Soil Aggregation and Microbial Responses to Straw Pulping Byproducts

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\section*{Abstract}
Incubations studies examined the effects of straw pulping byproducts, black liquor (BL) and fine fiber (FF) on soil aggregation and microbial responses over 30 days. Additions of BL or FF at a rate of 1.5 g C kg\textsuperscript{-1} increased soil respiration, dehydrogenase and \textsuperscript{\textbullet}glucosidase activities, and soil wet stability of macro-aggregates. Compared to BL or FF, fungicide treated BL or FF decreased wet stable macroaggregates; but bactericide treated BL or FF increased wet stable macroparaggregates, suggesting that the fungal activity was likely responsible for macroaggregation. Dehydrogenase and \textsuperscript{\textbullet}glucosidase activities cannot be used as microbial indicators in soils treated with fungicide or bactericide.

\section*{Introduction}
Black liquor (BL) and fine fiber (FF) produced by the pulp and paper industry are an environmental problem when disposed as an industrial waste. Polysaccharides are liable C pools for soil organisms and act as a transient binding agent (Martens, 2000). Lignin is a precursor of humic substances, enhancing soil aggregation (Magill and Aber, 1998). Land use of these byproducts, BL or FF which contains polysaccharides, lignin and phenolic substances should improve soil microbial activity and soil aggregation while offering an environmentally friendly disposal approach.

\section*{Objectives}
\begin{itemize}
  \item To determine the extent of soil aggregate formation due to BL and FF as soil amendments;
  \item To assess the relative importance of fungi and bacteria in soil aggregate formation through selective inhibition of fungi and bacteria;
  \item To study whether soil dehydrogenase and \textsuperscript{\textbullet}glucosidase activities can be used as indicators of microbial activity that promotes soil aggregation when BL or FF-amended soils are treated with fungicide (F) or bactericide (B).
\end{itemize}

\section*{Materials and Methods}
Bluegrass straw was pulped with KOH and H\textsubscript{2}O\textsubscript{2} at a ratio of 10:1:100 (w/w/w) at ambient pressure and 95 °C for 1 hour according to modified Universal Pulping process. BL was separated from each pulped straw and recycled 8 times, and FF was obtained by filtering BL with a 53 \textmu m sieve.

\section*{Results}
\begin{itemize}
  \item Maximum soil macroaggregation occurred later than maximum soil respiration;
  \item BL or FF had immediate effect in increasing wet stable macroaggregation, and macroaggregation increased over 30 days of incubation;
  \item Bactericide treated BL or FF increased soil wet stable macroaggregation, and fungicide treated BL or FF decreased soil wet stable macroaggregation;
  \item Fungal hyphae were observed where macroaggregates were formed;
  \item Dehydrogenase and \textsuperscript{\textbullet}glucosidase activities did not correlate with soil respiration rates.
\end{itemize}

\section*{Conclusions}
\begin{itemize}
  \item BL and FF both increased soil respiration, dehydrogenase and \textsuperscript{\textbullet}glucosidase activities and soil wet stable macro-aggregates;
  \item Fungal activity was likely responsible for wet stable macro-aggregation;
  \item Dehydrogenase and \textsuperscript{\textbullet}glucosidase activities cannot be used as microbial indicators of soils receiving biocides (fungicide or bactericide or both).
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\section*{References}
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