Modulating molecular and structural arrangement of starch for controlled digestion using vitamins

Pallab Kumar Borah1, 2, Raj Kumar Duary2, and Anwesha Sarkar1

*1Food Colloids and Processing Group, School of Food Science and Nutrition, University of Leeds, LS2 9JT, United Kingdom*

*2Department of Food Engineering and Technology, School of Engineering, Tezpur University, Napaam, Assam, 784 028, India*

Controlled starch digestion is believed to provide a slow postprandial rise in blood glucose level, leading to low glycemic index, which is needed for people suffering from food-associated diseases, such as obesity, diabetes, and cardiovascular disease. This study presents a novel tool to impact the gastrointestinal digestibility of high amylopectin corn starch by vitamin B9 grafting at 0-30 wt % of starch dry weight. Vitamin B9 was grafted to starch using dicyclohexylcarbodiimide and 4-dimethylaminopyridine chemistry and the grafting efficiency (%) was higher than 90 for all the samples. A combination of Fourier transform infrared spectroscopy (FT-IR), confocal laser scanning microscopy (CLSM), dynamic light scattering (DLS), ζ-potential measurements and in vitro digestibility were performed to follow the effect of such grafting. Deconvoluted FT-IR spectra revealed that the ratio of absorbances at 1047 to 1022 cm−1 decreased and 1022 to 995 cm−1 increased with 0-30 % Vitamin B9 grafting, suggesting a change in the molecular order and crystalline structures. An increase in the peak at 947 cm-1 indicated the formation of V-type complexes typical in the presence of copolymers. The CLSM revealed uniform binding of Vitamin B9 to the starch supramolecular assembly. Increased degree of grafting from 0-30 wt % led to a reduction in the hydrodynamic diameter of the starch with a wider size distribution and gradually reduced the ζ-potential suggesting anionic nature of the product as compared to the non-ionic corn starch. Slowly digestible starch content increased by > 10% in the Vitamin B9 grafted product. We postulate that the reduction in granule hydrodynamic diameter and enzymatic digestion for the vitamin grafted product might be due to the enhanced molecular interactions, electrostatic changes and tight binding among units acting as a barrier to enzyme diffusion. These results suggest that grafting vitamin B9 to starch can be a promising tool to induce electro-structural changes in starch, which in turn can enable to modulate starch digestion.