Silver NPs dispersed water extract of fly ash as green and efficient medium for oxidant-free dehydrogenation of benzyl alcohols

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TEM image of spent catalyst:

![TEM image of spent Ag@WEFA catalyst](image)

**Fig.S1.** TEM images of the spent Ag@WEFA catalyst
Spectral & analytical data of compounds:

(1a) **Benzaldehyde**: Colourless liquid; $^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 9.71 (s, 1H), 7.59 (m, J= 7.4 Hz, 2H), 7.30 (t, 1H), 7.19 (t, 2H).

(2a) **4-Methylbenzaldehyde**: Colourless liquid; $^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 9.57 (s, 1H), 7.37 (d, J = 7.2 Hz, 2H), 6.87 (d, J= 7.2 Hz, 2H), 1.96 (s, 3H).

(3a) **4-Chlorobenzaldehyde**: Colourless solid; m.p.50°C; $^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 9.98 (s, 1H), 7.83 (d, J = 7 Hz, 2H), 7.51 (d, J = 6.5 Hz, 2H).

(4a) **4-Nitrobenzaldehyde**: Pale yellow solid; m.p.105°C; $^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 10.18 (s, 1H), 8.41 (s, 1H), 8.12 (d, J = 6.5 Hz, 1H), 8.09 (d, J = 6.5 Hz, 1H), 7.30 (t, J = 6 Hz, 1H).

(5a) **4-Hydroxybenzaldehyde**: Colourless solid; m.p.112°C; $^1$H (400 MHz, CDCl$_3$): $\delta$ 9.83 (s, 1H), 7.80 (d, J = 8.4 Hz, 1H), 6.95 (d, J = 8.4 Hz, 1H).

(6a) **4-Dimethylaminobenzaldehyde**: Yellowish white powder; m.p. 72°C; $^1$H (400 MHz, CDCl$_3$): $\delta$ = 9.79 (s, 1H), 7.79 (d, J = 7.5 Hz, 2H), 6.75 (d, J = 7.5 Hz, 2H), 3.12 (s, 6H).

(7a) **4-Methoxy benzaldehyde**: Colourless liquid; $^1$H (400 MHz, CDCl$_3$): $\delta$ 9.86 (s, 1H), 7.83 (d, J = 7.0 Hz, 2H), 7.80 (d, J = 8.0 Hz, 2H), 3.92 (s, 3H).

(8a) **4-Florobenzaldehyde**: Colourless liquid; $^1$H (400 MHz, CDCl$_3$): $\delta$ 7.19-7.24 (m, 2H), 7.90-7.94 (m, J = 5.8 Hz, 2H), 9.97 (s, 1H).

(9a) **4-Bromobenzaldehyde**: Colourless solid; m.p. 56-57°C; $^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 9.98 (s, 1H), 7.76 (d, J = 6.4 Hz, 2H), 7.70 (d, J = 6.4 Hz, 2H).

(10a) **3-Chlorobenzaldehyde**: Colourless liquid; $^1$H NMR (CDCl$_3$) $\delta$ 9.93 (s, 1H) 7.76 (s, 1H), 7.72 (d, J = 6.5 Hz, 1H), 7.50 (d, J = 7.0 Hz, 1H), 7.42 (d, J = 6.5 Hz, 1H).
(11a) 3-Bromobenzaldehyde: Yellow liquid; $^1$H NMR (400MHz, CDCl$_3$) δ=9.96 (s, 1H), 7.61 (s, 1H), 7.50 (d, J = 7.5 Hz, 1H), 7.38 (d, J = 7.0 Hz, 1H), 7.11 (d, J = 7.5 Hz, 1H).

(12a) 3-Nitrobenzaldehyde: Yellow solid; m.p. 58°C; $^1$H NMR (CDCl$_3$) δ 10.13 (s, 1H), 8.71 (s, 1H), 8.49 (d, J = 7.5 Hz, 1H), 8.25 (d, J = 7.5 Hz, 1H), 7.80 (t, J = 7.5 Hz, 1H).

(13a) 2-Chlorobenzaldehyde: Colorless liquid; $^1$H NMR (400MHz, CDCl$_3$) δ10.33 (s, 1H), 7.78 (m, 1H), 7.75 (m, 1H), 7.34 (m, 1H), 7.27 (m, 1H).

Fig.S2. $^1$H NMR spectrum of compound (1a) in CDCl$_3$. 

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Fig.S3. $^1$H NMR spectrum of compound (2a) in CDCl$_3$. 
Fig. S4. $^1$H NMR spectrum of compound (3a) in CDCl$_3$. 
Fig.S5. $^1$H NMR spectrum of compound (4a) in CDCl$_3$. 
Fig. S6. $^1$H NMR spectrum of compound (6a) in CDCl$_3$. 
Fig. S7. $^1$H NMR spectrum of compound (7a) in CDCl$_3$. 
Fig. S8. $^1$H NMR spectrum of compound (9a) in CDCl$_3$. 
Fig. S9. $^1$H NMR spectrum of compound (10a) in CDCl$_3$. 
Fig. S10. $^1$H NMR spectrum of compound (11a) in CDCl$_3$. 
Fig.S11. $^1\text{H}$ NMR spectrum of compound (12a) in CDCl$_3$. 
Fig.S12. $^1$H NMR spectrum of compound (13a) in CDCl$_3$.

Table.S1: Recyclability of the catalytic system comprising Ag@WEFA

| Entry | Run | Time (h) | Yield (%) |
|-------|-----|----------|-----------|
| 1     | 1$^{st}$ | 3 | 96 |
| 2     | 2$^{nd}$ | 3 | 94 |
| 3     | 3$^{rd}$ | 3.5 | 93 |
| 4     | 4$^{th}$ | 3.5 | 92 |
| 5     | 5$^{th}$ | 4 | 90 |

Reaction conditions: 4-methylbenzyl alcohol (1 mmol), Ag@WEFA (3 mL), reaction temperature 70 °C, N$_2$ atmosphere