Structure, physical breakdown and functionality of third-generation snacks enriched with catechins using a human gastric simulator

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Depending on the formulation and the processing conditions used, extrusion can either lead to an expanded product or to a minimally expanded pellet. In this case, pellets are expanded afterwards, in an independent thermal device (e.g. oven), leading to a third generation (3G) snack. Several structural changes occur during both unit operations, and a clear relationship between processing variables, the structure of pellets and expanded products must be further understood. Similarly, the retention of functional compounds that may be added, such as polyphenols, in conjunction with the effect on structure development and subsequent digestive breakdown after expansion is of scientific and technical interest.
We analyzed the effect of extrusion temperature (110, 135°C, and 150°C) and moisture content (27, 29 and 31%) in rice-flour pellets and their microwave expansion, through a microstructural approach using micro-CT. In addition, we examined the effect of processing conditions on catechin retention (HPLC), antioxidant capacity (DPPH and ORAC) and total polyphenol content (TPC) in catechin-enriched products. In vitro essays were developed using a dynamic gastric model (Human Gastric Simulator-HGS), to examine the antioxidant capacity and starch hydrolysis, together with the physical breakdown of the expanded pellets, during gastric and intestinal digestion every 30 min (30-180 min).
Results showed that the highest pellet expansion was obtained at the lowest moisture content (27%) and the highest extrusion temperature (150°C), in both categories with and without catechin addition, probably due to an increased friction inside the extruder barrel. These pellets, in turn, led to the highest expansion after microwave heating (50 s, 800 W). Interestingly, in all pellets a lower catechin content was measured compared to the one measured in the expanded ones (59 ± 6% and 94 ± 6%, respectively), probably due to the pellet dense glassy structure, which entrapped the phenolic compounds precluding their release. HGS essays determined that the highest antioxidant capacity (~336 µM Trolox/g dry matter) was also obtained in expanded pellets that were prepared with the lowest moisture content and were processed at 150°C. However, all samples reached a similar level after 180 min of gastric digestion and the average bio-accessibility was 54%.