Mealiness assessment in apples & peaches using MRI techniques

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INTRODUCTION

Since January 1996, a wide EC Project entitled "Mealiness in fruits. Consumers perception and means for detection" is being carried out. Mealiness is a sensory attribute that cannot be defined by a single parameter but through a combination of variables (multidimensional structure). Previous studies propose the definition of mealiness as the lack of crispiness, of hardness and of juiciness. A destructive instrumental procedure combined with a integration technique has been already developed enabling to identify mealy fruits by destructive instrumental means (see other contributions of Barreiro and Ortiz to this AgEng 98). Current aims are focused on establishing non destructive tests for mealiness assessment.

Magnetic Resonance Imaging (MRI) makes use of the magnetic properties that some atomic nuclei have, especially hydrogen nuclei from water molecules to obtain high quality images. In the field of internal quality evaluation, the MRI has been used to assess internal injury due to conservation treatments as chilling injury in Persimmons (Clark & Forbes, 1994) and water-core in apples (Wang et al, 1988). In the case of persimmons, the chilling injury is described as an initial tissue breakdown and lack of cohesion between cells followed by formation of a firm gel and by a lack of juiciness without changes in the total amount of water content. Also a browning of the flesh is indicated (Clark & Forbes, 1994). This definition fits into the previous description of mealiness.

OBJECTIVES

- To search for MRI image features which could be used for mealiness assessment in apples and peaches.

MATERIAL AND METHODS

Eight *apple fruits* corresponding to the ***variety*** *"Top-Red"* have been tested under mechanical and MRI techniques. These fruits correspond to selected samples of a wide experiment for mealiness assessment on 420 fruits (see other contributions of Barreiro to this AgEng 98). Four apples correspond to a small sample of fruits stored under Controlled Atmosphere conditions in commercial storage chambers for a 6 months period, while the rest of 4 apples correspond to a small sample of fruits stored under 2ºC also in commercial chambers for the same period. After the set of MRI was performed on the mentioned apples, there was a need of searching for water-cored apples within the wide experiment in order to confirm the MRI features extracted for the fruits originally tested. As for stone fruits, eight ***peaches cv "Maycrest"*** have been tested under mechanical and MRI imaging techniques. These fruits correspond to selected samples of a wide experiment for mealiness assessment on 270 fruits (see other contributions of Barreiro and Ortiz to this AgEng 98). Most of the material used for MRI correspond to fruits from a high maturity stage stored for 2 weeks under 1ºC (3 fruits, expected to be non mealy) and 5ºC (3 fruits, expected to be mealy), while the rest correspond to fruits from low maturity stage stored for 2 weeks under 1ºC (expected to be non-mealy).

The MRI imaging procedure was taken from the protocol developed in a previous MRI experiment (see 1st Year Report). MRI experiments were performed on a Bruker Biospec 4.7T/40 (Rittlingen, Germany) spectrometer complete with actively-shielded imaging gradients capable of reaching 100 mT m along all axes. Fruits were imaged as 64X64 matrices using the standard two dimensional spin echo sequence. 1 slice and 20 echoes were collected with different echo time, TE, of 8 and 9.5 ms, and a fixed repetition time of 3000 ms.

The mechanical tests carried out on the samples can be summarised as: Magness Taylor penetration test: The maximum penetration force was registered and will be used as Magness Taylor firmness; and Confined compression test: The parameters registered through this test were: Force/deformation ratio within the elastic behaviour (N/mm this magnitude will be used as compression hardness), and the Juice area (mm²) of the spot accumulated in a filter paper placed underneath the probe during the test (this magnitude will be used as compression juiciness). The solid soluble content was measured using a digital refractometer PR-101 ATAGO.

RESULTS AND DISCUSSION

At the time of writing this summary only the apple data had been analysed with the following results :

Identification of Mealy Fruits by Mechanical Means

The confined compression test proposed by the Physical Properties Laboratory (ETSIA-UPM) for the identification of mealy fruits by destructive instrumental means (see other contributions of Barreiro and Ortiz to this AgEng'98 indicates that only 1 out of the 4 fruits tested submitted to Controlled Atmosphere conditions had developing mealiness, while 3 out of the 4 fruits tested stored under 2°C had already developed mealiness at that stage classification of the fruits into : Hard (Magness-Taylor Firmness above 16N) and Soft (Magness-Taylor Firmness bellow 16N), or into non mealy (hard or soft combined with juiciness above 400mm2) and mealy (soft combined with juiciness bellow 400mm2) has been used to extract features from the MRI.

Extraction of Features within the MRI images for Mealiness Assessment

From each MRI corresponding to the 8 fruits tested, several characteristic parameters as the minimum value/image, the average T2 value/ image, and the maximum T2 value/image were extracted (see Table 1) studied in relation to the classification of the fruits into Hard/Soft and Non-Mealy/Mealy. There is no significant effect of Hard/Soft Magness-Taylor Firmness on the characteristic T2 parameters, but there is a significant effect (1% significant level, F=13.21) value for the Mealy textured fruits of the minimum T2 value/image with lower minimum T2.

Apart from the study on several characteristic T2 parameters, further work has been carried out on the whole histograms of the fruits as a visual study of the images indicated the presence of high/low T2 contrast areas by the core of mealy apples similar to the ones obtained for water-cored apples. The study carried out on the histograms see Fig. 1) revealed that normal distributions of the T2 values are found for all the Non-Mealy apples, while all the Mealy apples show a tail in the histogram by the high T2 extreme similar to the tail observed in an histogram of a water-cored apple. The high/low T2 contrast areas found for the Mealy fruits indicates, as proposed by Clark and Forbes for persimmon (1994), the presence of water in a motional way that may lead to this water-core disorder The proportion of pixels involved in the tails of the histograms for the Mealy apples (around 14%) is similar to the proportion of pixels involved in the tail of a water-cored apple (16%). The observation of a tailed histogram allows to segment the image for the assessment of the tissue area were the water appears in a motional way.

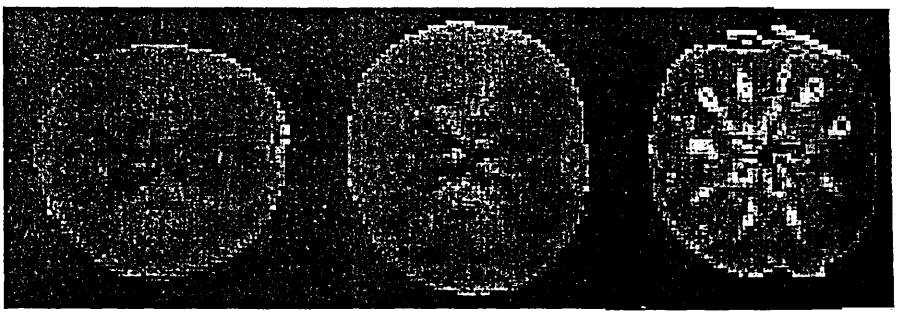

Figure 1. From left to right MR images of a non-mealy, a mealy and a water-cored apple

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REFERENCES

Chen P., and Sun z. 1991. A review of Non-Destructive Methods for Quality Evaluation abd Sorting of Agricultural Products. Journal of Agricultural Engineering Research 49 :85-98

Clark C.J. and Forbes S.K. 1994. Nuclear Magnetic Resonance Imaging of the development of chilling injury in 'Fuyu' persimmon (Diospyrus Kaki). New Zealand Journal of Crop and Horticultural Science Vol 22 :209-215

Wang S.Y., Wang P. C. And Faust M. 1989. Non-Destructive Detection of Water-core in apple with Nuclear Magnetic Resonance Imaging. Scientia Horticulturae 35 :224-234