

EFFECT OF BONE MATTER ON PYROLYSIS PRODUCT DISTRIBUTION AND COMPOSITION IN A FIXED REACTOR

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1. ABSTRACT

Bio-char from biomass pyrolysis offers a geotechnical solution to the global issues of climate change, soil degradation and food shortage[1]. Addition of bone matter to the biomass appeared promote char formation, increased carbon and energy content of the char, increase nitrogen and phosphate content of char for soil amendment while optimising the oil production for bio-chemical and renewable energy generation[2].

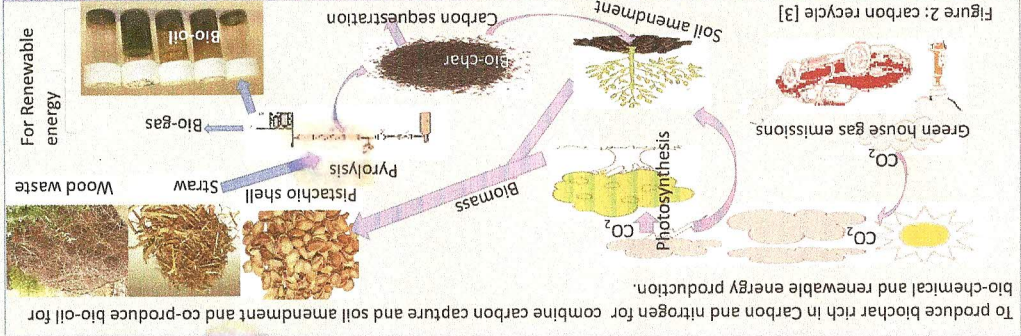
2. INTRODUCTION

WHY BONES?

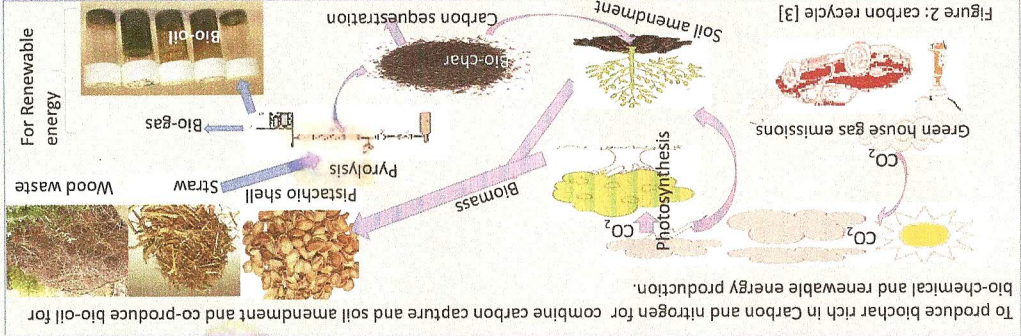
- ▶ waste utilization
- ▶ its elemental components (K, Ca, etc) can promote char formation while generating a high quality bio-oil.
- ▶ its nitrogen content improves soil amendment properties of char.
- ▶ Tailored bio-char structure to mimic terra-preta.

To produce biochar rich in Carbon and nitrogen for combine carbon capture and soil amendment and co-produce bio-oil for bio-chemical and renewable energy production.

3. AIM AND OBJECTIVES



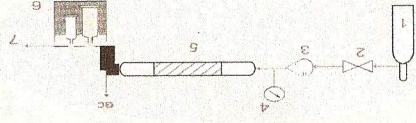
3. AIM AND OBJECTIVES



4. METHODOLOGY

❖ Focus: Co-pyrolysis of bone matter with pistachio, wood and wheat straw in a fixed bed reactor.

❖ Process: The pyrolysis plant was set-up as shown in Figure 3, mixed biomass and bone matter was placed in the fixed bed reactor and heat up to the desired temperature and held for a desired time. Pyrolysis conditions: 300°C, N-flowrate at 60ml/min, holding for 1hr.



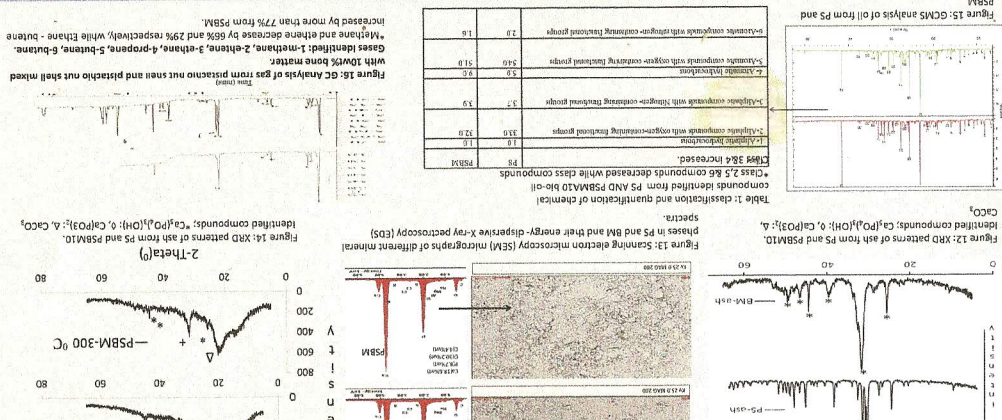
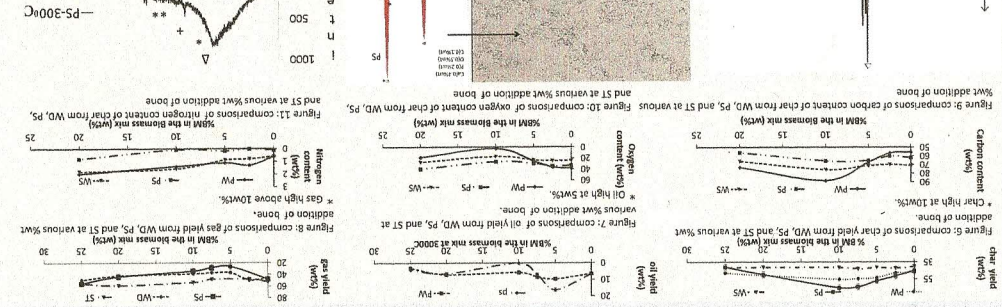
5. RESULTS

Both physical & chemical properties of biomass changes after pyrolysis. The char changes from brown to dark black in colour with anisotropic properties as shown in Figure 4.

Figure 4: Physical appearance of biomass. The figure shows wood pellets before and after pyrolysis. The wood pellets before pyrolysis are light brown and fibrous. The wood pellets after pyrolysis are dark black and more uniform in shape.

Figure 5 port experiment. The figure shows plants grown on soil amended with biochar produced between 300°C-350°C gave higher yield.

RESULTS CONT.



6. PROPOSED MECHANISM

The propose mechanism on the effect of bone matter on the formation of char rich in carbon and nitrogen is based on the results supported by E.A, GC-MS, SEM-EDS and XRD as shown in Figure 17.

Figure 17: Proposed mechanism of effect of bone matter on biomass pyrolysis[2]. The diagram shows the proposed mechanism of the effect of bone matter on biomass pyrolysis. It includes the chemical structures of CH₂OH, C₂(H₂O)₂(OH), and Ca(OH)₂, and the reaction pathways involving dehydration/decarbonylation promoted by CaO.

7. CONCLUSION

The effect of bone matter on the three biomass investigated showed similar behaviour.

❖ At optimum (5wt%-bio-oil, 10wt% for bio-char and >10wt% for bio-gas) addition of bone matter to biomass, biochar and oil yield could be optimized for soil amendment, energy production while retaining solid carbon for sequestration.

❖ In this method, the use of low temperature (300°C) lowers CO₂ emission and primary energy demand, it is cost effective, and environmental friendly as compare to other carbon capture alternative where cost and safety has hinder their application.

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REFERENCES: [1] OENIK, J.L, MCCLELLAN, T, UHARA, G, ANTA, M, J & CAMPBELL, S (2019). Charcoal Volatile Matter Content Influences Plant Growth and Soil Nitrogen Transformations. *Soil Science Society of America Journal*, 14, 1259-1270.

[2] Mohammed Alhassan and John Andresen (2011). Effect of bone during fixed bed pyrolysis of Pistachio nut shell. *J. Fuel Processing Tech.*

[3] Mohammed Alhassan and John Andresen (under review). Effect of bone during fixed bed pyrolysis of Pistachio nut shell. *J. Fuel Processing Tech.*