Real-time measurements of apple cubes enzymatic degradation by micromechanics : preliminary results

Jean Francois Maingonnat, Crepin Ella Missang, Alain A. Baron, Catherine M.G.C. Renard

Real-time measurements of apple cubes enzymatic degradation by micromechanics: preliminary results

J.F. MAINGONNAT[1,2], C. ELLA MISSANG[3], A. BARON[4], C. M.G.C. RENARD[1,2]

1. INRA, UMR408 Sécurité et Qualité des Produits d'Origine Végétale, F-84000 Avignon, France
2.Université d'Avignon et des Pays de Vaucluse, UMR408 Sécurité et Qualité des Produits d'Origine Végétale, F-84000 Avignon, France.
3.Unité de Recherche Agrobiologie, Université des Sciences et Techniques de Masuku, BP 941, Masuku Franceville, Gabon.
4. INRA, Station de Recherches Cidricoles, F-35650 Le Rheu, France
* corresponding author: jean-francois.maingonnat@avignon.inra.fr

Summary:

The diffusion of micronutrients from vegetables is mainly governed by the breakage of the structures at different scales: vacuole, cells, tissues or whole fruit. The aim of this preliminary work is to study the feasibility of micromechanics applications to characterize the breakage level of enzymatically degraded apple cubes.

Material and methods:

- Apple (Granny Smith) cubes (7 x 7 x 6 mm^3) immersed one night in a 0,6 M mannitol solution (turgor pressure equalization)
- Miniature tensile stage (Deben Microtest DB-T200Petri) equipped with a 100 N load cell, *Figure 1*
- An apple cube is immersed in the mannitol & enzyme solutions during the compression cycles at room temperature
- Up to 30 compression & go back cycles, preload 3 N, strain 5% (0.35 mm), speed 0.2 $mm.min^{-1}$
- Enzyme Pectofruits XL® (Spindal), concentrations: 0, 0.5, 1, 3, 5 ml /100 ml of 0.6 M mannitol solutions

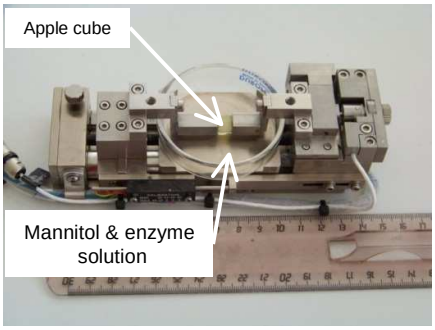

Figure 1: Miniature tensile stage (Deben Microtest).

Results:

Figure 2

Without enzyme:

(i) Load *vs* deflection curves are straight lines ⇨ elastic behaviour, E ≈ 2 MPa,

(ii) load amplitude **dL** remained almost constant during 1½ or 2 hours

With enzyme:

(i) load amplitude **dL** decreased with time

(ii) the higher the enzyme concentration, the lower load amplitude **dL**

(iii) for high enzyme concentration the elastic behaviour disappeared

(iv) for high enzyme concentration, the softening effect appeared sooner than for low enzyme concentrations

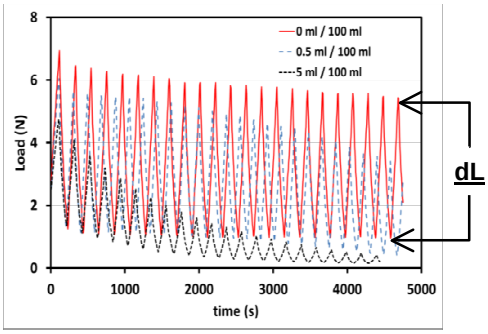

Figure 2: Representative Load vs time curves for different enzyme concentrations.

Figure 3

As the different tests were carried on with different apples, the results are normalized by plotting **dL** / **dL_{max}** *vs* time.

(i) a lag phase ( ) for the lower enzyme concentrations

(ii) the texture loss is higher for higher enzyme concentrations

(iii) the measured texture loss kinetics were almost linear for low enzyme concentrations and exponential up to a minimum for higher ones.

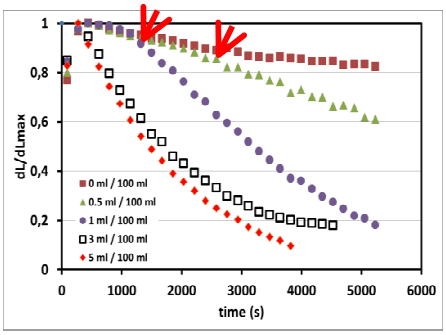

*Figure 3: Representative evolution of **dL** / **dL_{max}** as a function of time for different enzyme concentrations.*

Conclusion:

Compression cycles in a miniature tensile stage permitted to characterize the texture loss of enzymatically degraded apple cubes as a function of time. Other micromechanical tests (compression until rupture, micro-puncture) will be performed. Better experimental conditions (temperature control, stirring) are required for modeling the degradation kinetics of fruits and vegetables with micromechanics.

Fruit & Veg Processing
Avignon, 18-21 April 2011