

Rheological Stability and Changepoint Detection of IDDSI Level 3 Diets under 37°C Saliva Simulation

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Background

- IDDSI Level 3 (L3) dysphagia diets can drift in texture during oral processing as the bolus warms toward 37°C and mixes with alpha-amylase-containing saliva. Early viscosity loss may reflect thermal equilibration and physical dilution, whereas later acceleration may indicate enzyme-driven matrix breakdown, a dynamic poorly captured by single time-point bedside tests.

Objective

- To compare seconds-resolved rheological stability of three L3 matrices under a controlled 37°C saliva simulation and quantify nonlinear time-to-failure using a changepoint-based metric as an index of the temporal margin before structural collapse.

Method

- L3-compliant rice porridge (starch-based), commercial cream yogurt, and water thickened with a commercial xanthan gum/dextrin-based thickener were tested on a rotational rheometer pre-equilibrated to 37°C. At 20 s, artificial saliva containing alpha-amylase or distilled water control was injected in situ at a 9:1 sample ratio (~10% dilution) under continuous stirring (60 rpm; shear rate 55.8 s⁻¹, selected to approximate oral processing). Apparent viscosity was recorded continuously for 10 min. Independent triplicate runs were performed for each matrix and condition. Responses exceeding the instrument's torque-limited range were recorded as an upper-limit plateau. Changepoints were identified by piecewise regression to estimate the onset of accelerated viscosity decline.

Results

For rice porridge, baseline viscosity reached the instrument's torque-limited upper plateau. Following distilled water injection, viscosity fell below this limit within ~10 s, consistent with physical dilution. In contrast, across triplicate runs, artificial saliva produced a prolonged upper-limit plateau (~50 s) under the torque-limited condition, followed by a distinct changepoint at ~70 s. After this point, accelerated enzymatic thinning reduced viscosity to an average of 81 cP by 10 min. Despite containing dextrin, the xanthan-based thickener maintained stable viscosity (~240 cP) with no detectable changepoint. Yogurt exhibited a brief saliva-associated accelerated decay window (30–45 s), then a gradual viscosity decline.

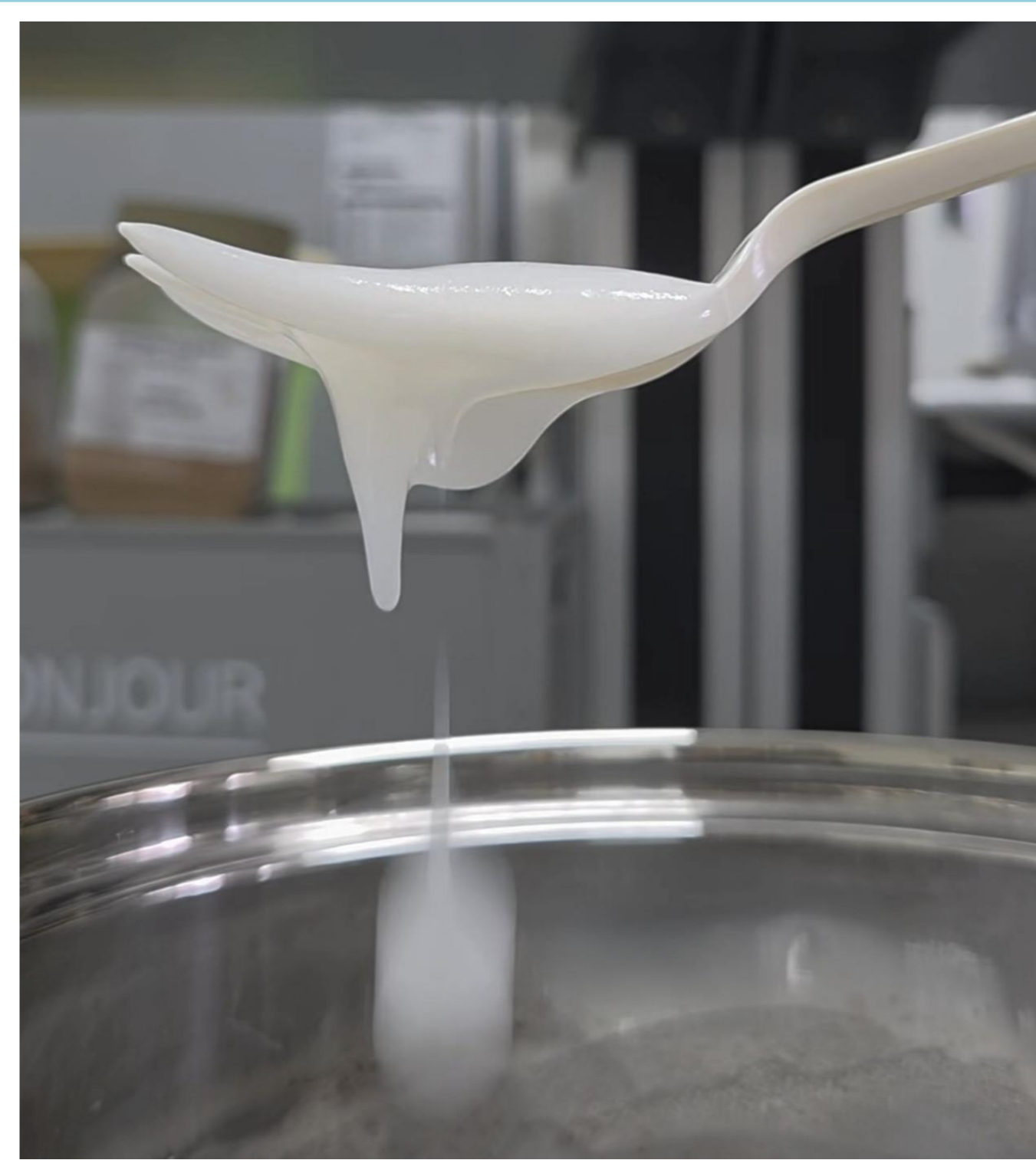


Figure 2. Rice porridge met IDDSI Level 3 by fork drip test despite an upper-limit apparent viscosity plateau at baseline under the selected rheological condition.



Figure 3. Xanthan gum-thickened water met IDDSI Level 3 by flow test despite relatively low apparent viscosity at the selected shear condition.

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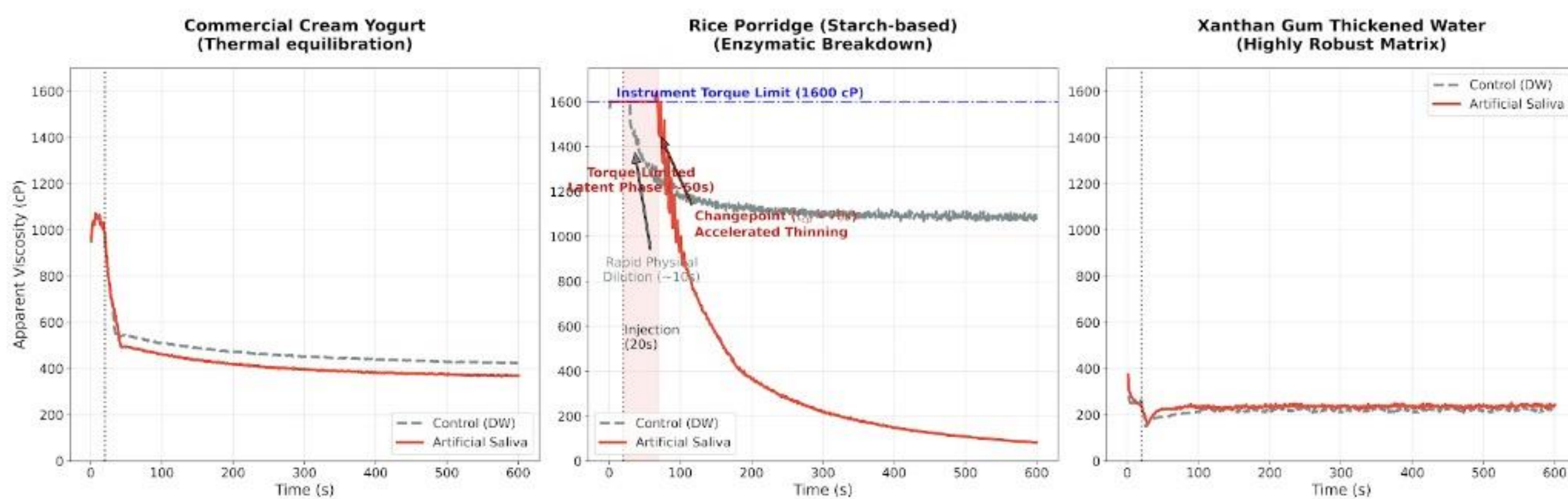


Figure 1. Seconds-resolved rheological trajectories under 37°C saliva simulation reveal matrix-dependent stability and a distinct changepoint in starch-based porridge.

Conclusion

- Under a 37°C saliva simulation, L3 diets demonstrated matrix-dependent, time-varying stability. Starch-based porridge exhibited a transient latent phase followed by rapid structural collapse, whereas xanthan/dextrin-thickened water remained robust and yogurt showed a brief destabilization window followed by gradual thinning. These findings highlight the need for time-aware feeding protocols, particularly when starch-dominant diets are used in patients with prolonged oral processing time, and support development of enzyme-resistant food matrices with greater stability against texture drift. Future studies evaluating non-viscosity parameters such as adhesiveness and cohesiveness are warranted to clarify bolus safety and pharyngeal residue risk.

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