

# Insight into humic substances with cotton straw derived amendments by solid state $^{13}\text{C}$ NMR and FTIR spectroscopy

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## Abstract

Carbon sequestration of organic materials and biochar in soil is a vital way to increase soil organic carbon (SOC), but the stability of SOC especially the humic substances (HS) is different with these amendments. In this study, cotton straw, compost derived from cotton straw (compost) and biochar derived from cotton straw (biochar) were added with equivalent carbon content into soil and incubated for 180 days. The structural characteristics of humic acid (HA), fulvic acid (FA) and humin (Hu) was studied by solid-state  $^{13}\text{C}$  nuclear magnetic resonance (NMR) spectroscopy and Fourier transform infrared (FTIR) spectroscopy. The results showed that the aryl C of Hu and FA increased by biochar treatment or biochar incorporated straw or compost and decreased with low ratio of biochar incorporated straw or compost. In addition, phenolic C of Hu and HA increased by straw treatment or biochar incorporated straw and increased with low ratio of biochar incorporated straw or compost. However, O-alkyl C of Hu and HA increased by compost treatment or biochar incorporated compost and increased with low ratio of biochar incorporated straw or compost. These results suggest that the stability of FA amended with straw or compost can be enhanced by incorporating biochar through increasing aryl functional groups, but the stability of HA amended with straw or compost can be enhanced by incorporating biochar through increasing alkyl groups. Biochar was in favor of aryl C formation of FA and Hu, while straw or compost was beneficial to alkyl C formation of HA and Hu.

## Highlights

1. The chemical recalcitrance of HA, FA and Hu with straw, compost and biochar is different and is also vital for C sequestration in soils.
2. Biochar was in favor of aryl C formation of FA and Hu, while straw or compost was beneficial to alkyl C formation of HA and Hu.
3. The stability of HA amended with straw or compost can be enhanced by incorporating biochar through increasing alkyl functional groups.
4. The stability of FA amended with straw or compost can be enhanced by incorporating biochar through increasing aryl functional groups.

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