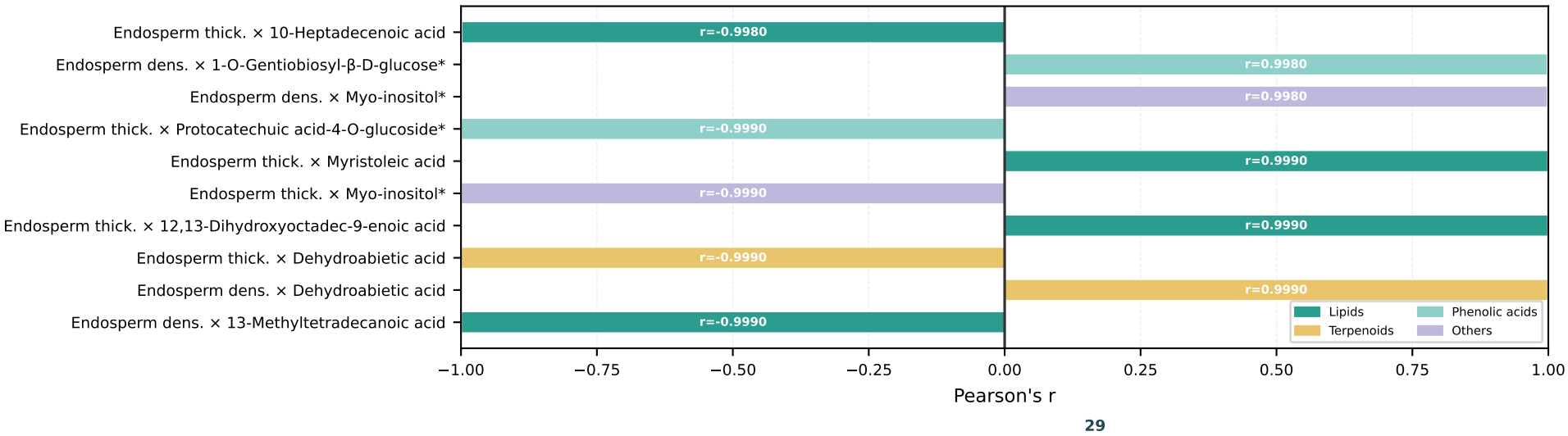
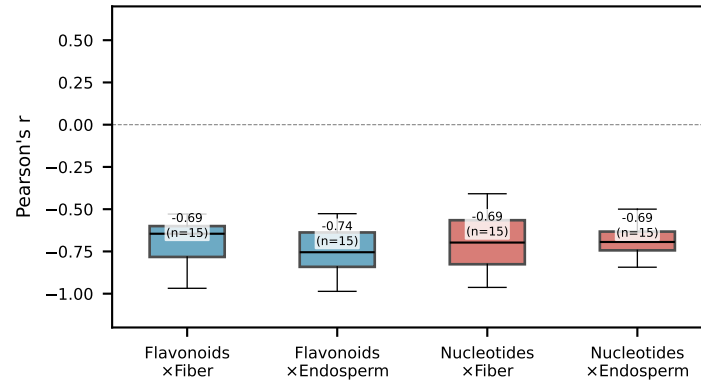


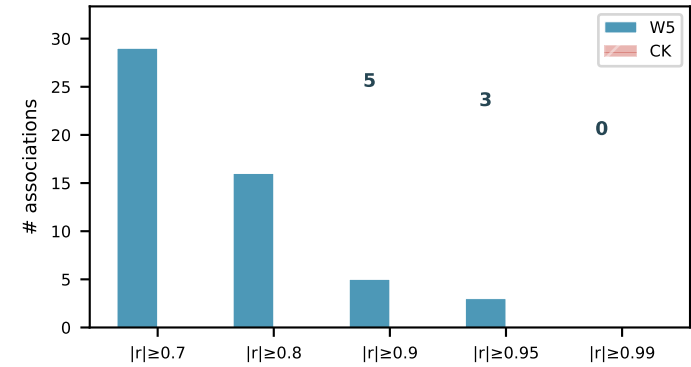
A Top CT-metabolite associations by |r|



B Class-level correlation patterns



C Asymmetry: W5 vs CK



D Integrated interpretation

Total significant (FDR $q < 0.05$): 3,376 in W5 | 55 pairs at $|r| > 0.99$ | 29 at $|r| > 0.995$

Key pathway insights:

- Flavonoids anti-correlate with structural density (mean $r = -0.83$ fiber, -0.78 shell, -0.71 endosperm)
 - Defence declines as structural tissue develops
- Nucleotides correlate with endosperm density (mean $r = +0.88$ with endosperm density)
 - Growth metabolism fuels solid endosperm formation
- Citric acid × shell thickness ($r > 0.99$)
 - TCA cycle linked to oxalate/mineralisation

Canalisation diagnostic:

- CK: zero at $|r| \geq 0.7$ | stark asymmetry between W5 and CK
- Genetic homogeneity canalises development (W5) vs heterogeneity dilutes signal (CK)