g. lignocellulose, starch, extractives etc.) of sugars that may be liberated in pre-treatment are known. We strive to get as close to mass closure as possible for the whole pre-treatment process and this involves analysing in detail both the liquid (see page 12) and solid outputs.

We are the Only Company to Provide Lignocellulosic Data within One Day and at Low Cost!

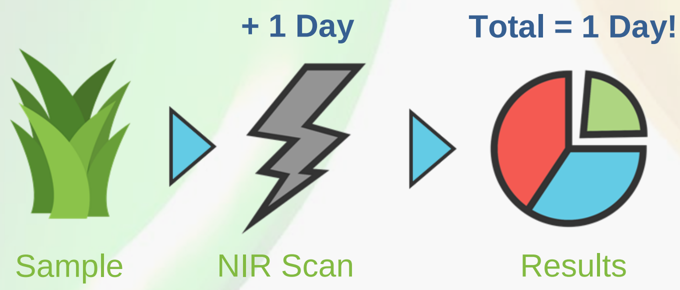
We can follow standard chemical analysis methods for determining the lignocellulosic composition of biomass. However, these chemical analysis methods can be slow, taking up to two weeks for a sample, as numerous steps and items of equipment are involved. To date, the length of this analytical process has meant that the number of samples that can be analysed has been restricted by time and by finance limitations.

But we at Celignis have the solution! As an alternative to our chemical analysis packages you can get your solid biomass samples analysed using our unique rapid-analysis Near Infrared (NIR) method. This involves us scanning your sample and then applying our proprietary algorithms to predict the content of 13 different lignocellulosic parameters. This means that we can provide you with data within one day for as low as $60 per sample. No other company is able to provide this service for advanced biofuel feedstocks.

CHEMICAL ANALYSIS METHOD

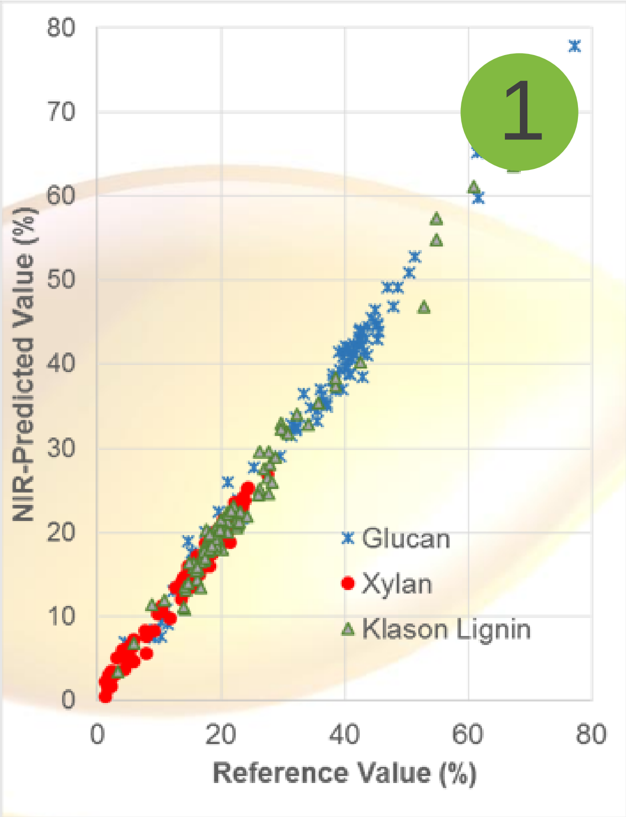


CELIGNIS RAPID ANALYSIS METHOD



You are no longer limited in the number of samples you can evaluate!

Benefits of our Rapid NIR Method



1 ACCURATE – DATA YOU CAN RELY ON

When the data from our NIR prediction models were compared with data from standard chemical analyses we found a very close correlation (R^2 of ~0.97 for the main constituents of lignocellulose). Furthermore, as well as providing data for the predicted composition, our NIR package also provides an estimate for the error (deviation) in the prediction and, if we find this to be high, we will undertake the chemical analysis at no extra charge.

2 SUITABLE FOR ALL BIOMASS TYPES

Our models have been demonstrated on thousands of samples covering a wide variety of feedstocks including energy crops, crop residues, organic wastes, pre-treated samples, and process residues.

3 FITS WITH YOUR REQUIREMENTS

The rapid turnaround and low cost mean that you can quickly see the value of your samples or process conditions and make responsive decisions or modifications accordingly. You can also analyse many more samples than before, improving your chances of finding the optimal sample!

BIOMASS FEEDSTOCK ANALYSIS

2. Analysis for RINs Credits

Renewable Identification Numbers (RINs) are credits used for compliance of Renewable Volume Obligations (RVO) and the currency of the Renewable Fuel Standard (RFS).

There are five different types of individual RINS (D3, D4, D5, D6 and D7) based on the fuel type, feedstock, and greenhouse gas reduction requirement, of which D3 and D7 are the cellulosic RINs with the highest RIN values. Biofuels generated from feedstock with 75% or greater cellulosic content are allowed to claim 100% cellulosic RINs and the fuel derived from feedstock with less than 75% cellulosic content will receive cellulosic RINs only in proportion to cellulosic content. According to this scheme, the cellulosic content is defined as the "adjusted cellulosic content" which totals the cellulose, hemicellulose, and lignin contents and expresses this number on a dry-ash-free basis.

The EPA produced a list of feedstocks (e.g. corn stover, switchgrass) that can be assumed to have a minimum 75% adjusted cellulose content. Feedstocks that are not approved under D3 and D7 codes, such as annual cover crops (low cellulosic content) and mixed feedstock (mix of D3 and D7 approved feedstock with unapproved feedstock), will require biomass analysis to qualify for the cellulosic RINs credits from the EPA.

How our Analysis Can Help with RINs Credits Applications and Renewable Volume Obligations

ADJUSTED CELLULOSE

Our methods of lignocellulose analysis are approved techniques according to the EPA guidelines on determining adjusted cellulosic content.

We differentiate between structural sugars (such as those in cellulose and hemicellulose) and those present in sucrose, starch, and the extractives and report each of these structural sugars individually, as well as the lignin content (as both Klason and acid soluble lignin).

Our online Database and Excel and pdf reports also sum these structural sugars (i.e. cellulose and hemicellulose) along with the lignin content and express the result (the adjusted cellulosic content) on a dry-ash-free basis so that you can see if the sample meets the 75% threshold or if partial allocation of D3 RINs, based on the the proportion of total mass that is cellulosic, is required.

BIOGAS FEEDSTOCKS

We can determine the percentage cellulosic RINs and maximum achievable RINs for biogas production from D3 and D7 unapproved feedstocks (i.e. RFS EMTS (EPA Moderated Transaction System) reporting codes 335 and 336) by doing biomass composition analysis and biomethane potential (BMP) tests.

SERVICES TO INDUSTRY

3. Bioprocess Development

We are proud of the knowledge, passion, and work ethic of our team. They have played key roles in the formulation, optimisation, and commercial evaluation of biomass valorisation processes in industry and academia and, together, we have the multidisciplinary expertise to evaluate all stages of your bioprocess and suggest real improvements

We have a diverse, rapidly-expanding, global array of clients that recognise the expertise that we have with regards to biomass composition and its relevance in designing and optimising biomass conversion processes. We are also key partners in a number of multinational research projects that target significant advances in the state of the art for biomass valorisation.

Accurate data are not enough. We have in-depth understanding of the implications of composition and can design processes to fully valorise biomass

A few examples of our industrially-relevant activities...

1 Fungal and Bacterial Enzymes

Our personnel can investigate strategies for reducing enzyme loadings whilst maintaining, or even enhancing, product yields. We can also, based on our array of existing packages for the enzymatic hydrolysis of biomass and pre-treated biomass, determine how efficient a pre-treatment technology is in producing a substrate suitable for hydrolysis with enzymes and suggest tweaks in the pre-treatment process that may lead to enhanced yields and reduced costs per unit output.

2 Process Optimisations

We have a very strong understanding of the chemistry of biomass and how to evaluate the conversion and valorisation of the main constituents. We target mass-closure in our analysis so that the conversion mechanisms can be understood. Such knoweldge will be key in developing relevant and effective tools for modelling and optimising biomass transformations. We can also investigate each process node for less energy/chemical intensive alternatives without compromising yield. Our team are happy to discuss examples of our track-record.

3 Microbial Fermentations

Know-how in the area of microbiology, bioprocess engineering and design of experiments (DOE) can significantly reduce the number of experimental runs and time involved in the preliminary screening and optimisation process. We have the expertise to optimise fermentation processes for high yield and productivity in short-time. Our personnel have proven scientific records in producing enzymes, biofuels, biosurfactants, exopolysaccharides and prebiotics through aerobic and anaerobic fermentation.

4 Feedstock Profiling

Biomass composition is complex and highly variable. There is increasing recognition that commercial technologies require high-margin as well as high-volume products. We have developed detailed analysis methods for quantifying high-value constituents in biomass extractives and are working on cost-effective methods for their concentration and separation. We have undertaken numerous studies concerning seasonal and regional variations in feedstock composition; evaluated the financial/risk implications; and looked at how process changes could address these.

4. Analysis of Process Liquids

RELEVANT ANALYSIS PACKAGES

P12 – Sugars in Extract: Glucose, Xylose, Fructose, Sucrose, Mannose, Arabinose, Galactose, Rhamnose, Xylitol, Sorbitol, Arabinitol, Mannitol, Glycerol, Raffinose, Trehalose

P13 – Carbohydrates in Solution: As P12 plus Total Oligomeric Sugars

P15 – Uronic Acids: Glucuronic, Galacturonic, Mannuronic, Guluronic, 4-O-Methyl-D-Glucuronic

P21 – Bio-Oil Aqueous Phase: Levoglucosan, Mannosan, Galactosan, Cellobiosan, Glucose, Xylose, Mannose, Arabinose, Galactose, Rhamnose, Cellobiose

P22 – Organic Acids and Furans: Levulinic Acid, Formic Acid, Hydroxymethylfurfural, Furfural, Acetic Acid

Biomass conversion processes can produce complex liquids containing an array of products. We have the methods, equipment, and expertise to allow you to find the real chemical value in your process liquids.

MONOSACCHARIDES

We quantify arabinose, galactose, rhamnose, glucose, mannose, xylose and fructose.

SUGAR ALCOHOLS

Analytes we can determine include mannitol, sorbitol, arabinitol, glycerol, and xylitol.

URONIC ACIDS

We can quantify Galacturonic, glucuronic, guluronic, mannuronic, and 4-O-Methyl-D-Glucuronic acids in biomass/liquids.

OLIGOSACCHARIDES

In our labs we can determine disaccharides and oligosaccharides in two different ways:

- Directly – for sucrose, trehalose, raffinose, and melibiose.
- Indirectly via acid hydrolysis of the liquid to break apart the oligosaccharides and determine their constituent monomers.

ANHYDRO-SUGARS

Including levoglucosan, mannosan, galactosan, and cellobiosan.

Our Analysis Methods Are Suitable For

PRE-TREATMENT LIQUIDS

Biomass pre-treatment processes (e.g. steam explosion, liquid hot water, dilute acid hydrolysis) can produce a complex liquid output containing free sugars (e.g. xylose), degradation products (e.g. furfural), and oligosaccharides.

Our “Carbohydrates in Solution” package first determines the free sugars and then subjects the liquid to a mild form of acid hydrolysis to break apart the oligosaccharides. The resultant solution is then re-analysed and the amounts of each of the sugars in the oligomeric forms are determined.

We also have a “Sugar Degradation Products” analysis package that can quantify products including furfural, HMF, levulinic acid, formic acid, and acetic acid.

PYROLYSIS BIO-OILS

The bio-oil fraction obtained from biomass can also be highly complex. We have packages to determine the important carbohydrates (including anhydrosugars such as levoglucosan, galactosan, mannosan, and cellobiosan) in the water phase of the oil as well as the oligomeric sugars.

EXTRACTIVES

We can characterise carbohydrates in water-extracts and a range of constituents in the ethanol-extracts of biomass.

5. Seaweed Analysis

The biomass in our seas represents huge potential for contributing towards the future bioeconomy and we have a range of analysis methods suitable for evaluating these complex feedstocks.

Seaweed has been recognised as a potential "third-generation" biomass feedstock. Its commercial utilisation, however, is not without challenges. In particular, the composition of seaweed can be much more complex and diverse than many of the traditional cellulosic feedstocks. Fortunately, we have developed a number of chromatography programs to allow you to see the potential value that seaweed samples may have for a chosen biomass conversion process.

Important Seaweed Properties Determined

1 Mannitol & Fucose

The polysaccharides of seaweed not only contain the standard aldoses seen in lignocellulosic biomass but also the deoxy-sugars fucose and rhamnose as well as the sugar alcohol mannitol. With our in-house developed chromatography methods, we are able to quantify all of the important aldoses, deoxy-sugars, and sugar alcohols present in seaweed.

2 Uronic Acids

While acids such as galacturonic acid and glucuronic acid may typically only be present in land biomass in small amounts, uronic acids can be more prevalent in seaweeds, and the range can be more diverse. For instance, brown seaweeds contain alginic acid, a polymer of mannuronic and guluronic acid. In seaweed we can quantify four different uronic acids.

3 Amino Acids

We have a dedicated analysis package for the quantification of 17 different amino acids present in seaweed samples. These amino acids are determined using a customised acid hydrolysis procedure for the proteins in seaweed samples followed by a specialised ion chromatography programme that allows for their separation and quantification.

BIOMASS FEEDSTOCK ANALYSIS

6. Anaerobic Digestion

Anaerobic digestion will expand rapidly in the future and we can provide you with crucial data on feedstock suitability and process residues. Our staff also have experience in developing and optimising digestion processes for a number of clients across the globe and can work with you on getting the most from your feedstock and technology

Anaerobic digestion involves four key stages (hydrolysis, acidogenesis, acetogenesis, and methanogenesis) and underperformance of any of these stages will have significant impact on the preceding and subsequent stages. Anaerobic digestion is traditionally used to treat biodegradable wastes and sewage/wastewater sludges, but these days it has garnered attention as a source of renewable energy. The process has also been increasingly used as a means by which to generate renewable heat and/or electricity from industry process residues. The biogas produced is either used in a gas engine or it can be upgraded to biomethane that can be suitable, in some cases, for direct injection into the gas grid.

The potential of a process residue or feedstock to produce biogas is tested by biomethane potential (BMP) test. Though the BMP is considered the maximum biomethane potential of the tested feedstock, the methane production can be further improved by designing optimum feedstock mixes and additives.

We provide analysis and consultation services to help evaluate feedstock and process suitability for maximising biomethane yields and RINs credits

BIOMETHANE POTENTIAL

The biochemical methane potential (BMP) can be considered to be the experimental theoretical maximum amount of methane produced from a feedstock and is expressed in terms of methane per gram of volatile solids (VS - the non-ash component of dry biomass).

We determine the BMP of samples in our lab. It involves mixing the organic substrate with an anaerobic inoculum in a closed reactor that is incubated at a set temperature, with the contents mixed for a set period of time over which the sample is digested and biogas is produced. The volume of biogas is monitored allowing for a cumulative plot over time. Our experiments can last either 14, 28, or 40 days and involve routine analysis of biogas composition (methane, carbon dioxide, hydrogen sulphide, ammonia, oxygen).

DIGESTATE ANALYSIS

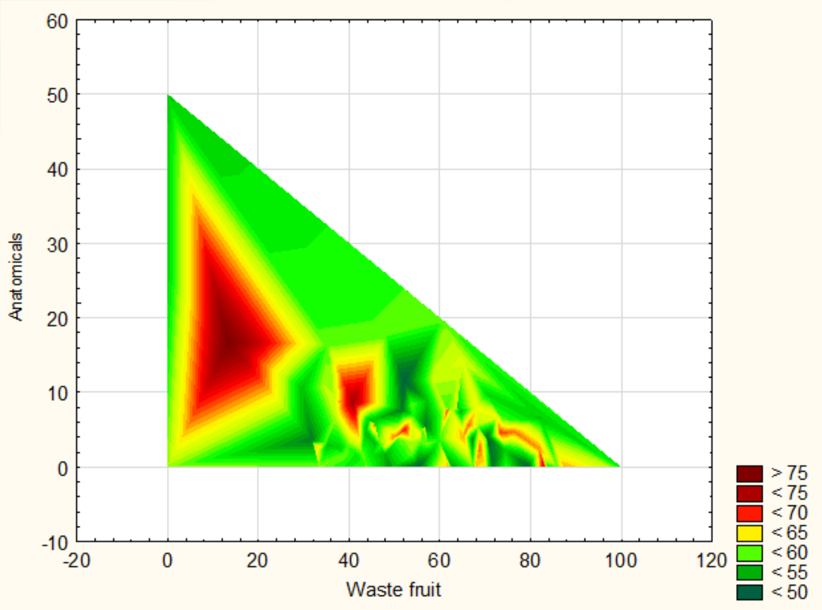
Digestate is the residue that remains after a sample has been digested. We can characterise digestate samples for a range of properties in order to ascertain the most appropriate end-use for this output and also to evaluate the efficiency of the anaerobic digestion process.

Our expertise in lignocellulosic analysis can allow for detailed insight regarding the fate of the different biogenic polymers during digestion. For example, comparisions between the relative amounts of cellulose, hemicellulose, and lignin in the starting feedstock and the digestate can shows the extent to which these constituents have been digested. Such data can assist stakeholders in modifying process conditions in order that the specific biomass feedstock can be more efficiently valorised.

PROCESS OPTIMISATION

Anaerobic digestion has multiple variables including: organic loading rate; solids retention time; hydraulic retention time; feedstock mixtures; and trace element concentrations. Each variable has a significant effect on biogas production and feedstock conversion efficiency. The biogas plant should be routinely monitored for pH, akalinity, volatile fatty acids (VFAs), and other indicators of process balance. If imbalances are noticed, the digester feeding rate and the supplementation of nutrients and additives should be changed. Digester nutrient balance is maintained by keeping a proper ratio of carbon, nitrogen, phosphorous, and sulphur. Major and minor nutrients concentrations should also be kept at optimal levels.

At Celignis we provide consultation services for process optimisation, by monitoring the AD plant biogas production data and correlating these with key process indicators data obtained from analysis in our lab or third-party labs.



BIOMASS FEEDSTOCK ANALYSIS

7. Biomass Combustion

RELEVANT ANALYSIS PACKAGES:

P2 – Moisture Content

P3 – Ash Content

P31 – Volatile Matter

P32 – Proximate Analysis:
Moisture, Ash, Volatile Matter, Fixed Carbon

P33 – Ultimate Analysis:
Carbon, Hydrogen, Nitrogen, Sulphur, Oxygen, Ash

P34 – Calorific Value and Elements:
Gross Calorific Value, Net Calorific Value, Ash, Carbon, Hydrogen, Nitrogen, Sulphur, Oxygen

P35 – Chlorine and Sulphur

P36 – Major Elements:
Aluminium, Calcium, Iron, Magnesium, Phosphorus, Potassium, Silicon, Sodium, Titanium

P37 – Minor Elements
Antimony, Arsenic, Cadmium, Chromium, Cobalt, Copper, Lead, Manganese, Mercury, Molybdenum, Nickel, Vanadium, Zinc

P38 – Major and Minor Elements

P40 – Combustion Package:
Gross Calorific Value, Net Calorific Value, Chlorine, Moisture, Ash, Carbon, Hydrogen, Nitrogen, Sulphur, Oxygen, Volatile Matter, Fixed Carbon

P41 – Ash Melting Behaviour (Oxidising Conditions)
Shrinkage Starting Temp., Deformation Temp., Hemisphere Temp., Flow Temp.

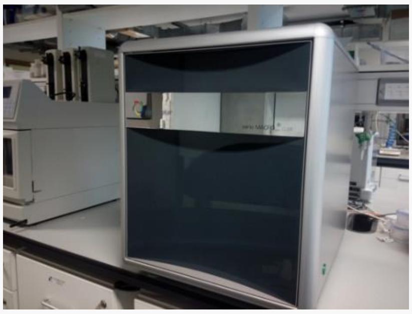
P42 – Ash Melting Behaviour (Reducing Conditions)
As P41 but under reducing conditions

Currently the main energy use of biomass is for combustion. We have a range of packages to help you determine the value of your feedstocks for the production of heat and electricity.

Our laboratory is equipped with a number of state-of-the-art items of equipment that allow us to determine the most important combustion-related properties of biomass.

We recognise that it is important that you have confidence in the analytical data that you receive. That is why we follow internationally-recognised standard analysis methods and undertake most analyses in duplicate, reporting values for each of the replicates analysed, along with the average and the standard deviation. This allows us to repeat the analysis (at no extra charge) if the deviation values are high.

Moisture and ash contents are of crucial importance for combustion. This is reflected in our online, Excel, and pdf reports where data for bioenergy-related parameters are expressed on dry-mass, as-received, and dry-ash free bases, according to standard method EN 15296:2011.

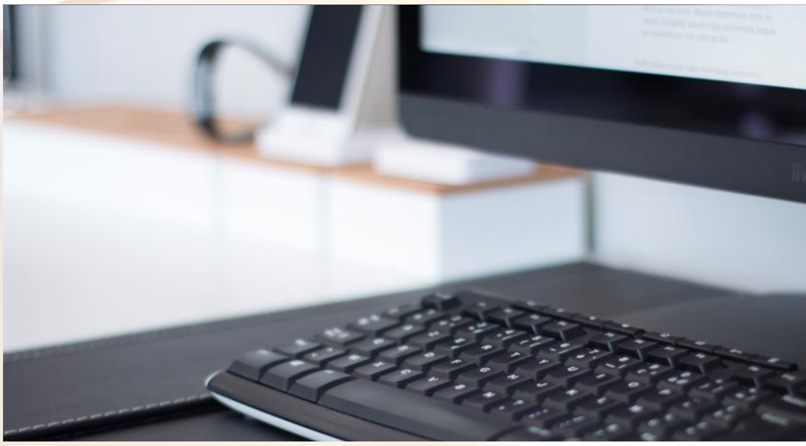


WE MAKE IT EASY TO ACCESS YOUR DATA

8. The Celignis Database

CONCEPT

We realise how important your samples are and your need to access data as quickly and as easily as possible. That is why we created the Celignis Database. This is a password-protected website where you can place your orders and view the results of our analysis, even when the order itself has not been fully completed. The Database is responsive to use on laptops, tablets, and mobile phones and helps to take the complexity out of the process of selecting which of our analysis packages are the most suitable for your samples.

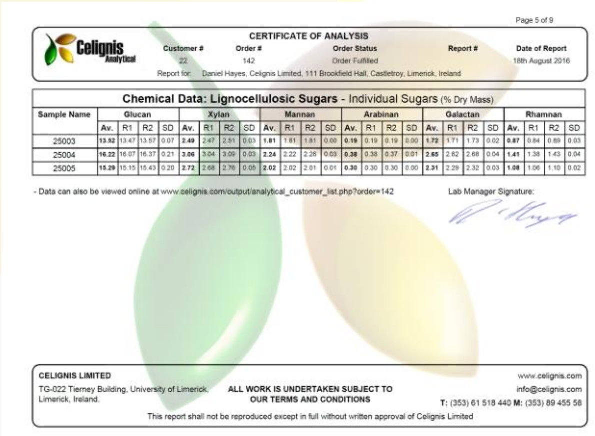


DETAIL

We present summary results as well as detailed data for each sample with results represented in tabular and graphical forms. We also use the compositional data to estimate the potential biofuel yields from your samples. Data relevant to thermal processing are shown on dry-mass, as-received, and dry-ash-free terms.

REPORTS

You can download the data any time from the Database as Excel and PDF reports. We also send you final reports by email once we have completed our analysis. These reports provide data for each of the duplicates analysed, the average, and the standard deviation, so that you can see the precision of our analysis. You can view example data on our guest account, enter user test@celignis.com and password celignis at www.celignis.com/output/login.php.



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CERTIFICATE OF ANALYSIS

Celignis Analytical

Customer #	Order #	Order Status	Report #	Date of Report
22	142	Order Fulfilled		18th August 2016

Report for: Daniel Hayes, Celignis Limited, 111 Brookfield Hall, Castletroy, Limerick, Ireland

Chemical Data: Lignocellulosic Sugars - Individual Sugars (% Dry Mass)

Sample Name	Glucan				Xylan				Mannan				Arabinan				Galactan				Rhamnan			
	Av.	R1	R2	SD	Av.	R1	R2	SD	Av.	R1	R2	SD	Av.	R1	R2	SD	Av.	R1	R2	SD	Av.	R1	R2	SD
25003	**13.52**	13.47	13.57	0.07	**2.49**	2.47	2.51	0.03	**1.81**	1.81	1.81	0.00	**0.19**	0.19	0.19	0.00	**1.72**	1.71	1.73	0.02	**0.87**	0.84	0.89	0.03
25004	**16.22**	16.07	16.37	0.21	**3.06**	3.04	3.09	0.03	**2.24**	2.22	2.26	0.03	**0.38**	0.38	0.37	0.01	**2.65**	2.62	2.68	0.04	**1.41**	1.38	1.43	0.04
25005	**15.29**	15.15	15.43	0.20	**2.72**	2.68	2.76	0.05	**2.02**	2.02	2.01	0.01	**0.30**	0.30	0.30	0.00	**2.31**	2.29	2.32	0.03	**1.08**	1.06	1.10	0.02

- Data can also be viewed online at www.celignis.com/output/analytical_customer_list.php?order=142

Lab Manager Signature:

CELIGNIS LIMITED
TG-022 Tierney Building, University of Limerick, Limerick, Ireland.

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EXPERTS IN THE BIOECONOMY

9. Meet the Team

Dan Hayes

Dan undertook his PhD at the University of Limerick and was involved in the leadership of several key research projects. He developed models to rapidly predict biomass composition and launched Celignis in 2014 to commercialise this work and offer analytical and process expertise to clients. Since then Celignis has grown to be the premier global provider of these services while also pushing the cutting edge of biomass research through involvement in pioneering multinational projects.

Lalitha Gottumukkala

A serial innovator with extensive knowledge and experience in enzymes, microbes, and fermentation. In her PhD she discovered a novel natural butanol fermenter that does not form acetone. She also developed strategies to co-produce solvents and organic acids. Has a passion for technology-transfer projects for industry-specific cost-effective solutions. Examples include: feedstock-specific enzyme cocktails; bespoke additives for biogas plants; hydrogels from process residues; high-solids-low-enzyme fermentations.

Vasudeo Zambare

Vasudeo is a multi-skilled researcher with biorefinery-industry experience in the US, Canada, EU, and India. He has developed bioprocesses for the leather, textile, paper and pulp, and biofuel industries. He also worked on developing soil conditioners and testing the biopharmaceutical potential of lichens. At Celignis, he is project manager of our involvements in a prestigous project focused on the extraction of high-value compounds from wood before converting the polymers to biofuels and biochemicals.


Planning


Chemometrics

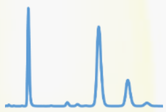

Partnerships


Process


Microbes


IP


Management


Analysis


Enzymes

WE ARE ALWAYS HAPPY TO CHAT ABOUT BIOMASS!

10. Contact Details

WEBSITE

There is a wealth of information at www.celignis.com on our various analysis packages and the wide range of analytes that we determine. We also present more detail on our unique rapid analysis method and the various feedstocks we have experience with.

ADDRESS

You are most welcome to visit our lab! We are in the Plassey Technology Park in Limerick, Ireland. We receive many samples from all over the world with no customs delays. We email a standard cover letter and an easy-to-use packing list template that ensures we receive your samples rapidly. You also receive automated emails from the Celignis Databse when the samples arrive and as soon as we obtain any data.

PHONE + EMAIL

Our email is info@celignis.com or call us at (+353) 61 371 725. To reach Dan Hayes on his mobile call (+353) 89 455 5582, use Skype ID dj-hayes, or email dan@celignis.com.

TESTIMONIALS

“Arigna Fuels has been working in conjunction with Dan and the team at Celignis for a number of years. Alone and as part of a larger consortium that are members of the International Biomass Torrefaction Council (IBTC), we have been characterising thermally processed biomass and their corresponding raw materials for the purposes of producing a domestic heating fuel. We receive a professional, amiable and rapid service from Celignis and wouldn’t hesitate to recommend them to others.”

Robert Johnson PhD, R&D Manager at Arigna Fuels

"Celignis has characterised a large number of our complex biomass samples using their NIR method and chemical analysis methods. We have been impressed with both the quality of data generated and the attention to detail employed in their analysis."

Darragh Gaffney PhD, R&D Manager Monaghan Biosciences

Biomass Analysis Services

FROM A LAB DEDICATED TO ADVANCING THE BIOECONOMY

CELIGNIS ANALYTICAL

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