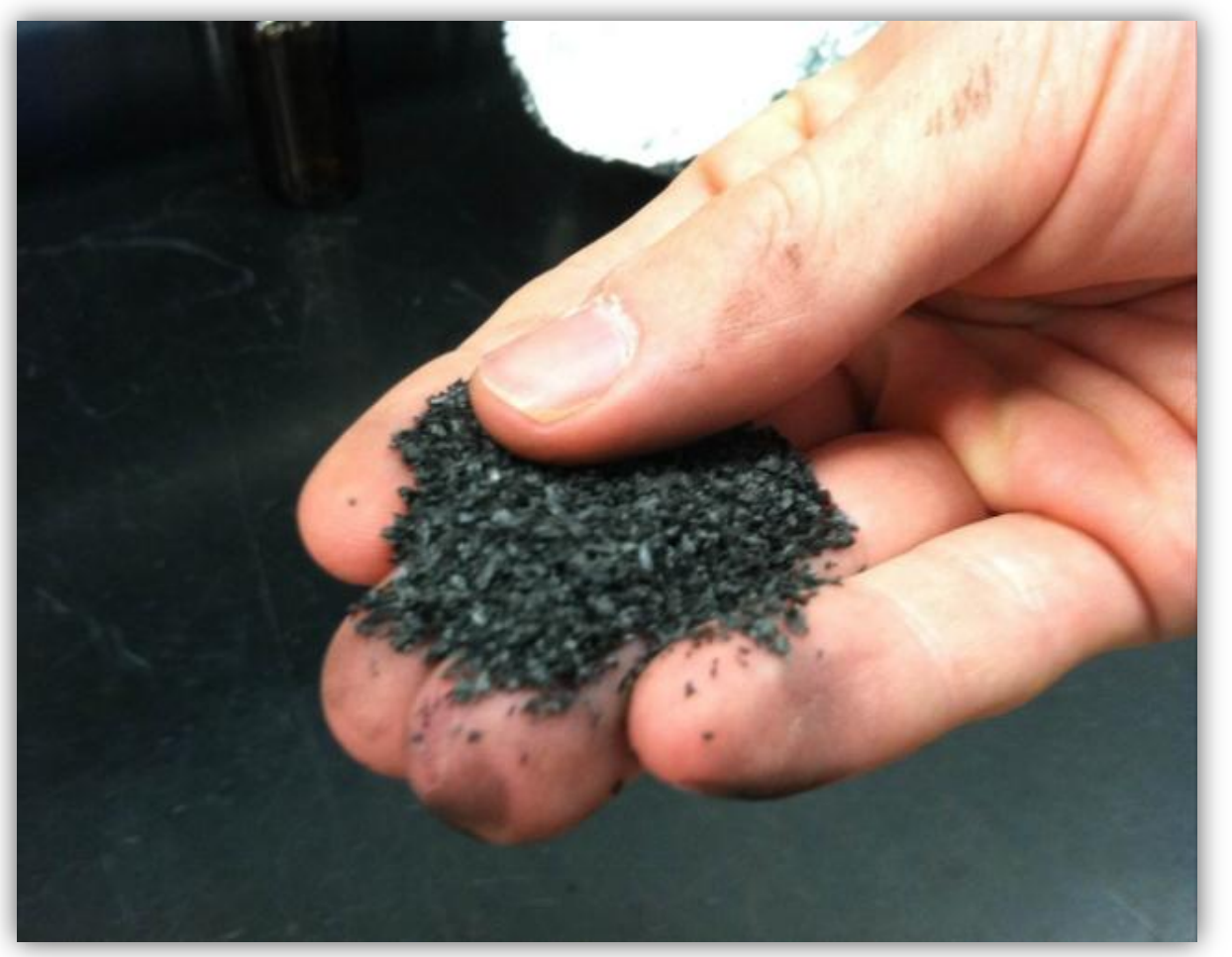


## Biochar Production

Char is formed when biomass (wood, agricultural waste, or human waste) is heated to high temperatures (300 to 1000°C) in an oxygen limited environment



So, is it Char? Biochar? Charcoal?  
**Charcoal** = biomass char produced for use as a fuel  
**Biochar** = biomass char produced for use as a soil amendment and/or CO<sub>2</sub> sequestration strategy  
**Char** – general term used for either application

### Why we decided to make char:

Our technology's capability of achieving high temperatures

High nutrient content manure biochars have performed best in meta-analysis of field trials

Biochars have greatest benefit in poor, acidic, coarse soils (common conditions in rural Africa)

Charcoal markets exist in many dense urban areas

Good adsorption results from biosolids chars

### Did you generate a char?

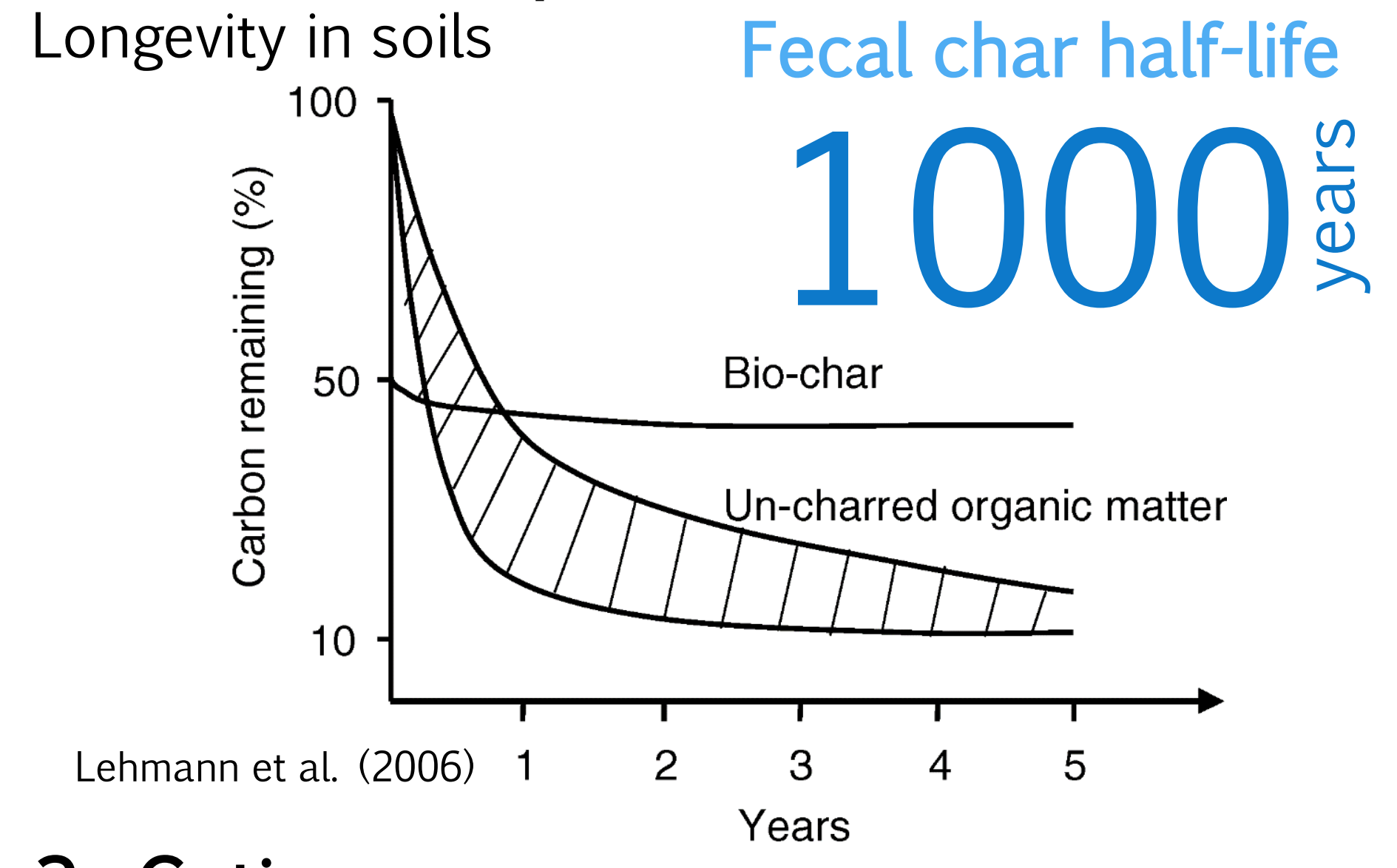
1. Is the product visibly carbonized (black throughout)?
2. Was a temperature of 300°C achieved in an oxygen limited environment?
3. Was the temperature achieved throughout the bulk mass?
4. Is the product effectively carbonized to be >30% organic C?



But... not all chars are equal.  
 Characteristics depend on feedstock (what you made it from), generation conditions (how you made it), and temperature achieved (how hot it got).

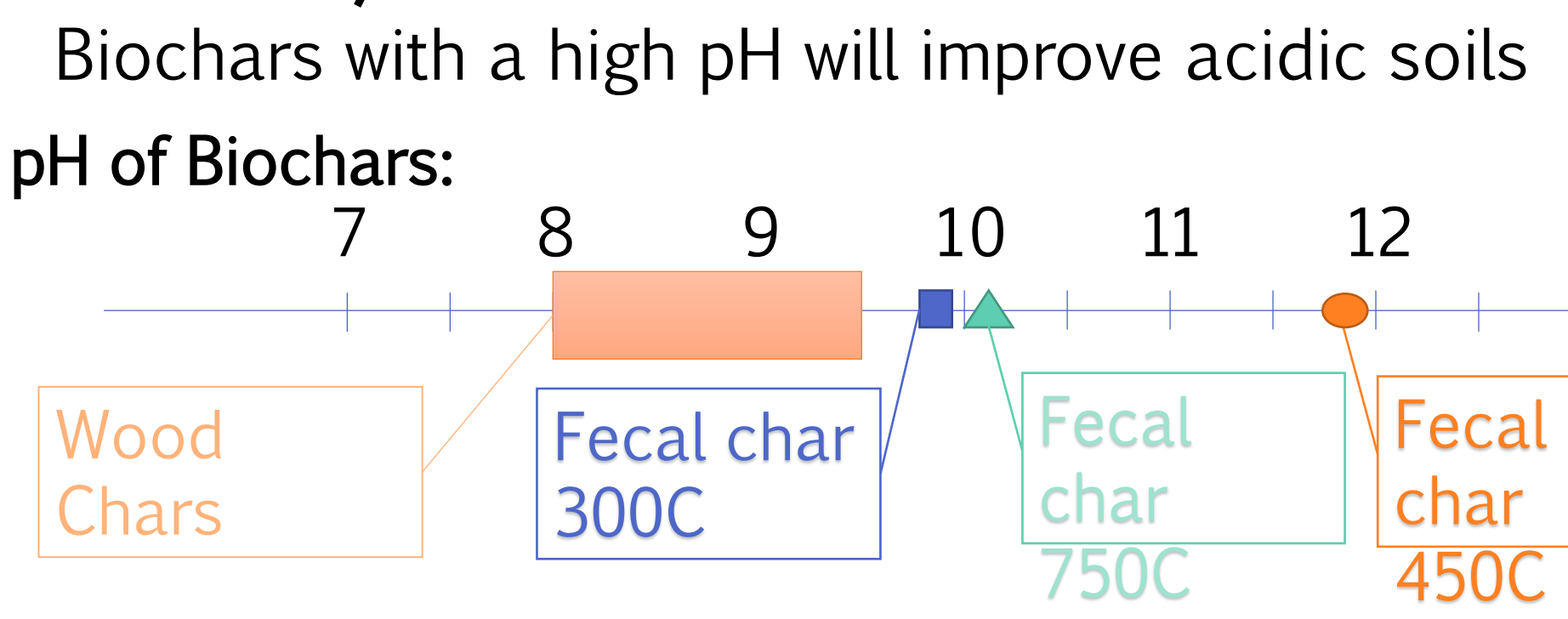
## Biochar as a Soil Amendment

### 1. Carbon sequestration



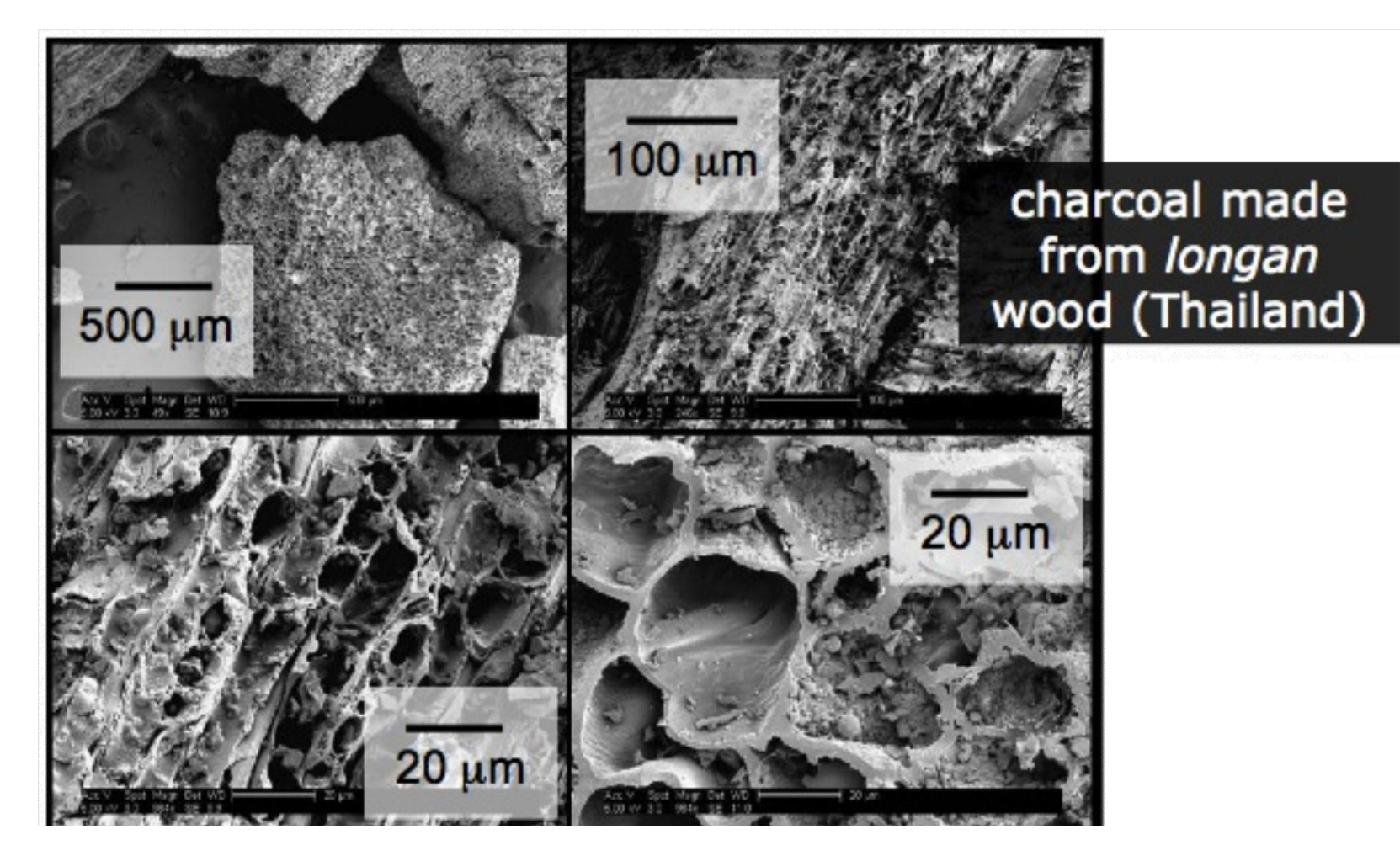
**2. Cation Exchange Capacity**  
 Coarse measurement of soil fertility

### 3. Acid/Base Content



### 4. Structure of Soil Amendment

Contributes to water/nutrient holding capacity and support for microbiota



**5. Nutrient Content**  
 High nutrient biochars can be slowly mineralized and have been shown to increase yields.

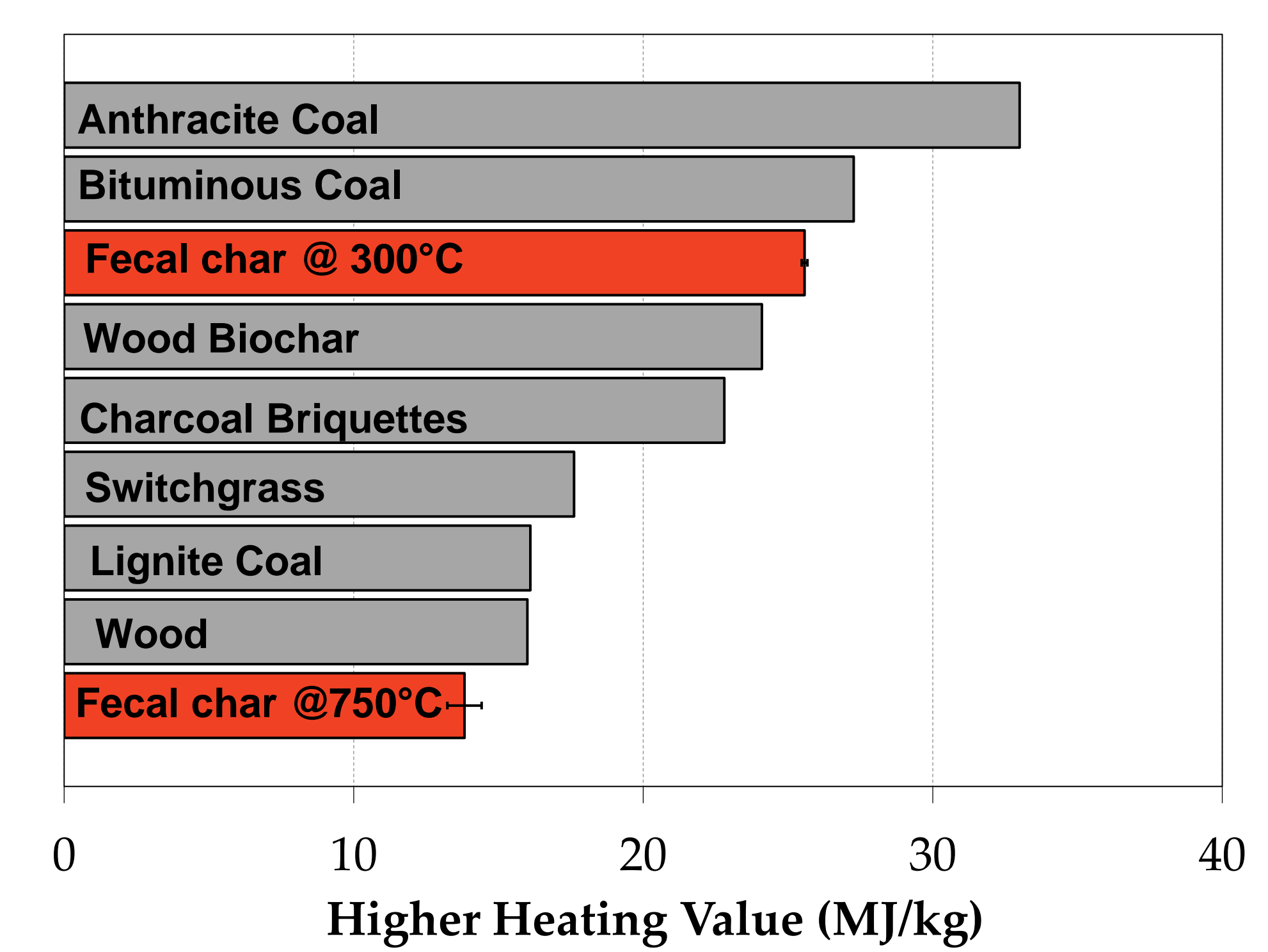
**Fecal chars have: 5-15X the nutrient content of typical wood biochars**

## Char as a Solid Fuel

Fecal chars made at 300°C have an energy content comparable to coals and charcoals:

**25.6 MJ/kg**

### Comparing fecal char to other fuels:



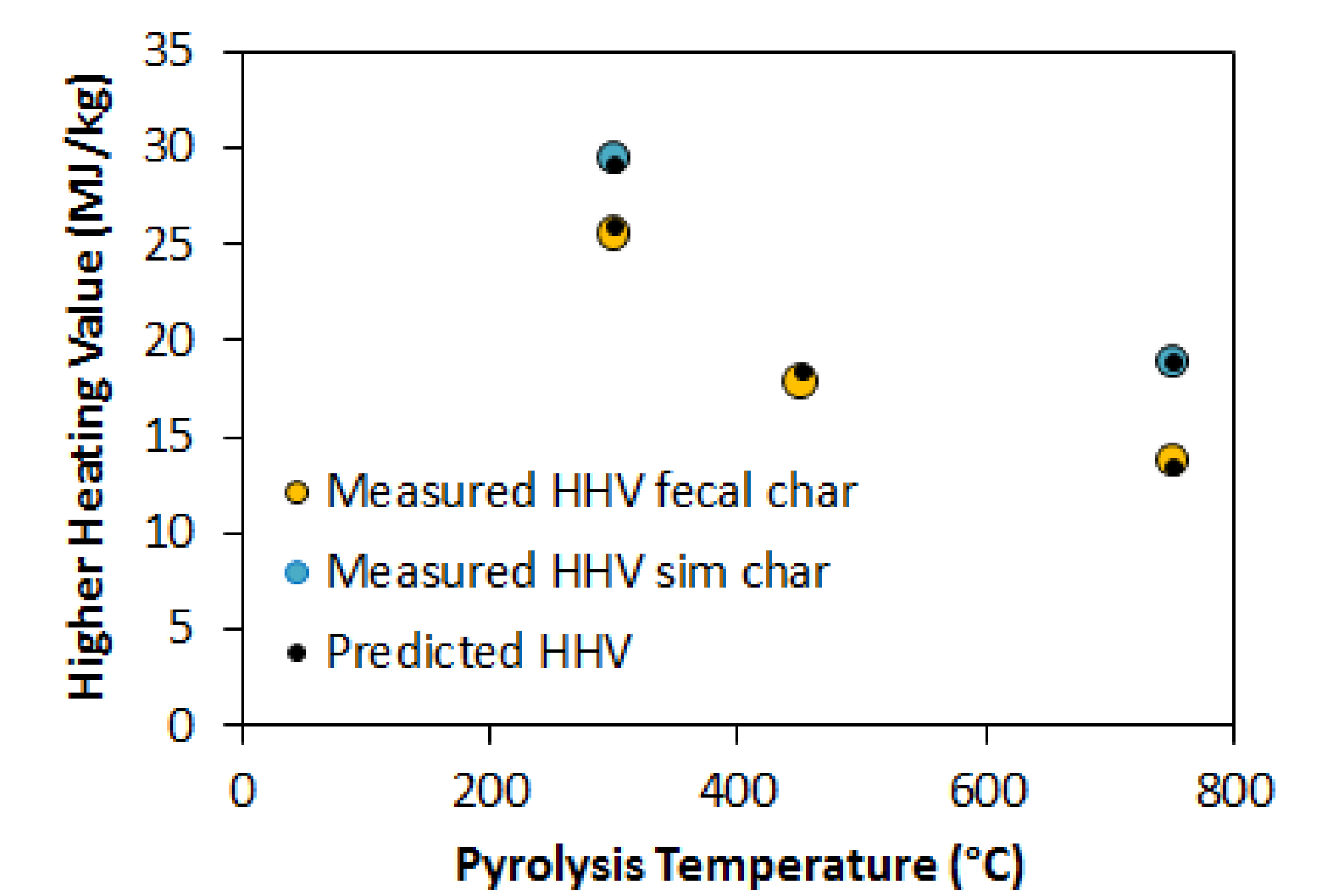
### Briquetting of Chars

Selected Molasses + Lime (20% + 7%) binders based on briquette strength and durability trials



### Predicting Higher Heating Value

Generated optimized model for feces based chars and validated this model with our ultimate analysis data



Chamiwala et al. 2002:

$$HHV (MJ/kg) = 0.3491C + 1.1783H + 0.1005S - 0.1034O - 0.0151N - 0.0211ASH$$

## Char as Low Cost Adsorbent

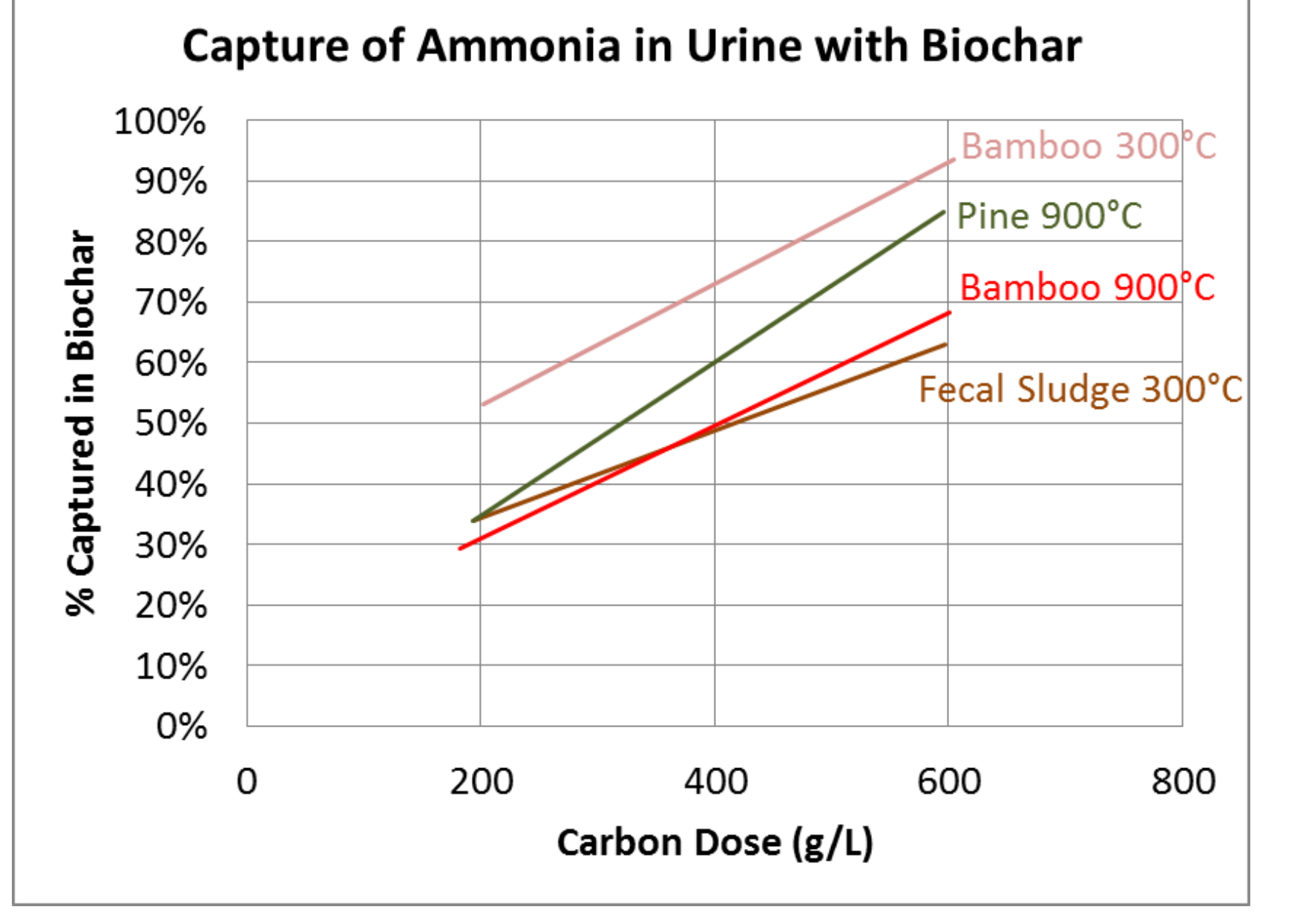
### Smells, smells, smells

Like activated carbon, chars can adsorb pollutants from air and water (such as H<sub>2</sub>S & NH<sub>3</sub>)

**500 ppm Removed to below detection**

### Nutrient Capture from Urine

Biochars ability to sorb nutrients from a urine stream

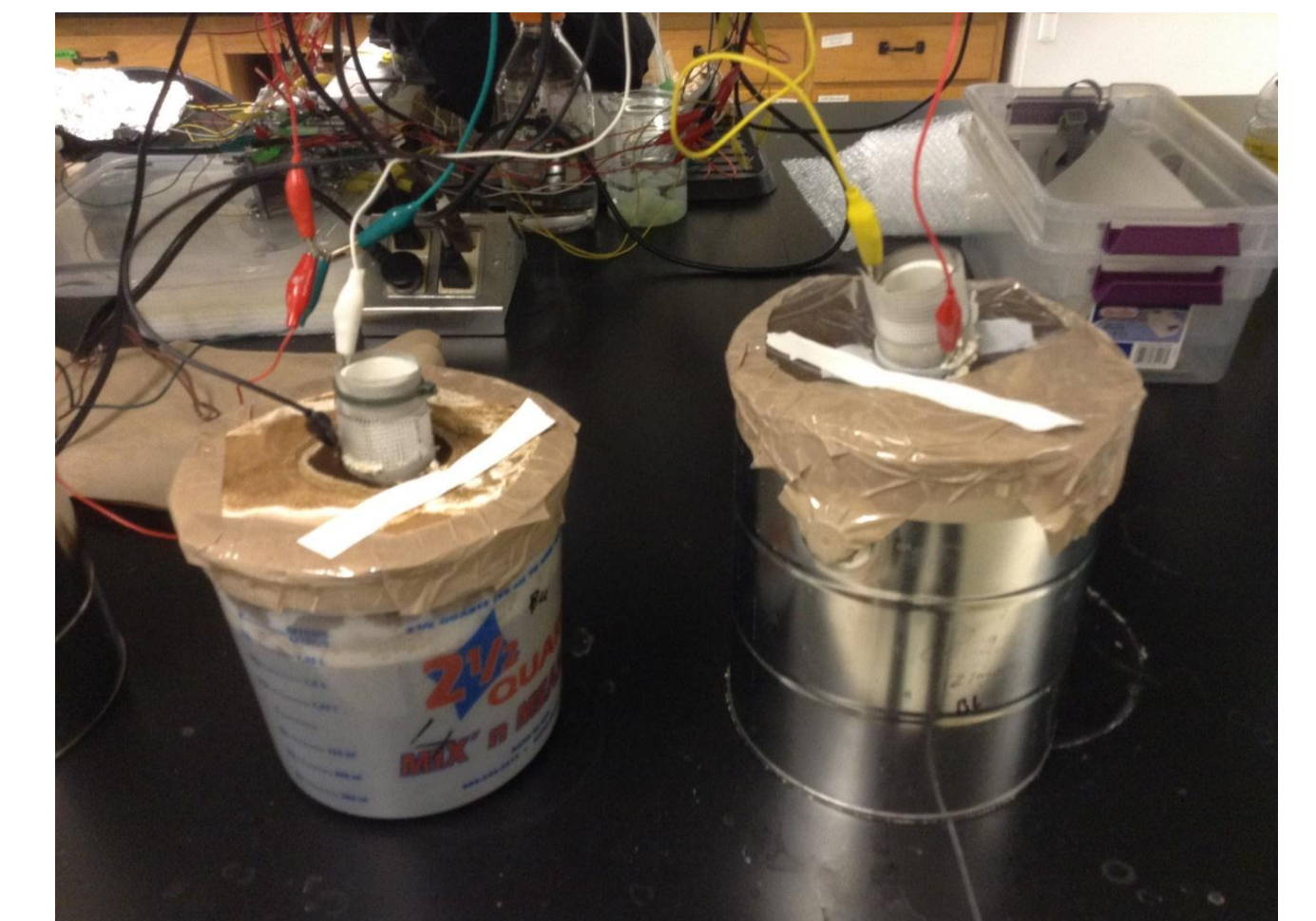


### Wastewater treatment & watershed protection

- Environmental Health Concerns
- Personal care products
  - Pharmaceuticals
  - Pesticides
  - Disinfection by-products

### Microbial fuel cell electrodes

- Treatment of wastewater and/or urine
- Power generation and monitoring of operation



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