

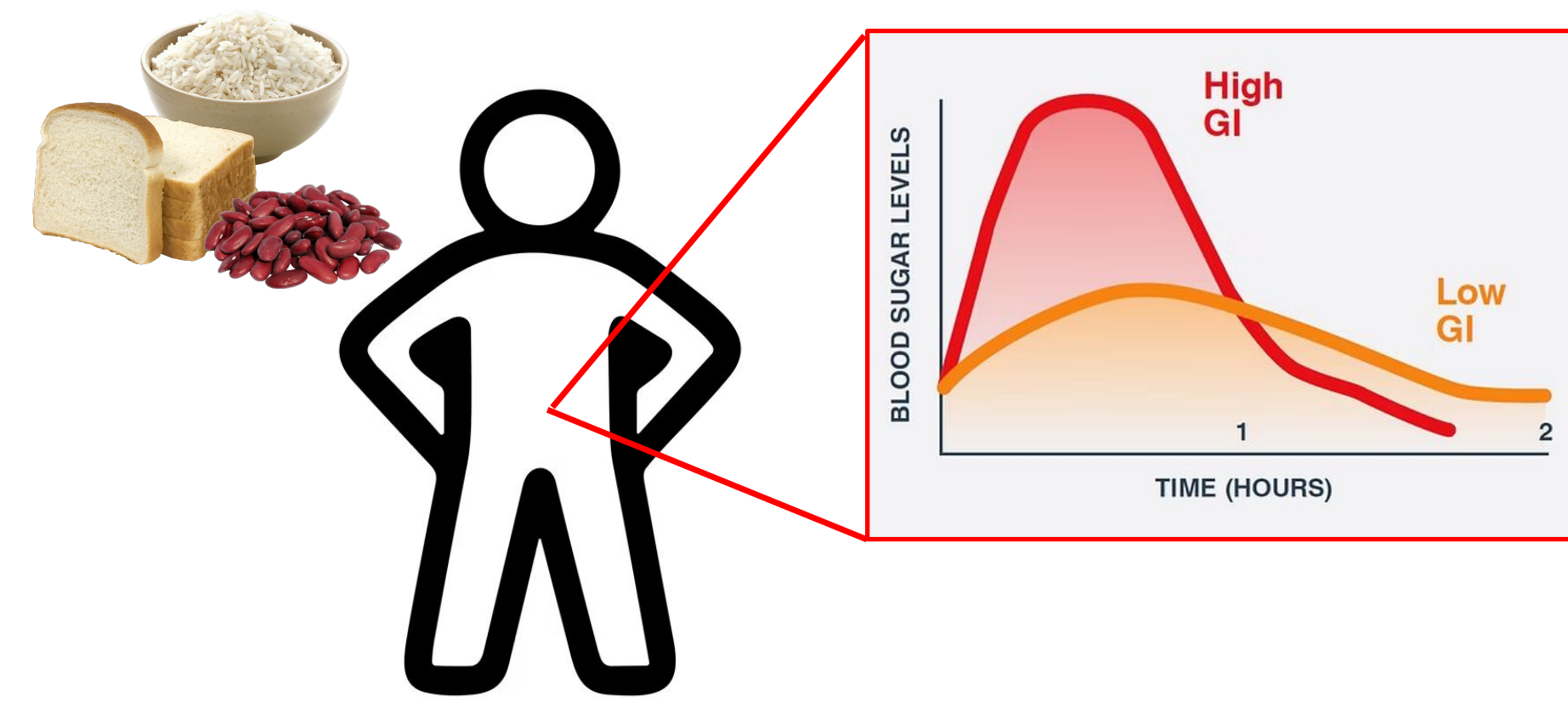
Food is the best medicine: developing starch with controlled digestion

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BACKGROUND

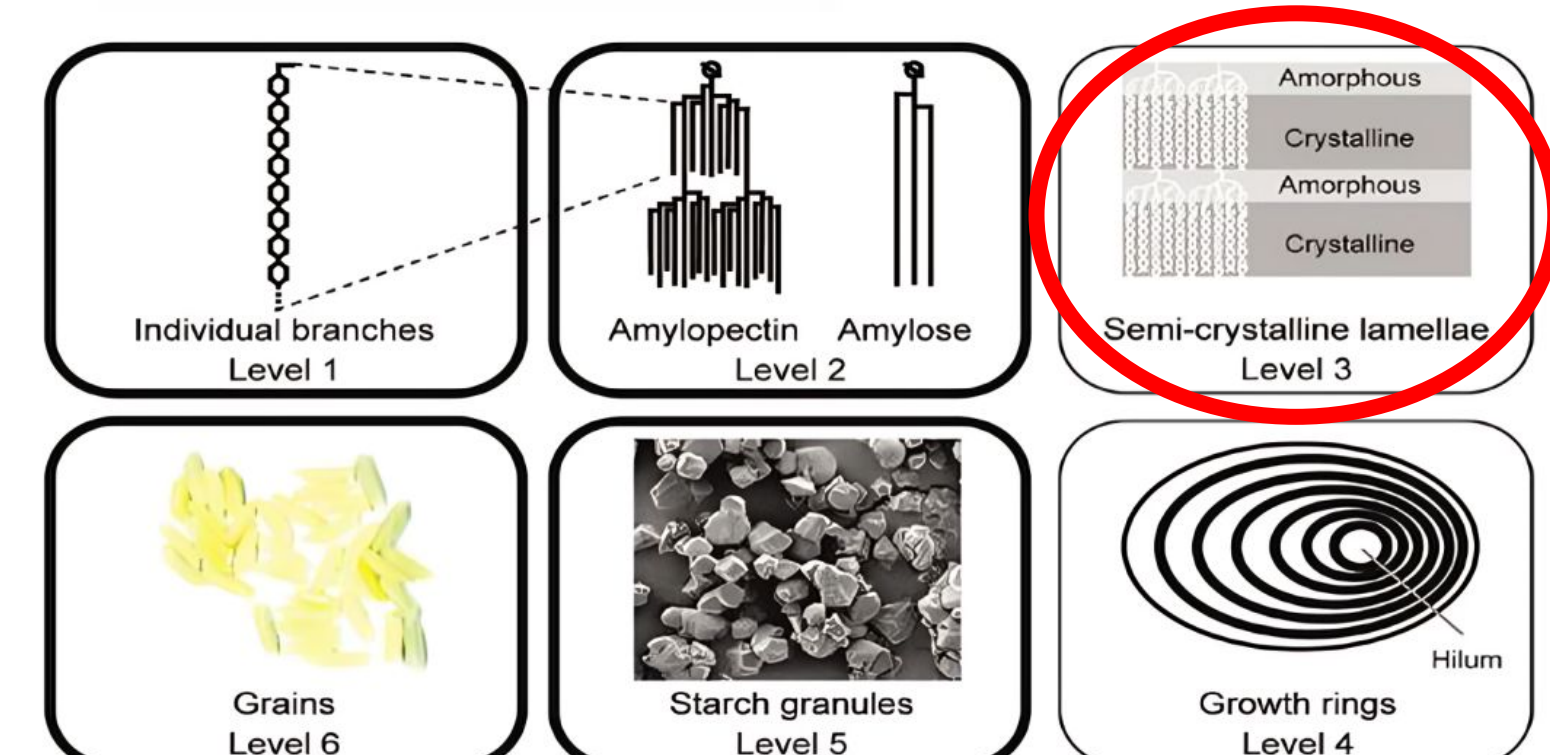
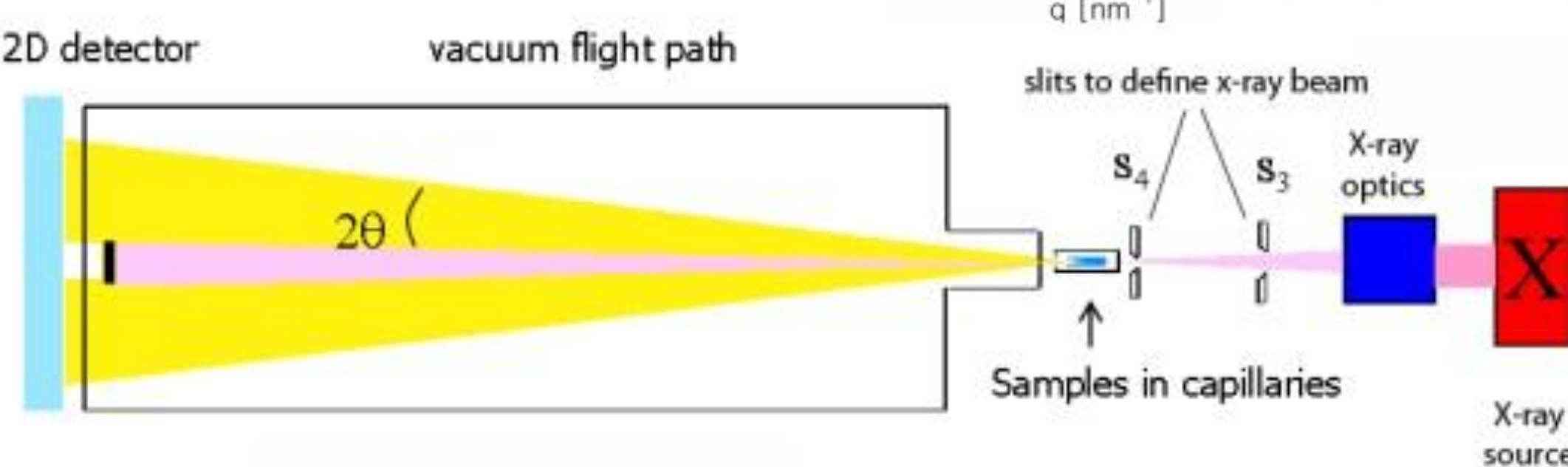
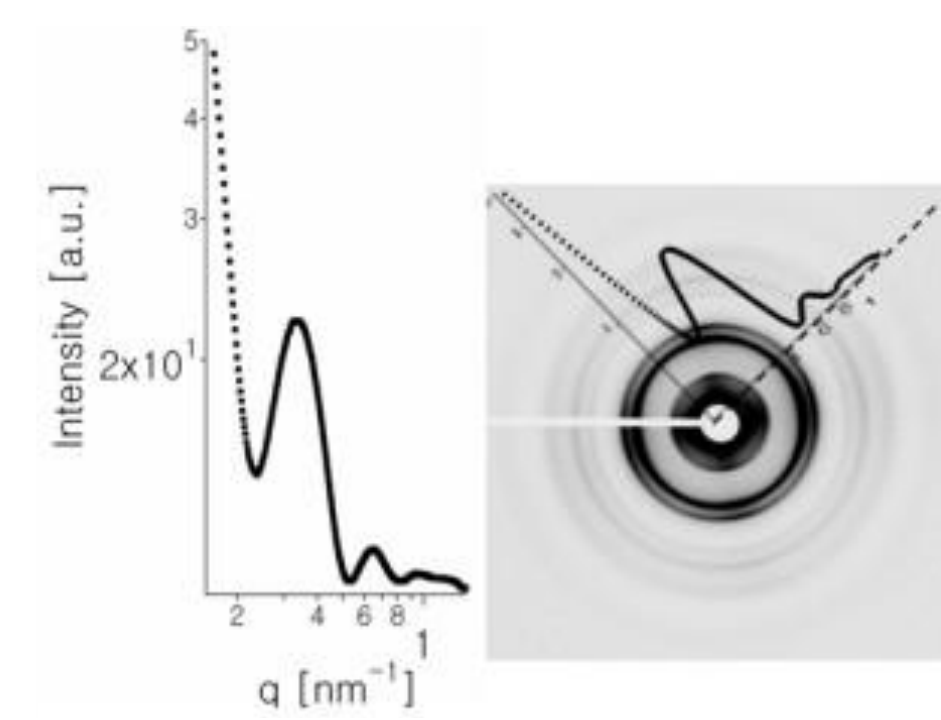
- Starch's **rate and extent of digestion** depend strongly on its **molecular and physical structure**.
- Resistant starch (RS)**: not digested in small intestine, reaches the large intestine → fermented by gut microbiota into **short-chain fatty acids (SCFAs)** that support intestinal health and regulate host metabolism (Han et al., 2023).



GOAL: to understand how **scratch nanostructure** governs **digestibility** for developing healthier carbohydrates sources

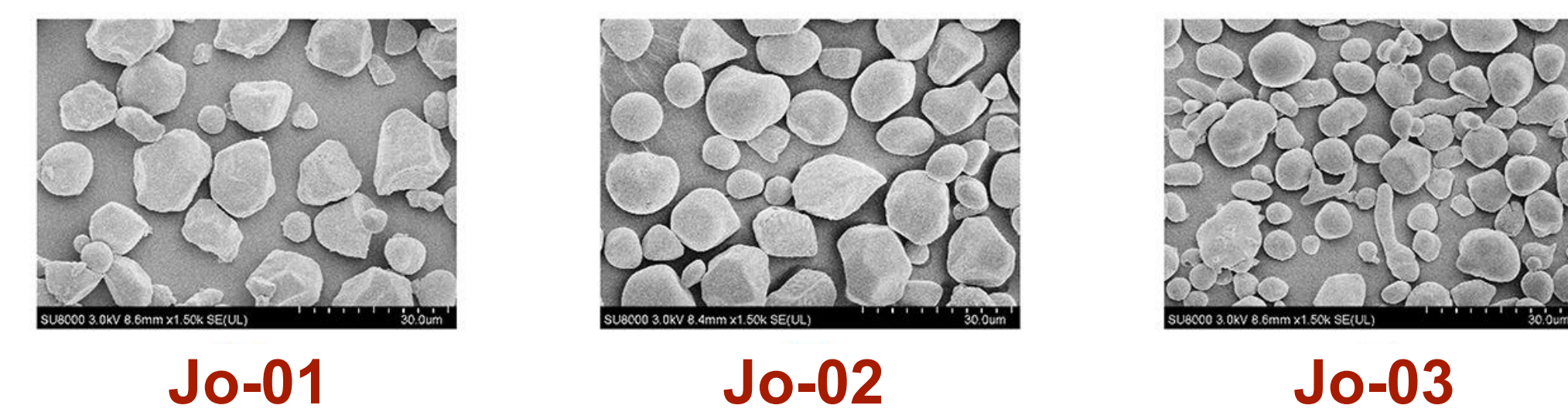
APPROACH

- Scattering techniques**
- Shine a very fine beam of **X-rays (or neutrons)** at sample and observe how the **beam bounces off** the internal structures.
- Examine materials without cutting or damaging the sample.



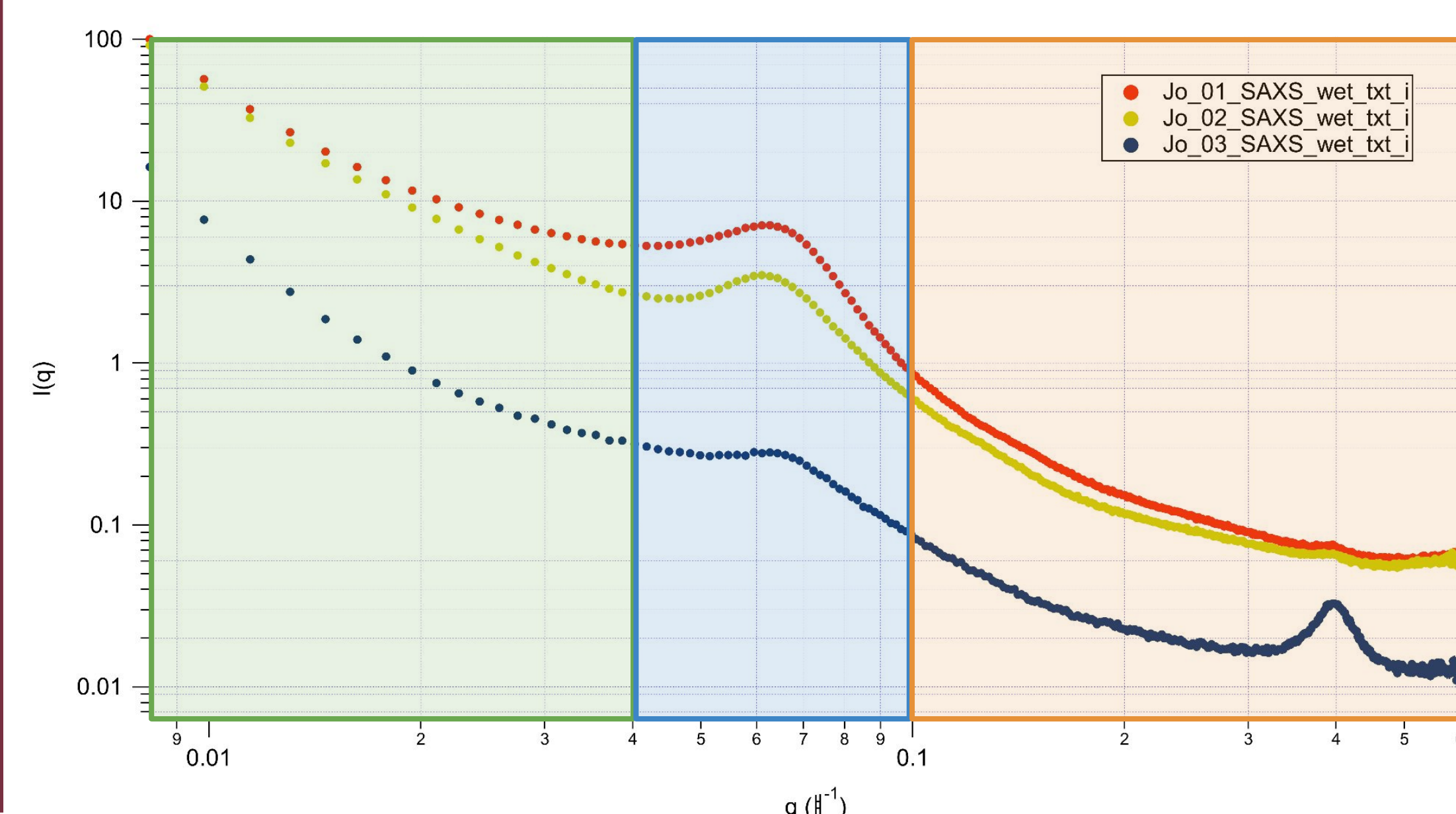
SAMPLE

- Jo-01: Waxy maize (amylopectin-rich)** → less dense packing, highly branched, short chains.
- Jo-02: Normal maize** → amylopectin + amylose, mixed branched and linear chains.
- Jo-03: High-amylose maize** → more linear chains, stronger inter-chain alignment, high packing density, strong crystalline domains.
- 13% moisture**

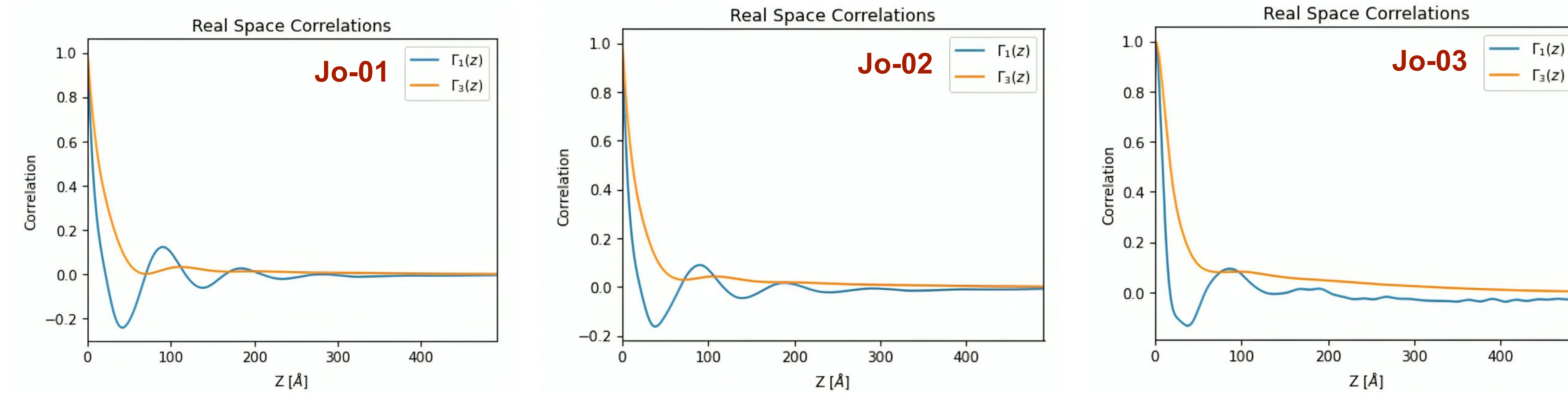


RESULTS

- Low-q region** (0.01-0.04 Å⁻¹):
 - Jo-01 has the highest intensity, while Jo-03 shows lower intensity → Jo-03 has a denser packing.
- Mid-q region** (0.04-0.1 Å⁻¹):
 - Broad **correlation peak**
 - Jo-03's peak is **weak and broad**, while Jo-01 has the strongest peak → Jo-01 has **more regular layering**, while Jo-03 is **denser** but less layered.
- High-q region** (≥ 0.1 Å⁻¹):
 - All curves decay smoothly
 - At Jo-03, there is a **short-range order peak**. → shows **strong crystalline** or pseudo-crystalline packing; enzymes have a harder time accessing these regions.



RESULTS



- Jo-01: strongest oscillations and highest amplitude peaks, well-defined lamellar periodicity** but **rapid decay** of correlation length → ordered yet loosely packed structures.
- Jo-02: reduced oscillation amplitude and moderate decay** → aligns with moderate digestibility.
- Jo-03: weaker lamellar oscillations but stronger short-range ordering and denser packing, reduced low-z intensity and damped peaks** → compact crystalline domains.

CONCLUSION

- Increasing **amylose content** increases **packing density** and **structural order**, and limiting enzymatic accessibility.
 - Waxy maize:** promotes enzymatic accessibility and rapid digestion.
 - Normal maize:** intermediate ordering and digestibility.
 - High-amylose maize:** shows resistance to digestion and restricts enzyme penetration (resistant starch).

OUTLOOK

- Results here are based on 13% moisture but real foods undergo multiple processing effects (cooking, fermentation, ...) **Future researchers** should investigate how each treatment alters the starch's **crystalline order** and **enzymatics penetration pathways**.
- Advancing structure-based design of starch offers a pathway to **develop carbohydrate foods** with **tailored** digestion profiles, **supporting** metabolic health and **reinforcing** the concept of food as **preventive medicine**.

REFERENCES

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