Different types of biochar products for agronomic application as soil improver and innovative fertilizer

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Background – The Global Phosphorus situation

**THE VULNERABILITY OF EU P-SUPLY → THE AGRICULTURE and FOOD SECTORs ARE AT RISK**

- Limited domestic EU P–reserves → EU entirely dependent on P-rock imports.
- Rising Global P-rock demand, especially for the low CADMIUM/URANIUM content materials → higher prices and competition.
- The security of P rock supply is under increasing pressure.

**POLITICAL & ECONOMICAL RISK**

- Main P-rock producers: China, US and Morocco (majority of reserves).
- US & China consume all domestic production. China apply 135% export tariff!
- Morocco: main exporter
- Stable supply from Tunisia, Jordan and Syria is no longer guaranteed (political instability). GAFSA production in 2011: only 30% of its total capacity!

**TECHNICAL:**

Excessive fresh-water consumption by P-industry:

- 1-3 m3 / ton of phosphate concentrate.
- compete with agriculture and drinking water
- WATER SHORTAGES in Western Sahara

Phosphorus is a critical raw material (COM (2014) 297 final)
**WHAT IS BIOCHAR?**

**BIOCHAR MATERIAL** is:
- plant and/or animal bone biomass origin,
- *stabile carbon* carboniferous material,
- used for **mandatory EU/MS Authority permitted** ecological soil enhancement, and eco-safe carbon negative applications.

**BIOCHAR PRODUCT** is:
- a **labeled** and full value chain safe product
- having extended **producer responsibly product guarantees**,  
- meets all the **EU/MS product criteria for production and product permits. REACH registered**,  

**INPUT SUSTAINABILITY CRITERIA**: The feed material:
- not from primarily and secondarily **land use**,  
- not competing with human food +animal feed + plant nutrition,  
- having environmentally sustainable logistics.

**Biochar always works, if not, than producer/user made mistake(s) by making schlock biochar and/or misuse.**
WHAT IS NOT BIOCHAR? I.

- NOT a fine ground charcoal and labile carbon,
- does NOT meet quality to be irrevocably put into open ecological soil environment,
- made from input feed material, that is originating from primer and secondary land use products, and/or competing with human food/animal feed supply/food crop plant production nutrient supply,
- the pyrolysis process is not towards zero emission performance,
- biochar production and product application are not EU/MS Government Authority permitted,
- having no labelled extended producer responsibility, and/or
- the output biochar product economical value and free market valorization is not based on common market demands and commercialization process, e.g. biochar valorization may not be based on grants and subsidies.

Biochar is NOT a renewable biofuel for energy
Biochar and energetic carbons are 2 very different products with

• 2 very different product functionalities and product criteria requirements,
• 2 very different production scenarios and processing conditions,
• 2 very different product safety aspects,
• 2 very different Authority permits and legal environments,
• 2 very different application areas, and
• 2 very different markets and users.

There is NO one biochar technology and/product fit for all
HOW ABC BIOCHAR IS MADE?

- **BIOCHAR PROCESSING**: pyrolysis – carbonization process in reductive (indirectly heated) thermal conditions, 650°C - 850°C (material core).

- **ABC Animal Bone bioChar processing** require higher efficient thermal processing, complex and higher level of technology, - than PBC Plant Based Biochar.

[Image of biochar processing equipment]

“3R”
Recycle
Reuse
Reduce
zero
emission
technology

There is no one fit for all biochar technology – product solution

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PAH content and manufacturing condition

During pyrolysis and other thermal treatment processes PAHs are the primary indicator contaminants → necessary investigation due to QA/QC and environmental safety of biochar:

- The REFERTIL project EU Commission recommendation for PAH 16 limit value was defined <6 mg/kg. Member States may apply improved PAH standards, such as 1 mg/kg PAH18 already applied for soil improvers since 2006.

- Several biochar samples were examined (DK, IT, FR, UK, ES, HU). Some cases high PAH content was detected.

- The occurrence of PAHs in biochar primarily derive from obsolete, low grade and inefficient pyrolysis condition.

- According to our measurements qualified and safe biochar samples ALWAYS contained <1 mg/kg PAH 16.

REFERTIL: www.refertil.info - www.3Ragrocarbon.com
PAH content of different biochar products

REFERTIL: recycling treated organic waste as compost and bio-char products
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PAH CONTENT:
Member States can define more strict limit

ABC permit in Hungary, <1mg/kg criteria defined

Advanced pyrolysis technology is required for QTY & SAFE biochar
Advanced PYROLYSIS for ABC
Recycled P-fertiliser production

History: since 1980’s over 30 large scale pyrolysis developments made, most of them failed.

New generation Pyrolysis:

• is a zero emission thermo-chemical decomposition process of plant and/or animal origin organic waste and by-products in the absence of oxygen, under vacuum and between material core temperature up to 850 °C.

• transforms organic materials into 3 different components: (1) gas, (2) liquid or (3) solid. - proportions depending upon both the feedstock and the pyrolysis conditions used.

• Slow pyrolysis (carbonisation) with relative long residence time could be applied for biochar production.
Analysis of PBC & ABC

ABC: Animal bone biochar
- High phosphate content (>30%)
- Other macroelements like calcium carbonate (~10%)
- Controlled and continuous nutrient supply
- Macroporous structure

PBC: Plant based biochar
- Much higher carbon content than ABC (>90%)
- Low P and nutrient content
- Good soil quality improver
- Micro- and mesoporous structure
Biochar product: Organic fertilizer or soil improver?

<table>
<thead>
<tr>
<th>BIOCHAR</th>
<th>$\text{P}_2\text{O}_5$ (dm)</th>
<th>$\text{N}$ (dm)</th>
<th>$\text{K}_2\text{O}$ (dm)</th>
<th>$\text{CaO}$ (dm)</th>
<th>NUTRIENT CONTENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Animal bone biochar</td>
<td>28-30</td>
<td>&lt;0.1</td>
<td>0.4-0.8</td>
<td>30-42</td>
<td>HIGH</td>
</tr>
<tr>
<td>(recycled N +5-6%)</td>
<td></td>
<td></td>
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<tr>
<td>Plant Based Biochar</td>
<td>0.01-0.3</td>
<td>0.3-1</td>
<td>0.1-1</td>
<td>0.2-6</td>
<td>LOW</td>
</tr>
</tbody>
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If the nutrient content is low, the dose/ha is high

higher load of contaminants to the land

REFERTIL: recycling treated organic waste as compost and bio-char products

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Total Phosphorus content of different biochars

Pyrolysis condition: T=550 °C, tres=60 min, p=-50Pa
ABC is a recovered organic P-Fertilizer having high nutrient density (30% $P_2O_5$) and pure P-content.

**INPUT:** cat. 3 bone rendering byproducts

**Major aspects:**
- nutrient density,
- nutrient solubility,
- product safety,
- economy €,
- legal compliance

**Zero emission pyrolysis reductive thermal processing, <850 °C**
Advanced pyrolysis technology is required for QTY & SAFE biochar.
THE STATE-OF-THE-ART OF ABC PRODUCTION


2. True value reductive environment.

3. Full recovery and valorisation of by-products (bio-oil) towards zero emission performance. **CHALLENGING ISSUE**

4. Long term meet all strict and comprehensive environmental norms and industrial standards.

5. Rational CAPEX & OPEX costs. ROI 3-5 years.

6. Continuous quality control of the labelled biochar output products.

7. Maintaining extended producer responsibility and legal liability for the biochar products, relevant insurance cover signed.

8. Maintaining EU and MS Authority biochar application/production MANDATORY PERMITS/REACH.
ABC – ECONOMIC BENEFIT AND USP

- **Providing 10-30% yield** incensement. The more efficient P utilization >10% decreasing the overall quantity of fertiliser need.
- **low cost price organic nutrients**: ABC is a cost effective €975/ton alternative of the mineral fertiliser.

- < 3-4 years ROI for producer
- < 1 years ROI for farmers
- Higher value food crop product
- Farmers can access higher fund from second pillar of CAP
- Decreasing the cost of the environmental pollution resulting from P leach out.
2016-2018 Biochar Challenge:

Convert biochar science into market competitive industrial manufacturing & application practice.

Past years over >3500 biochar scientific publications made, mostly TRL3-TRL6.

Now it is right time to progress from laboratory into TRL9 market competitive industrial manufacturing & application practice.

All progressive biochar cooperation welcome in any applied S&T, product/application fields.
THANK YOU!

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