

Pectins are cell wall polysaccharides that play a key role in maintaining the shape, strength and elasticity of tissues during plant growth. These biopolymers are the main factor responsible for the texture and quality of the fruits. Pectins in the food industry are mainly used to form gels, as thickeners and texture stabilizers. They are also an important ingredient in the diet due to their pro-health effects, promoting the regulation of blood glucose levels and lowering cholesterol levels.

Pectins are an extremely diverse group of biopolymers, consisting of various monosaccharides and uronic acids, and can be esterified with methanol or ethanol. In addition, these compounds have a complex spatial structure due to the presence of side chains and functional groups which interact with each other and with the molecules of other chemicals, including solvents. The conformation of pectins, i.e. the way they are spatially organized, affects the properties of the cell wall, and thus the growth and texture of fruit. Pectin molecules are organized into different conformational forms at the primary, secondary and tertiary levels depending on several internal and external factors. Internal factors such as the structure of the molecule (backbone and side chains) and methyl ester content, as well as external factors such as pH, ionic strength and concentration, affect pectin gelation mechanisms. The basic structure of pectin is a sequence of galacturonic acid and rhamnose molecules linked in long chains, which can form spatially into a helix (secondary structure). Structures of higher orders are formed by ionic, hydrophobic or hydrophilic inter-chain interactions that result in three-dimensional structures, such as gels, complexes or viscous solutions.

In solution, the interaction between the biopolymer-forming units and solvent molecules affects the final conformation of the polymer. The parameters describing the nature of polymer molecules are the persistent length and the radius of gyration. The persistent length of polymer molecules is related to the bending stiffness of the polymer and provides information about the stiffness of the molecules. This parameter can be assessed by multi-angle laser light scattering (MALLS), atomic force microscopy (AFM) and force spectroscopy. The gyration radius describes the spatial dimensions of the polymer chain and provides information on its elasticity.

Fruits from which pectins are extracted undergo significant changes during storage. Pectins are the most susceptible to enzymatic and non-enzymatic degradation of all cell wall components. The extraction efficiency and properties of extracted pectins depend primarily on the biological state of the fruit. This suggests the hypothesis that the pectin's conformation in solution and gelling capacity may be influenced by the biological state of the plant material from which the pectin is extracted. To date, no scientific evidence has been published to verify it. Therefore, **the main objective of this project is to fill the existing knowledge gap by answering the question of how typical post-harvest practices affect the molecular properties of pectins, specifically their conformation in aqueous solutions.**

To answer the question posed, the chain structure of pectin molecules will be determined by AFM imaging, force spectroscopy (persistent length) and MALLS (gyration radius). The data obtained will be the starting point for determining the conformation of the chain in aqueous solutions. There are only a few possible scenarios for the organization of pectin chains in aqueous environments. These can be referred to as two extreme cases: a statistical cluster or a worm-like conformation. They will be identified by methods of membrane osmometry, spectroscopy nuclear magnetic resonance, dynamic light scattering, and rheological measurements.

The properties of pectins have not yet been fully elucidated due to the intrinsic complexity of these polysaccharides and their considerable variability caused by physiological processes in plant material. Therefore, this project aims to comprehensively describe the functionality of pectins in relation to the physiological state of plants, molecular structure and the nature of the solutions in which they are placed. The results obtained will open up new possibilities for the use of fruits as a source of pectins and more precise adjustment of their functional properties for technological purposes. This will be possible by defining the possible conformations of the chains of different pectin fractions in different solutions, taking into account the ripening state of the plant material.