

# Effects of Re-Usable Organic Materials on Transformation of Soil Organic Matter to Improve Selected Soil Properties and Functions

Doctoral Dissertation by Collins Amoah-Antwi

The thesis deals with the effects of the application of biochar and brown coal waste to soil. Analysis related to the chemical, physical and biological characteristics of these soil amendments were performed in order to evaluate the improvement of soil quality parameters and functions.

Additional environmental and agronomic aspects are evaluated as well.

## **General considerations**

The author has produced a large set of data and several experiments during the PhD track, generating three articles on the topic, plus an additional one dealing with microbial growth following soil amendments.

The publication of most of the data in international renowned journals is the most important aspect of the research work, contributing to the overall maturity of the candidate and also to the international visibility, so reinforcing the personal career.

At the same time, the thesis work is well structured and dense of interesting information. So, I consider that in general the work produced by the candidate is more than acceptable for the final discussion and for reaching the PhD title.

Of course, several comments on the structure and organization of the text are included to my evaluation and reported as follows.

These comments and criticism are meant to contribute to the overall quality of the work and to suggest potential issues of further discussion, analysis and improvement of the work done but mainly on the future work of the candidate.

Most of the comments relate to the way the work has been structured, and paragraphs and concepts have been sequenced along the text.

In addition, several comments are also related to the way the experimental work has been presented more than how the work has been performed.

Many details of the experimental protocols are not very clear at first but they appear only after deductive thoughts by the reader whereas they should be better presented and become immediately evident to the reader.

Further, some extra comments indicate some extra exercise of speculation and reference to selected readings more than elaboration on the data produced during the project.

Some of the results are unfortunately not extremely exciting but this depends also on the time frame of the experiments and the need of longer periods of applications and treatments to see consistent results in this field.

The final evaluation of the thesis is very good in that several publications have been produced and others can come along during the PhD plan selected by the candidate.

At last, this work will be very useful and enable the candidate to develop further research program on this subject.

## **Specific considerations**

### Summary

The first aspect to be considered is the initial description of these materials, which are not primarily amendments but by-products of different industrial processes aiming to various objectives.

The use of additional soils from external trials is not clearly defined.

The aspects related to the amounts of the various amendments is not clear here. Especially, when related to the comparative amount of C, N and/or different elemental contents.

The portion related to the effects of amendments on the chemical properties of soils and, especially, the part related to external soil analysis is not well described and sounds somewhat confused and unclear.

A rational structure of the thesis work, steps and sequential actions are not clearly presented and this aspect does not help the reader to understand the overall research questions and objectives of the work done.

### Introduction

The occurrence and definition of humic acids in biochar and brown coal wastes is not very appropriate, in my opinion. It is better in the introduction, to consider them as organic compounds, biomolecules or humic-like substances, in case they have been isolated and characterized.

## Research Hypothesis

... "II. reusable organic material sources such, as biochar, brown coal waste and farmyard manure, increase SOM contents and, consequently, may be efficient for immobilizing soil contaminants including heavy metals, hence reducing their potential uptake by plants and protecting groundwater resources;"

This research hypothesis affirms somehow that biochar and brown waste is "reusable" material sources, anticipating in a way something that cannot really be demonstrated beforehand. Literature in this field is very abundant and several studies sustain a substantially differing position. So, it is better to leave the "reusability" and "quality" issues to be demonstrated clearly.

## Aims and objectives

The specific objectives II. And III. can merge together:

*II. investigate the effects of biochar and BCW amendment on physicochemical soil properties;*

*III. evaluate the efficacy of biochar and BCW as stable sorbents for reducing the bioavailability of HMs (cadmium (Cd), zinc (Zn) and lead (Pb)) in soil*

## Literature review

No conflicting positions and related papers are including in the literature review. It is also important to cite papers and present opinions diverging from the given one, accepted by the authors; also, in order to present a clear comparison about open positions.

The sentence at page 26 should be better explained. No papers are cited to support the clear statement of BCW modifying the structure of the studied soils:

*"The structural benefits of humic substances from oxidised BCW also improved the structural properties of two soils, Orthic Xerofluvent and Udic Ustochrept, which reportedly reduced soil via erosion loss by 36%. This was largely attributed to an increase in water retention and to some extent, the associated improvement in aggregate stability which together delayed the onset of runoff and favoured water entry into soil through the stable pore spaces within the soil beds."*

## Materials and methods

The structure and the organization should be prepared in a different way.

The analytical methodology of the analysis and the related description should appear after the section on experimental site and organic materials.

In order to have an easy understanding for the reader it should be:

Site description; sampling design, sample collection and pre-treatments; a table to report all the samples to be analyzed; chemical and physical characterization of the samples, at the beginning (the reason is the presentation of the samples at the beginning allows to evaluate differences, specific treats, etc.).

The Experiments description can come later on.

Analytical methodologies should report references of methods and technical aspects reported. The ones reported are not completely sufficient.

A table reporting physico-chemical characteristics of all the soil and organic amendment samples can help to evaluate specific results. The one presented (table 4.2) can be improved adding complete soil analysis. Also, the soil analysis where HA were isolated from are not evident.

It is not clear from the experiment description that the amendments were applied according to dry, fresh weight or by C and/or N content. This makes an enormous difference, and the following description can be strongly affected by that. It is not easy to follow the discussion.

Specific physiological aspects should have been considered in the experiments (germination rate, growth effects, etc. following the treatments).

## **Main findings**

In many studies, the Biochar is water-washed before the use and therefore the occurrence of salts and cations can be due to production processes more than to adsorbed elements.

It is not clear whether the differing analytical characteristics of the organic amendments are compensated by the doses or the amounts added to soil samples. Indeed, the amounts applied appear to be distant from the usual agronomic applications.

Some of the changes may be not permanent but temporary (pH), especially when measured in pot samples.

Most of the comments are speculative and not directly correlated to the observations and data. Unfortunately, results are in general not too exciting and some additional factors and parameters could have been included for a thorough analysis.

Results about the humic acids structural characteristics are not sufficient to reach a large enough set of data to perform a careful evaluation.

In addition, slight variation in spectral shapes related to no statistical treatment are not sufficient to contribute resolving the structural nature of the humic substances (or humic-like substances).

In general, the amendments do not show important improvements in soil parameters, usually considered positively correlated with time.

Also, crop results are linked very much to the mineral fertilizers more than to the studied amendments, even though the variability in crop yields is somewhat very limited.

I declare the doctoral dissertation of Mr. Collins Amoah Antwi entitled: "***Effects of re-usable organic materials on transformation of soil organic matter to improve selected soil properties and functions***" meets the conditions set out in the Act of March 14, 2003 on academic degrees and academic title as well as degrees and title in the field of art (i.e. Journal of Laws of 2003, No. 65, item 595, as amended).

Therefore, I am applying for acceptance of Mr. Collins Amoah Antwi doctoral dissertation and admission to further stages of the doctoral dissertation.



Teodoro Miano