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P.II.4 — Thermal pyrolysis of grape stalk under inert and pressurised hydrogen atmospheres: effect of reactor configuration on bio-product distribution

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Poster Presentations #30

P.II.4 — Thermal pyrolysis of grape stalk under inert and pressurised hydrogen atmospheres: effect of reactor configuration on bio-product distribution

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Keywords: *Grape stalk; biomass valorisation; Pyrolysis; Pressurised hydrogen*

Winemaking generates 10.5-13.1 million tonnes of solid by-products worldwide each year [1]. Grape stalks are a largely underexploited lignocellulosic stream whose high lignin and cellulose content makes them an attractive renewable carbon source for the biorefineries. Pyrolysis offers a flexible, scalable route to valorise this biomass into bio-oil, gas, and biochar.

Grape stalks from a local Madrid winery (volatile matter ~65 wt.%, ash ~5 wt.%) were pyrolysed in upflow (UF) and downflow (DF) fixed-bed configurations at 550 °C, comparing two atmospheres: inert nitrogen at atmospheric pressure (1 bar/N_2) and pressurised hydrogen (6 bar/H_2).

The main product yields are presented in Figure 1A. In the UF, changing the atmosphere slightly affected the product distribution, reducing char formation in favour of gas production. Under 1 bar/N2, the DF yields ~19 wt.% bio-oil, over three times the UF value, owing to shorter vapour residence time minimising secondary cracking. Nevertheless, the undetected GC-MS fraction under DF/N2 (Figure 1B-inset), reaches the largest value across all conditions, consistent with significant lignin-derived oligomer formation. Pressurised H2 (6 bar) in DF reactor, strongly suppresses this advantage, converging bio-oil yields to ~6 wt. %, while promoting partial deoxygenation and hydrocracking of heavy oligomers into lighter detectable compounds, mainly gas. Oxygenated aromatics (O-AR), though minor, appear only in the DF, suggesting that the shorter vapour residence time preserves these primary lignin-derived products, which under the longer UF contact are likely further deoxygenated or repolymerised into heavier, GC-undetectable fractions. Overall, N2 in DF maximises bio-oil along with acids, light oxygenates, and furans, pressurised H2 shifts conversion towards lighter products and nearly eliminates furans via hydrodeoxygenation. This demonstrates that atmosphere and reactor configuration act as complementary levers for tailored bio-product distributions from grape stalks.

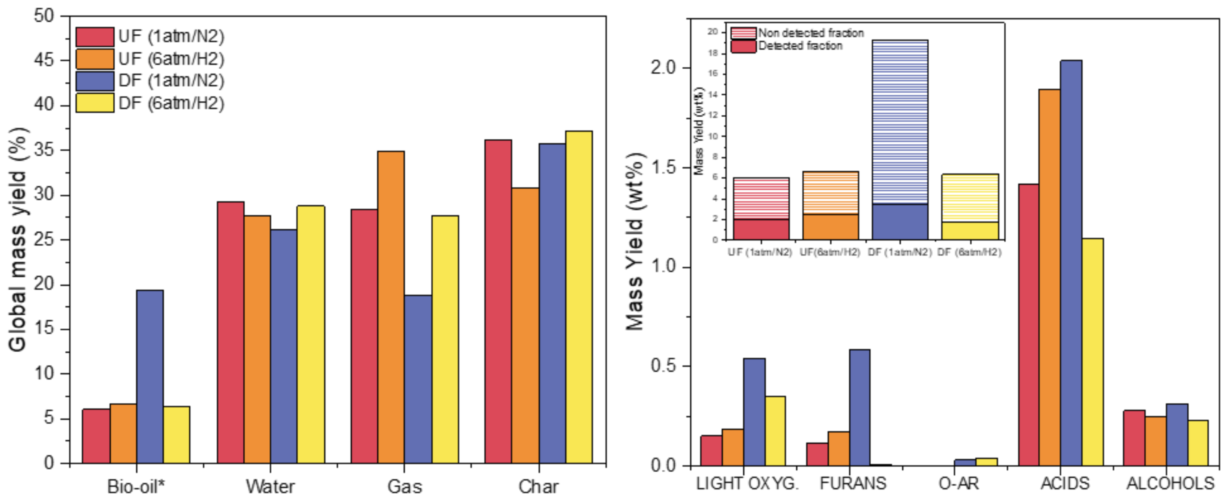

Figure 1. Global bio-oil, water, gas and char yields (a) and bio-oil fraction yields by GC-MS (b) for all four pyrolysis conditions.

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