Characterisation of associations between condensed tannins and plant cell walls

OBJECTIFS

The objectives are to find new information pertinent to the nutritional value of fruits and vegetables. In this framework, we have investigated binding of tannins (procyanidins) to the plant cell walls polysaccharides in fruits. This is related to the nutritional quality of fruits and vegetables because common processes (freezing, but also cooking, pressing or mastication) realize a destructuration of the plant tissues that bring in contact the (initially separated) tannins and cell walls. Subsequently, tannins bind to cell walls. The neoformed complex is further stabilized during cooking to form covalent bonds, probably through cleavage of condensed tannins in acidic conditions, with formation of highly reactive carbocations. The cell walls – tannins complex is ingested and reaches intact the lower gut. In the lower gut, bacteria from the colon ferment the tannins, generating metabolites that are responsible for the health-beneficial effects of these molecules.

ACTIONS

Cell wall materials were extracted from undisrupted cells and from distinctive pear cells that are parenchymatous and stones cells. Procyanidines from cider apple were extracted, purified and characterized.
In order to investigate non-covalent and covalent interactions between cell walls and procyanidins we artificially created complexes at 25 °C and 95 °C and then quantified them by UV-visible spectrometry and isothermal titration calorimetry (ITC at 25°c and 45°C).
Covalent adducts were attempted to be traced by successive solvent extraction and enzymatic digestion in crude boiled pear and artificial complexes generated between procyanidines and the different cell wall materials

RESULTATS

Concentration of bound procyanidins varied between the distinctive cell walls (stone cells< stone + parenchymatous< parenchymatous) and increased at 95 °C. The highest bound procyanidin content after complex formation at 25 °C and 95 °C was observed in the case of the cell wall extracted from parenchymatous cells. Undisrupted cell walls that contained a balanced ratio of the various polymers retained procyanidins with higher degree of polymerization. ITC assays at 25 °C revealed hydrophobic interactions between undisrupted cell walls and cell walls extracted from parenchymatous cells, the degree of interaction was very low for stone cells. Undisrupted cell walls exhibited the highest affinity values at 25 °C. At 45 °C we had the occurrence of a reverse curve phenomenon which was characteristic of very high affinity values and positive ?H and ?S. The phenomenon entirely relied on the cell wall structure. Attempts to trace potential adducts in crude boiled pear were unsuccessful. However, when successive solvent extraction and enzymatic digestions were applied to artificial generated complexes, they revealed additional peaks at 520 nm. The decrease in neutral sugars for all the different cell wall types was significantly different and much higher when procyanidins were bound to cell wall, especially for the cell wall coming from parenchymatous cells. Arabinose was highly decreased followed by fucose and galactose.
Interactions between cell walls and procyanidins induced by heat treatment could lead to the occurrence of newly formed structures resulting from the implementation of physicochemical interactions. We propose that the cell wall structure plays a critical role in the nature of these interactions. These phenomena could affect the organoleptic characteristics and alter the nutritional quality of processed foods predominantly affecting the level of their bioavailability

PERSPECTIVES

Development of a method to isolate covalent adducts.
Study of the impact of non-covalent and covalent complexes between procyanidins and cell walls on colonic fermentations of procyanidins.

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