



# Tools for Development and Optimisation of Ready-to-Eat Foods and Prediction of Shelf-life, Quality and Safety

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## Introduction

Leafy vegetable salads play an important role in contributing vitamins, minerals, and dietary fibre in human diets. Due to their convenience and fresh-like properties, they appear to become one of the important food components in food industry. Texture is one of the important properties that consumers judge while choosing for fresh produce. Thus, study on mechanical properties of fresh produce such as texture is essential to have better understanding on a particular product as well as to figure out the optimize parameters that can maximize the quality and shelf life of the fresh produce.

## Aim

One of the objectives of this project is to perform texture and image analysis on ready-to-eat salads and building a mathematical model for prediction of shelf-life, quality, and safety

## Materials and Methods

### Texture Analysis

#### Uniaxial Compression Test

- 75g each from 3 different types of good spinach leaves; Teen, Organic, and Salad were uni-axially compressed using Z030 universal mechanical tester (Zwick/Roell) with maximum force of 100N
- Compressibility or hardness of the spinach leaves was measured by a single cycle compression loading/unloading test
- Force-displacement curves were generated, and through this, bulk density of the samples, growth rate, and work required to compress the samples can be derived

#### Penetration Test

- A stainless steel spherical probe with identified cross-sectional area was penetrated through a section of a single spinach leaf using a texture analyser, T.A-XT machine from Stable Microsystem
- Force-displacement graph was generated for each of the particular spinach leaf penetrated where leaf fracture properties such as burst strength, displacement of the probe necessary to break each leaf, toughness, and stiffness can be derived and analysed



Figure 2: Penetration test set up using texture analyser, TA-XT (Stable Microsystem)

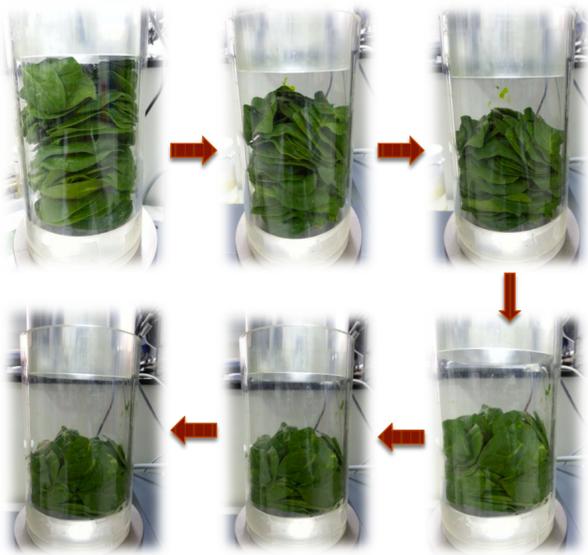


Figure 1: Spinach leaves inside the chamber before compression, after 0<sup>th</sup>, 1<sup>st</sup>, 2<sup>nd</sup>, 3<sup>rd</sup> and 4<sup>th</sup> compression respectively

### Image Analysis

#### Light Microscope

- The first set of experiment focused on analysing microstructure on different types of spinach leaves.
- The second set of experiment focused on analysing the microstructure of spinach leaves after being compressed at different input forces.
- For each treatment, the leaves were finely cut using a sharp disposable scalpel and placed on a glass slide protected with a thin cover glass. Images were view under 10 x 1.0 x 10 objective magnification

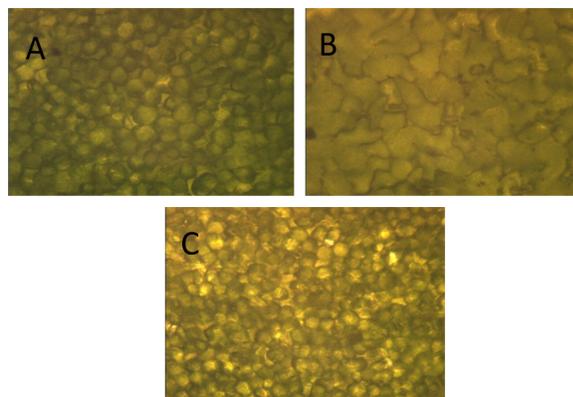


Figure 3: Light microscopy images of 3 different types of spinach leaves; A) Teen, B) Organic, and C) Salad

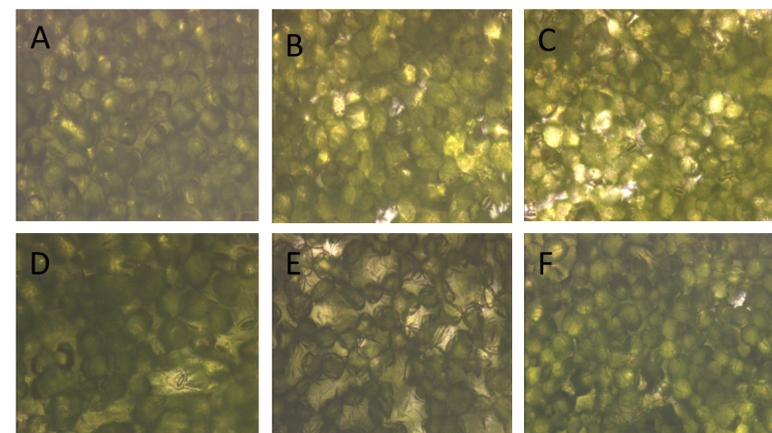


Figure 4: Light microscopy images of spinach leaves treated under different compression forces; A) Before, B) 30N, C) 60N, D) 100N, E) 110N, F) 170N

## Results and Conclusions

### Uniaxial Compression Test

- As the storage day increased, the MaxWork required to compress the spinach leaves decreased
- There was bulk density difference between Teen, Organic, and Salad spinach. This is because, different species have different densities
- The growth rate,  $k$  is calculated using model equation  $F_m = F_0 e^{kt}$  where  $F_m$  is the modelled force,  $F_0$  is the initial force, and  $t$  is the time
- As the compression increased, the growth rate increased

### Penetration Test

- As the storage day increased, the burst strength, which is the maximum force required to burst the leaf increased

### Light microscope

- Under the light microscope, Organic spinach has the biggest cell size compared to Teen and Salad spinach
- Under compression at different forces, the cell sizes of spinach are almost in the same range  $\approx 40 - 50\mu$
- Hypothetically, as the compression force increases, the breakage of the cells was assumed to be increased. However, after the test run, the results did not follow the hypothesis
- This is because, the compression test was done in the bulk system. After the compression, not all the leaves inside the chamber were broken. In most cases, only the leaves at the edges of the chamber were damaged while the leaves in the middle part of the chamber remained intact. Also, the selection of the spinach samples to be put under the light microscope was done in random

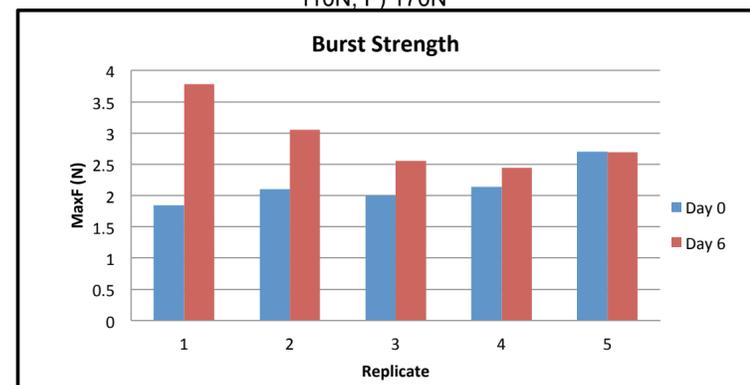


Figure 5: The burst strength of spinach at Day 0 and Day 6 for all 5 replicates from Penetration Test

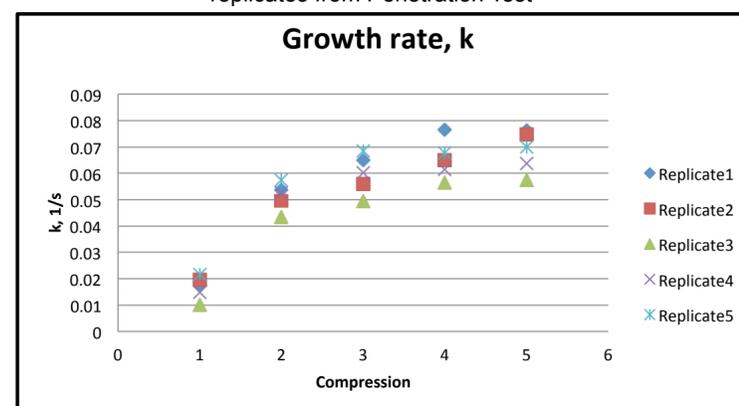


Figure 6: The growth rate of spinach leaves at 5 consecutive compression

