### Tuning functional properties by starch by a combination of enzymatic treatment and infrared processing

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It is now well acknowledged that reducing the swelling of starch may increase the strength of the starch-based gel whilst limiting the accessibility of digestive enzymes to the starch chains, resulting in a reduction in starch digestibility and therefore reduced calorific gains. Often heat processing is an approach used to achieve such reduction in swelling behaviour of starch. This study investigates for the first time the effect of infrared (IR) thermal treatment (220 oC/3 min/ 30 % moisture) and combination of enzymatic processing (5 h papain+ 3/5/7 h pullulanase) with IR on structural, physicochemical, and functional characteristics of sorghum corneous endosperm starch. The native sample exhibited high swelling power (SP) and solubility index (SI), however lacked the structural stability. IR treatment alone moderately reduced SP by 10.74%, indicating limited starch granule modification. Among the dual enzyme and IR treatments, 5IR (5h pullulanase treatment + IR) showed the most pronounced reduction in SP (20.58%) and SI (47.85%), signifying superior granule integrity due to enzymatic debranching and thermal restructuring. Microscopic analysis revealed the native sample had polygonal granules with smooth surfaces, while IR treatment resulted in central depressions, indicating partial restructuring. Dual treatments, 3IR (3h pullulanase + IR) and 7IR (7h pullulanase + IR), altered granule shape with surface pitting and size reduction. In contrast, 5IR granules exhibited a smooth, compact, and spherical morphology, demonstrating resistance to enzymatic hydrolysis and improved rigidity. Fourier Transform Infrared Spectroscopy (FTIR) spectra highlighted structural superiority of 5IR, with the highest 1047/1022 ratio and low 1022/995 ratio indicating increase in crystalline region and double helices proportion. X-ray diffraction confirmed maximum crystallinity index (62.66%) in 5IR, significantly higher than native (41.24%), IR (53.40%), 3IR (51.03%), and 7IR (44.27%). This increase was attributed to enhanced amylose-amylopectin interactions, chain rearrangements, and IR-induced retrogradation. Pasting parameters, including viscosity, were significantly reduced in 5IR, indicating superior stability compared to other samples. In summary, the novel findings illustrate that a unique combination of enzymatic processing with infrared thermal treatment is a promising processing approach to produce starch with reduced swelling ability, enhanced structural stability, and higher crystallinity. The dually modified starch might make an ideal hydrocolloid for applications requiring resistance against mechanical and thermal degradation with potential applications in a range of starch-based food and beverage formulation.

**Reference:**

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