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The Effects of in vitro Digestion on Cheese Bioactivity; Comparing Adult and Elderly Simulated in vitro Gastrointestinal Digestion Models

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Abstract : By 2050 it is projected that 2 billion of the global population will be more than 60 years old. Older adults have unique dietary requirements and aging is associated with physiological changes that affect appetite, sensory perception, metabolism, and digestion. Therefore, it is essential that foods recommended and designed for older adults promote healthy aging. To assess cheese as a functional food for the elderly, a range of commercial cheese products were selected and compared for their antioxidant properties. Cheese from various milk sources (bovine, goats, sheep) with different textures and fat content, including cheddar, feta, goats, brie, roquefort, halloumi, wensleydale and gouda, were initially digested with two different simulated in vitro gastrointestinal digestion (SGID) models. One SGID model represented a validated in vitro adult digestion system and the second model, an elderly SGID, was designed to consider the physiological changes associated with aging. The antioxidant potential of all cheese digestates was investigated using in vitro chemical-based antioxidant assays, (2,2-Diphenyl-1-picrylhydrazyl (DPPH) radical scavenging, ferric reducing antioxidant power (FRAP) and total phenolic content (TPC)). All adult model digestates had high antioxidant activity across both DPPH (> 70%) and FRAP (> 700 µM Fe^{2+}/kg.fw) assays. Following in vitro digestion using the elderly SGID model, full-fat red cheddar, low-fat white cheddar, roquefort, halloumi, wensleydale, and gouda digestates had significantly lower ($p \leq 0.05$) DPPH radical scavenging properties compared to the adult model digestates. Full-fat white cheddar had higher DPPH radical scavenging activity following elderly SGID digestion compared to the adult model digestate, but the difference was not significant. All other cheese digestates from the elderly model were comparable to the digestates from the adult model in terms of radical scavenging activity. The FRAP of all elderly digestates were significantly lower ($p \leq 0.05$) compared to the adult digestates. Goats cheese was significantly higher ($p \leq 0.05$) in FRAP (718 µM Fe^{2}/kg.fw) compared to all other digestates in the elderly model. TPC levels in the soft cheeses (feta, goats) and low-fat cheeses (red cheddar, white cheddar) were significantly lower ($p \leq 0.05$) in the elderly digestates compared to the adult digestates. There was no significant difference in TPC levels, between the elderly and adult model for full-fat cheddar (red, white), roquefort, wensleydale, gouda, and brie digestates. Halloumi cheese was the only cheese that was significantly higher in TPC levels following elderly digestion compared to adult digestates. Low fat red cheddar had significantly higher ($p \leq 0.05$) TPC levels compared to all other digestates for both adult and elderly digestive systems. Findings from this study demonstrate that aging has an impact on the bioactivity of cheese, as antioxidant activity and TPC levels were lower, following in vitro elderly digestion compared to the adult model. For older adults, soft cheese, particularly goats cheese, was associated with high radical scavenging and reducing power, while roquefort cheese had low antioxidant activity. Also, elderly digestates of halloumi and low-fat red cheddar were associated with high TPC levels. Cheese has potential as a functional food for the elderly, however, bioactivity can vary depending on the cheese matrix. Funding for this research was provided by the RISAM Scholarship Scheme, Cork Institute of Technology, Ireland.

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