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Phytoactive Products in Anaerobic Digestates

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AD NETWORK
Harnessing Anaerobic Digestion

Introduction

Digestate is the nutrient rich organic residue from anaerobic digestion and is typically used as soil conditioner but its disposal can be challenging.







Could we develop and improve the phytoactive properties of digestate and hence its agricultural and economic value?

Digestate Premium TM

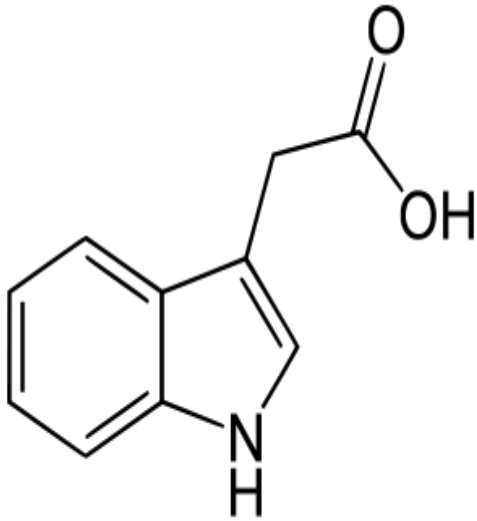
Aims of the Project

The phytoactive properties of digestates could be due to the following :

- Inorganic nutrients such N, P and K. 
- Can the bacteria present in digestates produce plant hormones? 
- Microbial release of phytoactive compounds (humic acids/soluble lignins)? 
- Can plant growth promoting bacteria or microbial plant disease inhibitors grow in digestates? 

Do the bacteria present in digestates produce plant hormones?

- One group of phytoactive compounds (plant hormones) have been detected in a number of microbial media. Not all have been identified but include :
 - Auxins
 - Ethylene
 - cytokinins
- Microbial isolates from soils have been shown to produce plant hormones.



Auxin

- Regulates and promotes plant growth
- Most important natural auxin is indole-3-acetic acid (IAA).
- Consists of a aromatic ring and a carboxylic acid group.
- Promotes plant growth at low levels but then becomes inhibitory

Developed a Range of Analytical Procedures for Auxins in Digestates

- Bioassay
 - Based on plant model *Arabidopsis thaliana*
- Chemical Analysis
 - UVVis Spectrophotometric Method
 - HPLC/Uvvis
 - UPLC ESI-MS/MS and GC/MS

Screening Analysis of Auxins and Confirmatory Analysis by HPLC

- Salkowski's procedure was used with a colour change at 530nm
- A reverse phase HPLC method with auxin detection at 274 nm.
- Spot samples confirmed with UPLC ESI-MS/MS

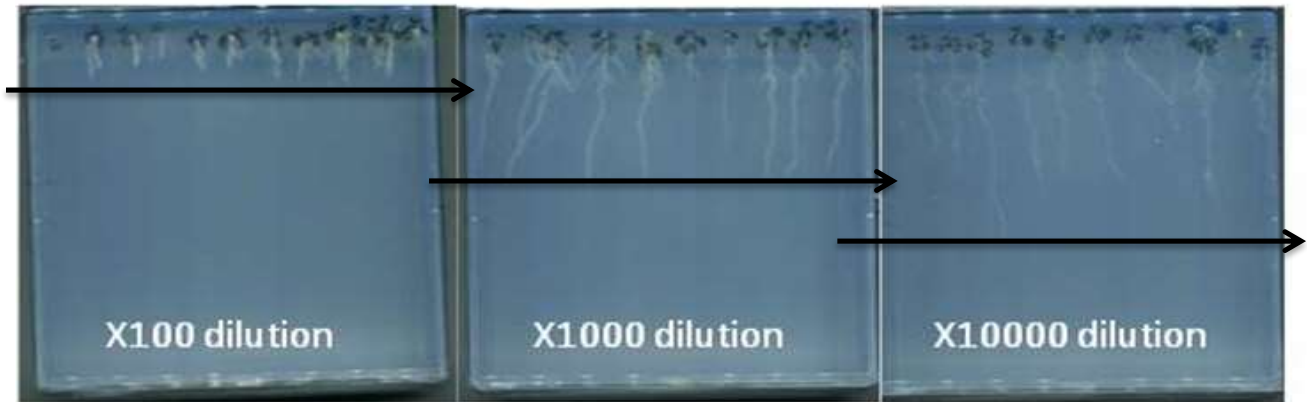


Auxin Analysis Results

			Salkowski		HPLC	
Site	Type	Sample	mg/L	uM	mg/L	uM
A	Food Waste	Raw Feed	1.2	6.7	1.1	6.1
A	Food Waste	Digestate	10.7	60.9	3.6	20.1
A	Sewage Sludge	Raw Feed	nd	-	nd	-
A	Sewage Sludge	Digestate	8.7	24.5	2.2	12.5
B	Sewage Sludge	Raw Feed	nd	-	nd	-
B	Sewage Sludge	Digestate	4.3	24.5	3.1	17.7
C	Maize	Feed	nd	-	nd	-
C	Maize	Digestate	10.3	58.9	14.2	81.1
C	Maize	Digestate (dewatered)	nd	-	nd	-

Arabidopsis thaliana bioassay

A)



B)



Inoculation with Plant Growth Promoting Bacteria

- A number of pure cultures from a range of plant growth promoting bacteria associated with soil/plant systems were selected.
- Used to inoculate autoclaved food waste/digestate/sewage sludge mediums.
- Some mediums were also supplemented with a auxin precursor.
- Increases in auxin levels were associated with the inoculation with *Bradyrhizobium japonicum*, *Pseudomonas fluorescens* and *Ensifer meliloti*.



Humic acids/soluble lignins/humins /fulvic Acid Analysis

Plant growth promoting properties of composts have been linked with increased levels of humic acids and soluble lignins.

Anaerobic feedstock and digestate samples were analysed by UV vis spectroscopy and by mass following extraction and separation with resin columns.

Few samples analysed but seems to be no significant difference between digested and undigested samples for this parameter.

Conclusions

- In total 21 samples from commercial anaerobic digesters were analysed.
- The increased presence of auxin was found in anaerobic digestates of food waste, sewage sludge, mixed crop and whole crop maize digestion compared to the incoming feed.
- The level of auxin could be effected by reactor operation, inoculation with plant growth promoting bacteria and chemical supplementation.

Future Work

Can we:

- Manipulate the auxin levels (plant hormone levels) in anaerobic digestates to show agronomic and economic benefit?
- Develop the digestate into a soil inoculant to boost plant growth ie. Improve nutrient uptake, disease resistance etc.
- Quantify the contribution of digestate organic carbon to soil health.

Acknowledgements

- The BBSRC Anaerobic Digestion NIBB proof of concept grant (**POC2015008**) and the FLEXIS research project (WEFO 80835).
- Paper presentation accepted for AD 15 in Beijing.
- Full journal paper to be submitted shortly

