

## ABSTRACT

**Introduction:** The aggressive search for renewable energy resources and essential pyrosynthetic compounds has marked an exponential rise in the thermal degradation of biomass materials. Consequently, clean and sustainable transport fuels are increasingly desirable in a highly industrialized economy, for energy security and environmental protection. For this reason, biomass materials have been identified as promising alternatives to fossil fuels despite the challenges resulting from the possible formation of toxic nitrogen-based molecules during biomass degradation. In order to understand the free radical characteristic challenges facing the use of bio-oil, a brief review of the effects of free radicals in bio-oil is presented.

**Methodology:** Pyrolysis was conducted in a tubular flow quartz reactor at a residence time of 2 s at 1 atm. pressure, for a total pyrolysis time of 5 min. The thermal degradation of biomass components was investigated over the temperature range of 200 to 700 °C typically in 50 °C increments under two reaction conditions; pyrolysis in N<sub>2</sub> and oxidative pyrolysis in 5% O<sub>2</sub> in N<sub>2</sub>. The pyrolysate effluent was analysed using a Gas chromatograph hyphenated to a mass selective detector (MSD).

**Results:** The yield of levoglucosan in the pyrolysis of cellulose in the entire pyrolysis temperature range was 68.2 wt % under inert conditions and 28.8 wt % under oxidative conditions. On the other hand, formaldehyde from pyrolysis of cellulose yielded 4 wt % while that from oxidative pyrolysis was 7 wt % translating to ~ 1.8 times higher than the yield from pyrolysis. Accordingly, we present for the first time dioxin-like and dibenzofuran-like nitrogenated analogues from an equimassic pyrolysis of cellulose and tyrosine. Levoglucosan and formaldehyde were completely inhibited during the equimassic pyrolysis of cellulose and tyrosine.

**Conclusion:** Clearly, any small amounts of N-biomass components such as amino acids in cellulosic biomass materials can inhibit the formation of levoglucosan-a major constituent of bio-oil. Overall, a judicious balance between the production of bio-oil and side products resulting from amino acids present in plant matter should be taken into account to minimize economic losses and mitigate against negative public health concerns.

**Keywords:** Bio-oil; Cross-reactions; Dibenzofuran-like analogues; Emerging pollutants; Free radical species.