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Supramolecular characterisation of starch in rice by NMR, SAXS and XRD

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Rice has fed more people over a longer period of time than any other grain [1] and currently provides 85 % of the energy intake to over half the world's population [2]. This makes it a suitable vehicle to help manage weight and obesity-related illnesses, especially type 2 diabetes and colorectal cancer.

Starch is the major component of rice (~90 %) and its supramolecular structure is known to affect rice digestibility. However, starch is one of the most complex materials found in nature with six known hierarchical levels of structure [3]. In rice, starch granule heterogeneity and its influence on digestibility depends upon genetic makeup, environmental influences (between geographical locations and seasons) and processing (such as milling and cooking).

Multiple levels of starch structure in cooked and raw rice were characterised to better understand how starch structure affects digestibility. Long range crystallinity was characterised by powder X-ray diffraction (XRD). Smaller scale crystalline structure in the form of helix content was assessed by 13C solid-state nuclear magnetic resonance (NMR) spectroscopy. The semi-crystalline lamellar structure of starch in rice was characterised by small angle X-ray scattering (SAXS) [4]. Complementary to SAXS, small angle neutron scattering (SANS) is a powerful technique in the analysis of soft condensed matter [5]. Sample versatility and solvent contrast makes SANS especially attractive in the analysis of granular starches under conditions relevant to food such as cooking [6]. Molecular mobility was also assessed by 1H solid-state NMR, determining the $T2$ relaxation time of starch in cooked rice.
This work aims to characterise the structural features of starch in a range of rice varieties, and to relate this information to rice digestibility. It is expected that the supramolecular structure of starch in rice will have a significant influence on the digestion of rice.

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Primary author(s) : Mr VAN LEEUWEN, Matthew (Western Sydney University)

Co-author(s) : Dr MATA, Jitendra (ANSTO); Prof. GILBERT, Elliot P. (ANSTO); Dr WUHRER, Richard (Advanced Materials Characterisation Facility (AMCF), Western Sydney University); Dr WARD, Rachelle (NSW

Department of Primary Industries); Dr CASTIGNOLLES, Patrice (Australian Centre for Research on Separation Science, Western Sydney Unviersity); Dr GABORIEAU, Marianne (Medical Sciences Research Group, Western Sydney University)

Presenter(s) : Mr VAN LEEUWEN, Matthew (Western Sydney University)

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