Engineering novel functional bread through fortification with quercetin nanoparticles

Abstract. Starch-based bread products are some of the most consumed foods in western countries. As a product that is composed primarily of refined starches, these foods are characterized by their high glycemic indexes and their ability to increase the risk of type 2 diabetes. This paper aims to fortify the bread with quercetin, one of the most potent natural antioxidants widely found in red onions, apples and berries, which, as a phytochemical, has anti-diabetic, anti-obesity, and other beneficial qualities. To enhance the solubility and bioaccessibility of quercetin in water, we employed the media milling technique to reduce quercetin particle sizes to the nanoscale. The successful preparation of quercetin nanoparticles was then demonstrated by the field emission scanning electron microscopy (FE-SEM) results. X-ray diffraction results indicated that the crystallinity of quercetin nanoparticles was lower than that of unprocessed quercetin particles, suggesting the media milling process increased the composition of amorphous phase. Solid state ^{13}C NMR results further confirmed that the chemical structure of quercetin was not changed by media milling. The addition of quercetin particles strengthened the storage modulus of the dough, and quercetin nanoparticles had a larger increase in mechanical properties than the unprocessed ones. Finally, the TNO dynamic gastrointestinal model-1 (TIM-1) results indicated that bread fortified with quercetin nanoparticles had higher in vitro quercetin bioaccessibility than bread fortified with pure quercetin. Our research suggests that the media milling technique we used to produce quercetin nanoparticles may serve as a cheap and simple way to increase the bioaccessibility and better harness the beneficial qualities of compounds such as quercetin when used to fortify bread products.

Key words: Quercetin nanoparticles, media milling, X-ray diffraction, rheological properties of dough, bioaccessibility, TIM-1 model.