

## Interactive effects of polyphenols and artificial cell walls on starch transitions and starch and polyphenol bioaccessibility

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Starch, dietary fibre, and polyphenols are key components of plant-based foods whose coexistence in carbohydrate-rich matrices underpins both structure and nutrition. While increasing attention has been given to pairwise interactions among these components [1-3], their combined (three-way) interactions remain poorly understood and are rarely captured in real food systems or clinical studies [4]. At the core of these three-way interactions lies competitive binding. Fibre-phenolic and starch-phenolic associations compete with phenolic-enzyme binding, which underpins phenolics' inhibitory activity [5]. Conversely, phenolic-enzyme and starch-phenolic interactions compete with fibre-phenolic binding, potentially causing fibre aggregation and viscosity loss [6]. Similarly, starch-phenolic binding, which influences starch structure and digestibility, can shift under competition with fibre-phenolic interactions [7]. Understanding such complexity requires representative study models capable of reproducing both the chemical diversity of phenolics and the supramolecular architecture of plant cell walls. To this end, a controlled model system was developed using wheat starch, a bacterial cellulose analogue of the apple cell wall (aACW), and an apple pomace polyphenol extract, ensuring consistent starch-aACW-polyphenol ratios. Blends - starch + polyphenols (S-PP), starch + aACW (S-aACW), starch + aACW + polyphenols (S-aACW-PP), and starch + polyphenol-preloaded aACW [S-(aACW:PP)] - were subjected to simulated hydrothermal processing (RVA), storage, and *in vitro* digestion using the INFOGEST model with pooled human saliva. Results highlight the pivotal role of cell wall-polyphenol interactions in modulating starch and phenolic functionality in starch systems, with competitive binding as a key mechanism. Polyphenol retention by cell walls reduced their effects on starch swelling, retrogradation, and digestibility, while fibre-phenolic binding protected polyphenols from degradation but limited their intestinal release. Overall, this study provides critical insights into how the texture, stability, and metabolic impact of polyphenol-fortified, fibre-rich foods, such as fruit and vegetable pomace ingredients, depend on the interactions between polyphenols and cell wall structures.

### Keywords:

Starch, Dietary fiber, Polyphenols, In vitro digestión, Component interactions, Competitive binding

### References:

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