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Effect of "Ameixa d'Elvas" plums candying on microstructure, texture and cell wall pectic polysaccharides composition

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Introduction

"Ameixa d'Elvas" is the name of a processed plum obtained by a traditional candying process, which has a Protected Designation of Origin (PDO). Only fruits of a particular type of Green Gage plum, 'Rainha Claudia Verde' variety (*Prunus domestica*), from a limited geographic area, and in a precisely defined stage of ripening (assessed by total soluble solids, acidity, and titratable acidity), can be used to obtain the "Ameixa d'Elvas" processed fruits. The candying process consists in boiling the intact plums in water for 15 min and then put them in sugar syrup, which is successively concentrated until 75ºBrix.

In order to understand the physical and chemical changes that occur during the candying process, the texture and microstructure were studied in fresh, boiled and candied plums, and the modifications occurring in these physical properties were correlated with the composition of cell wall pectic polysaccharides.

Materials and methods

The plums (*Prunus domestica* – "Rainha Claudia Verde") were provided by a local factory at three different steps of processing: unprocessed, boiled, and candied.

For observation by scanning electron microscopy (SEM), the pulp of the plums was fixed in 4% (v/v) glutaraldehyde in 1.25% (w/v) Pipes buffer (pH 7.6). After dehydration with ethanol and acetone, samples were critical-point dried with CO_2 and sputter coated with gold:platinum mixture, and examined using an Hitachi-S4100 scanning microscope (Pinto et al., 2002).

Texture analysis was performed by puncture tests using a Texture Analyser (TAHdi, Stable Micro Systems). Six plums from each step of processing were cut longitudinally, the seed was removed, and 5 readings were done for each half of fruit, in one half with skin, and in the other without skin. The force (N) required to push a probe of 2 mm diameter at 1.00 mm/s was measured.

Cell wall polysaccharides were obtained from alcohol insoluble residue (AIR) and sequentially extracted with water, imidazole and carbonate. Neutral sugars were analyzed as their alditol acetates by GC and uronic acids were determined by a modification of the phenylphenol colorimetric method (Coimbra et al., 1996).

Results and discussion

SEM analyses of pulp of unprocessed plums showed a tissue structure composed of parenchyma cells with thin primary cell walls. These cells have regular shapes and are tightly packed showing small intercellular spaces. This aspect contrasted with the irregular shape, large intercellular spaces observed in boiled and candied plum pulps (Fig. 1a-c). Boiled and candied plums showed also tissue fractures near vascular vessels in xylem regions (Fig. 1d-f).

Plum's texture analysis demonstrated that unprocessed fruits had higher resistance to penetration (Fig. 2). In these fruits the maximal force (N) for penetration was 37% higher in plums with skin than without. In boiled plums, with the thermal treatment, tissue softening was induced. However, candied plums showed recovery of consistency to similar values of fresh fruits without skin, even though the cell structure degradation observed by SEM. No significant differences were found when processed fruits (boiled and candied) were analysed with or without skin, revealing that boiling caused skin structure disruption.

The higher amount of cell wall polysaccharides obtained by water, imidazole and carbonate extraction in boiled

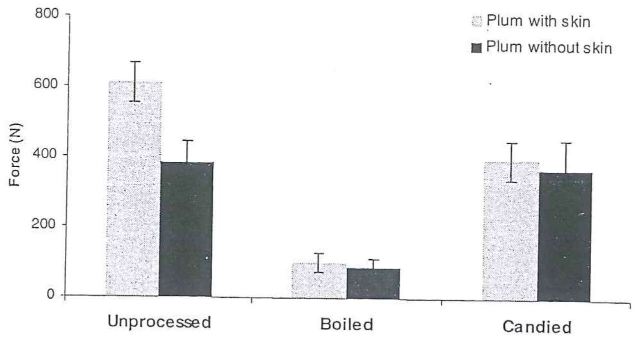

Figure 2.-Maximal force for a 2 mm probe to penetrate in the pulp of plums with and without skin.

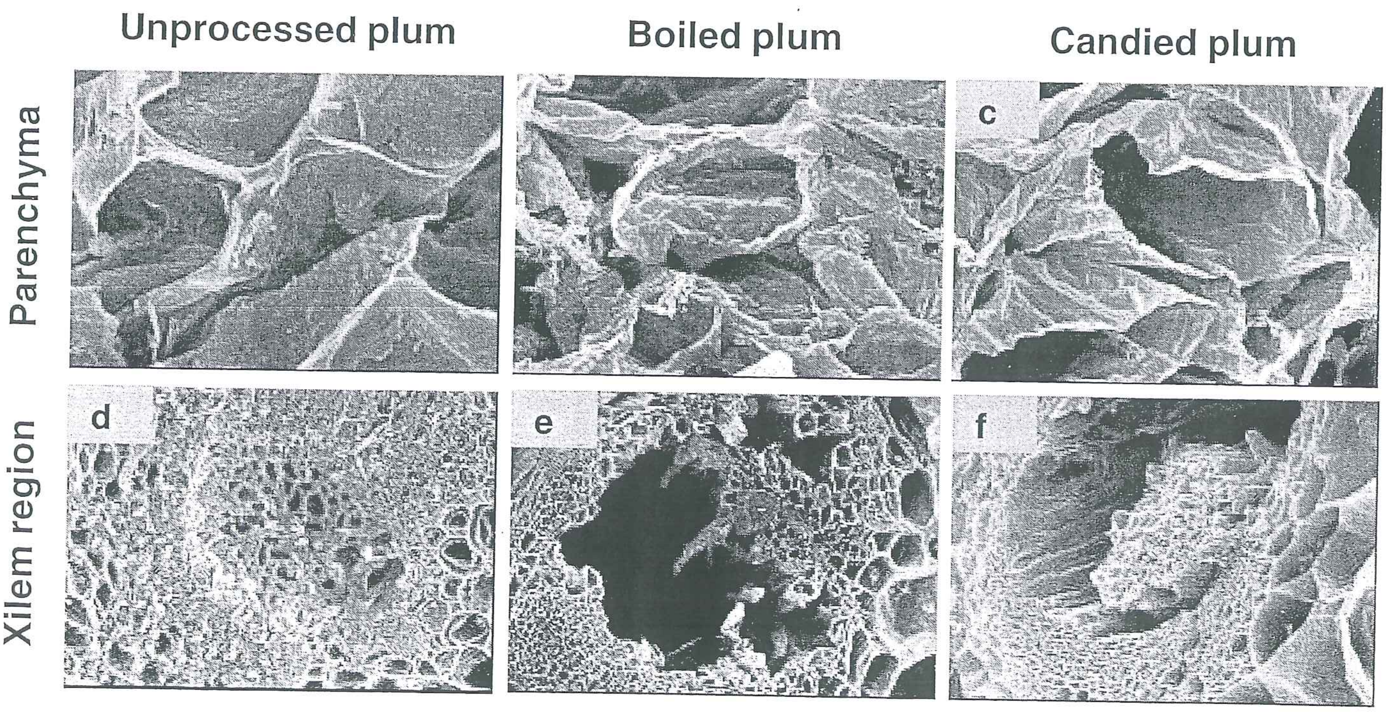

Figure 1.-SEM of "Ameixa d'Elvas" pulp during processing (a-c amp. 300x; d-f amp. 400x).

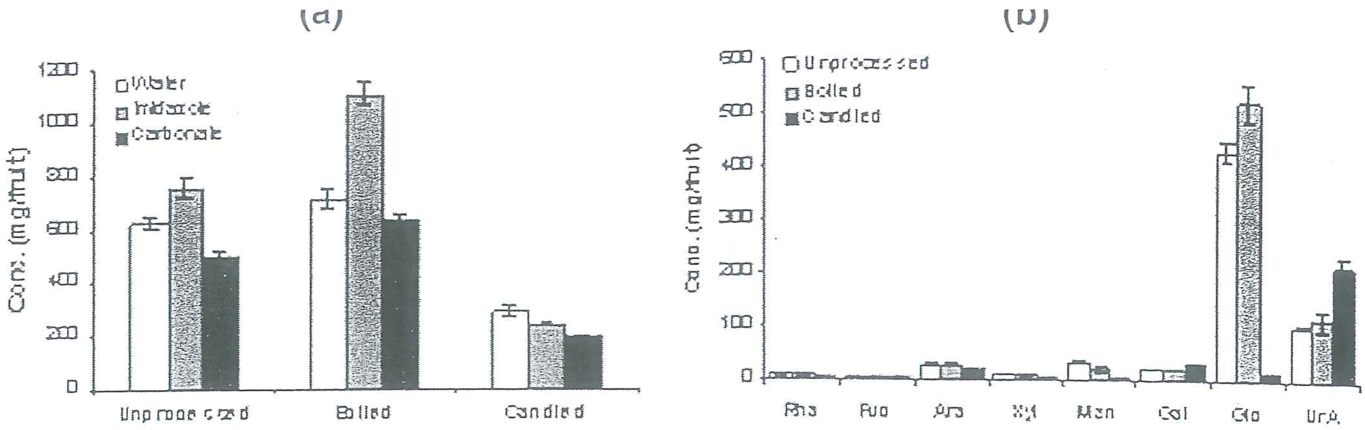

Figure 3.-(a) Total sugar content per fruit for water, imidazole and carbonate extracts from AIR of unprocessed, boiled and candied plums. (b) Sugars composition of water extracts of unprocessed, boiled and candied plums.

plums showed solubilization of polysaccharides induced by the thermal treatment. The lower amount of cell wall polysaccharides in candied plums showed the occurrence of diffusion to the sugar syrup during the process (Fig. 3(a)). Textural changes occurring during heating are related with chemical changes in the cell wall polysaccharides, specifically with depolymerization by b-elimination and solubilization of pectin (Stolle-Smits et al., 1997). In unprocessed and boiled plums, the imidazole extract was the more abundant in polysaccharides, while for candied plums was the water extract. The sugar composition of the candied plums water extract revealed a high amount of uronic acids. An opposite trend was verified for the water extract of unprocessed and boiled plums, which had a much higher amount of glucose (Fig. 3b). The degree of esterification determined for the pectic polysaccharides from water extract of candied plums was 73%. Since the water extractable pectic polysaccharides present in candied plums are highly esterified, gelation might occur in the presence of sugar that diffuses from the candying syrup, an event that could explain the increased resistance for penetration of candied plums.

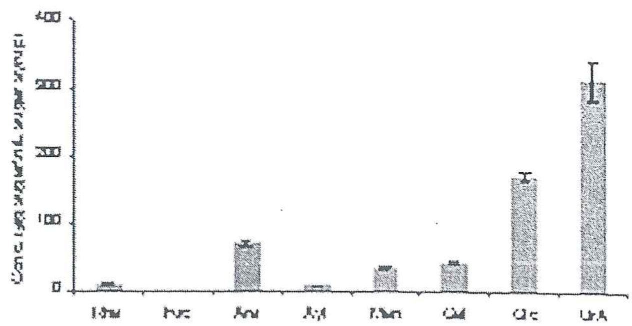

Figure 4.-Sugars composition of the polymeric material present in sugar syrup after candying.

Because during the candying process the amount of polymeric material and polysaccharides in plums decreased 70 and 60%, respectively, the amount of polysaccharides and their sugar composition in sugar syrup was also analysed. After the candying process, the sugar syrup contains 1% of polysaccharides. Uronic acids and glucose were the major sugars present (Fig. 4), what confirmed the diffusion of the polysaccharides from the fruit to the sugar syrup during candying.

Conclusions

Plums softening occur due to thermal treatment during boiling as confirmed in plums tissue observation by SEM, where it was visible the increase of intercellular separation at the middle lamella and fracture in xylem structure. Analyses of cell wall polysaccharides showed also solubilization of pectic polysaccharides, the main constituents of middle lamella region.

The sugar composition analysis of cell wall extracts of plums, revealed the presence of a high quantity of highly esterified pectic polysaccharides in the water extract of candied plums. This observation points to the conclusion that pectic polysaccharides gelification inside the fruits, after sugar diffusion from the candying syrup, should be the reason for candied plums pulp consistency recovery.

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