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CHARACTERIZATION OF HAZELNUT VARIETIES BY TEXTURE ANALYSIS

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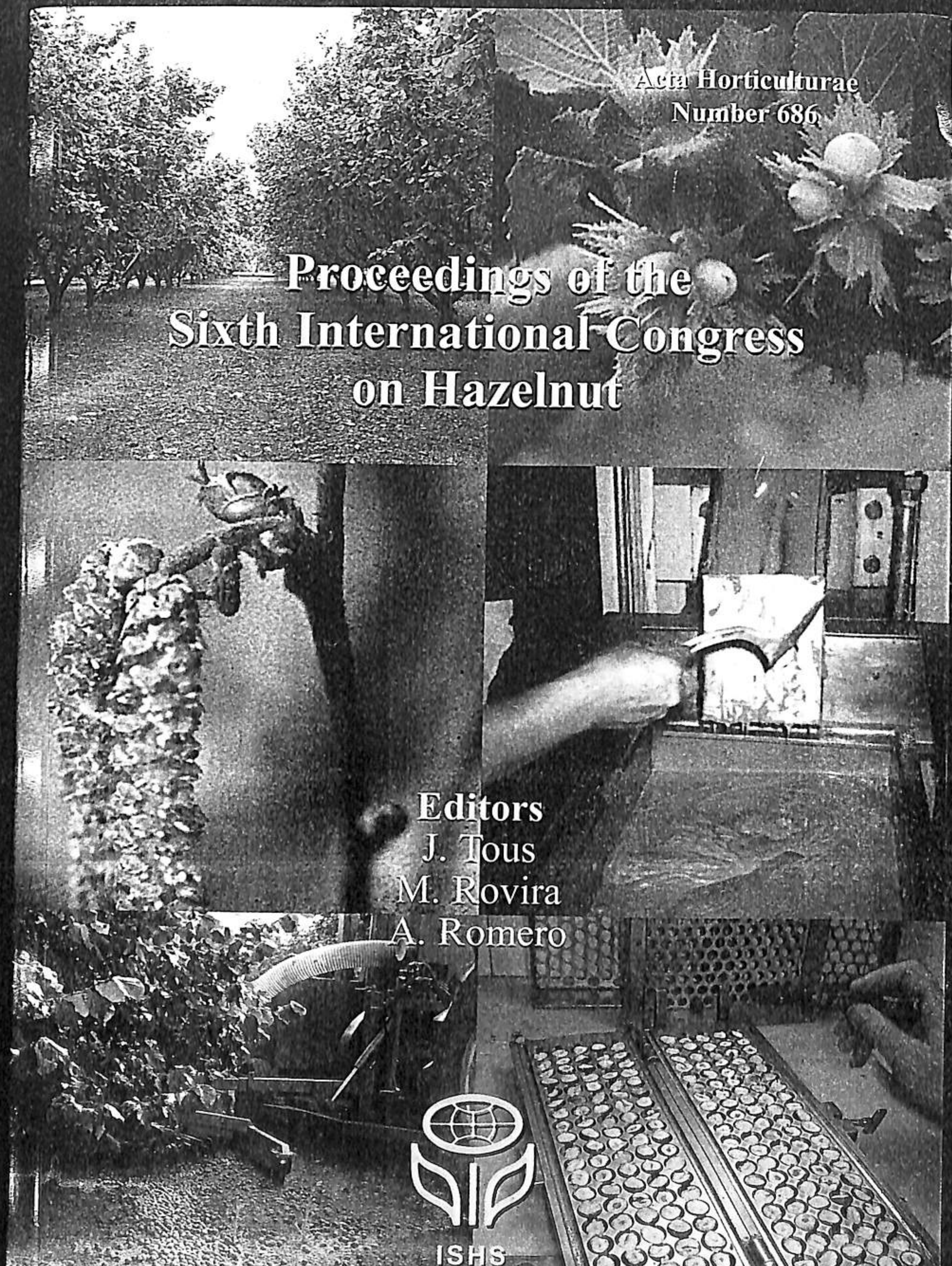
With the aim of identifying new parameters for the exploitation and protection of hazelnut products, a study was carried out on four varieties of hazelnut used for table consumption ('Barcelona', 'Ennis', 'Tonda Bianca' and 'Tonda Giffoni') and on five selections (B6, B59, C10, L35 and L39). To evaluate suitability for table use, the taste and aroma of the kernel are important but easy shell breaking could also be regarded as a good characteristic. Texture analysis was used to measure shell resistance to breakage using a TA.XT2i® Texture Analyser. A sample of 30 nuts of each variety was analysed on the three fruit dimensions (length, width and thickness). The following parameters were measured: hardness (force required to break shell) and hardness of work done (energy required to break shell), 1st fracture deformation (probe distance travelled to reach breaking force), 1st fracture % deformation (deformation divided by original sample height) and modulus of deformability (gradient curve between 20 and 80 % deformation prior to sample fracture). On the same fruits, shell thickness, nut and kernel weight and dimensions were also measured. Texture parameters can be successfully used to discriminate hazelnut varieties; in fact, the differences found among varieties are numerous and significant. Each variety showed the maximum value of hardness and work for one of the considered dimensions. For instance, as regards length dimension, hardness values vary from 769 N necessary to break 'Ennis' to 352 N to break L35, while the hardness of work done varies from 0.543 J of 'Tonda Bianca' to 0.263 J of L35. 1st fracture deformation and modulus of deformability gave interesting information about shell rigidity and fracturability. Among the morphological characteristics, shell thickness and shape index are related to texture parameters.



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Characterisation of Hazelnut Varieties by Texture Analysis

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Abstract

To evaluate suitability for table use, the taste and aroma of the kernel are important but easy shell breaking could also be regarded as a good characteristic. Texture analysis was used to measure shell resistance to breakage. A sample of 30 nuts of three varieties ('Barcelona', 'Ennis', and 'Tonda Giffoni') and three selections (B6, L35 and L39) were analysed on the three fruit dimensions (length, width and thickness). The following texture parameters were measured: hardness, hardness of work done, 1st fracture deformation, 1st fracture % deformation and modulus of deformability. On the same fruits, shell thickness, nut and kernel weight and dimensions were also measured. Texture parameters can be successfully used to discriminate hazelnut varieties. Each variety showed the maximum value of hardness and hardness of work done for one of the considered dimensions. 1st fracture deformation and modulus of deformability gave interesting information about shell rigidity and deformability. Among the morphological characteristics, nut weight, shell thickness and shape index are the most related to texture parameters.

INTRODUCTION

To characterize and determine nut quality of different cultivars analyses that evaluate morphologic, technological and compositive characteristics of fruit have been used (Botta et al., 1994; Ebrahem et al., 1994; Botta et al., 1997).

Recently, new investigation techniques such as colorimetric and sensory analyses have been introduced (Zeppa et al., 2001; Valentini et al., 2003) which enable differentiation of cultivars and have also been useful in the definition of important characteristics for the exploitation and protection of hazelnut products.

Shell characteristics have a basic importance with regards to the response to harvesting, drying, and storing. A study on shell structure has been conducted using an SEM (Caramiello et al., 2000).

Texture analysis can also be used to determine new parameters useful in the characterization of cultivars, but also to evaluate suitability for a particular use, especially for nuts used for direct consumption (Bourne, 2002).

The aim of this research was to measure the resistance of shells to breakage using a texture analyser and to identify which texture parameters could be used to discriminate cultivars.

MATERIALS AND METHODS

The study was carried out on three varieties ('Barcelona', 'Ennis', and 'Tonda Giffoni') and three selections (B6, L35 and L39) of hazelnut used for table consumption (Valentini et al., 2001). Samples were collected in 2002 in Cravanzana (the Cuneo district, northwest Italy) and analysed after four months of storage at a temperature of 15°C and 60% relative humidity.

A sample of 30 nuts of each variety was analysed on the three fruit dimensions: length, width, and thickness.

A Universal Testing Machine TA.XT2i® Texture Analyser (Stable Micro System, UK) was used to measure shell resistance to breakage. The compression test was performed using a flat circular aluminium plate (75 mm in diameter). The sample was placed on a perforated platform (HDP/90). To perform the test two loadcells (50 and 100 kg) were used and the speed test was 1 mm/s. The force-deformation curve was acquired in real time, as a graph (Fig. 1).

The following texture parameters were measured according to Calzada and Peleg (1978), Munoz et al. (1986a; 1986b): "hardness", force required to break shell (H); "hardness of work done", energy required to break shell (HWD); "1st fracture deformation", probe distance travelled to reach breaking force (FD); "1st fracture % deformation", deformation divided by original sample height (FD%); "modulus of deformability", gradient curve between 20 and 80% deformation prior to sample fracture (MD).

On the same fruits, shell thickness (mm), nut and kernel weight (g) and the fruit dimensions of length, width and thickness (mm) were also measured. The shape index was calculated using the method of Fregoni and Zioni (1963).

Texture and morphological analysis data were analysed using STATISTICA 6.0 (StatSoft, OK, USA).

RESULTS AND DISCUSSION

Results of the texture analysis showed a great difference among the considered varieties. Considering all the data measured, hardness (H), modulus of deformability (MD) and 1st fracture % deformation (FD%) were the most useful parameters to discriminate the cultivars (Table 1).

'Ennis' and 'Barcelona' had nuts with hardness values greater than 550 N and low deformability (values of MD greater than 550 N/mm and FD% less than 6%).

B6, L 35 and 'Tonda Giffoni' had easy-to-break nuts with very deformable shells. The value of H was about 400 N, MD less than 300 N/mm and FD% greater than 8%. L39 differed significantly only from 'Ennis' for H, but showed a medium deformability.

However, considering each nut's dimensions (length, width and thickness), the varieties showed different values for the considered parameters.

B6, 'Barcelona' and 'Ennis' had the highest H values for length (Table 2), while L35, L39 and 'Tonda Giffoni' had the highest forthickness. With regards to HWD the maximum values were for length for 'Ennis' and L39, and for thickness for the other cultivars. The dimension of width gave the smallest H values and HWD for all the cultivars except for L35 (minimum values on length) and 'Barcelona' (minimum value of H on thickness). 'Ennis' showed the highest H value (769 N) and B6 the smallest (327 N), while L35 had the highest value of HWD (0.55 J) and Barcelona the smallest (0.23 J).

FD, FD% and MD gave interesting information about shell rigidity and deformability.

The highest value of FD was that of L39 for the length (2.29 mm) and the lowest was that of 'Barcelona' for the width (0.70 mm). 'Barcelona' also showed the lowest and the highest values of FD%, from 3.4% to 11.8%. Regarding MD, values varied between 779 N/mm of 'Barcelona' (for length) and 182 N/mm of B6 (for width).

'Barcelona' and 'Ennis' were the most rigid when broken on length and width dimensions, while L39 and 'Ennis' were the least deformable in relation to the thickness dimension.

Nut characteristics were measured for correlation with texture parameters. The most important are reported in Table 3. Nut weights varied from 3.9 g of L35 and 2.9 g of 'Tonda Giffoni'. The percent kernel could be interesting to evaluate how well the kernel fills the nut, especially in nuts for table use that usually have a low percent kernel. 'Tonda Giffoni' had the highest value of percent kernel (0.47%) and 'Barcelona' the lowest one (0.41%). Nut shapes vary from the elongated 'Ennis' (0.82) to the rounded L35 (0.99). Concerning shell thickness 'Barcelona' showed a thick shell (1.62 mm) while B6 and L39 a thin shell (<1.1 mm).

Correlation between texture parameters and the nut's characteristics are reported in

Table 4. H and MD are positively correlated with shell thickness and nut weight and negatively correlated with shape index. In fact, 'Ennis' and 'Barcelona' showed the highest value of H and MD. The first had the most elongated shape, the second one had the thickest shell thickness. FD% are positively correlated with percent kernel and shape index. Rounded nuts with high percent kernel are generally more deformable (L35, B6, 'Tonda Giffoni').

CONCLUSIONS

Texture parameters can be successfully used to discriminate hazelnut varieties; in fact the differences found among varieties are numerous and significant.

'Ennis' and 'Barcelona', widespread on the market as nuts for table use, have the hardest shell to break. The selections L35, B6 and 'Tonda Giffoni' need low force values to break the shell while L39 needs an intermediate value.

Hardness, modulus of deformability and 1st fracture % deformation are the most useful texture parameters for characterising the cultivars. They are correlated with shape index and shell thickness. In general, elongated nuts with a thick shell are less deformable and are hard to break.

Each variety showed different values of texture parameters on the three fruit dimensions. The shell structure is likely to affect the resistance to breakage, particularly in number and aspect of fibres, sclereids and vessels. A deeper investigation into shell structure using a scanning electron microscope - could help to understand these results.

Easy shell breaking could be regarded as a good characteristic in a hazelnut for table use. A consumer acceptance test that includes this characteristic could be carried out to investigate how much consumers could be influenced by this aspect.

Literature Cited

Botta, R., Gianotti, C., Richardson, D., Suwanagul, A. and Sanz, C.L. 1994. Hazelnut variety organic acids, sugars, and total lipid fatty acids. Acta Hort. 351: 693-701.

Botta, R., Gianotti, C. and Me, G. 1997. Kernel quality in hazelnut cultivars and selections analysed for sugars, lipids and fatty acid composition. Acta Hort. 445: 319-326.

Bourne, M.C. 2002. Food Texture and Viscosity. Concept and Measurement. Academy Press, New York, NY, USA.

Calzada, J. and Peleg, M. 1978. Mechanical interpretation of compressive stress-strain relationships of solid foods. J. Food Sci. 43: 1087-1092.

Caramiello, R., Me, G. and Radicati, L. 2000. Structure and characteristics of the hazelnut shell in different cultivars and their agronomic and industrial influence. Acta Hort. 517: 195-205.

Ebrahem, K.S., Richardson, D.G., Tetley, R.M. and Mehlenbacher, S.A. 1994. Oil content, fatty acid composition, and vitamin E concentration of 17 hazelnut varieties, compared to other types of nuts and oil seeds. Acta Hort. 351: 685-692.

Fregoni, M. and Zioni, E. 1962. Caratteristiche morfologiche, merceologiche e chimico-industriali dei frutti di alcune cultivar di nocciolo della Liguria. Atti Convegno internazionale sul nocciolo, Alba, 13-14 ottobre. p.125-156.

Munoz, A., Pangborn, R. and Noble, A. 1986a. Sensory and mechanical attributes of gel texture - I Effect of gelatin concentration. J. Texture Studies 17: 1-16.

Munoz, A., Pangborn, R. and Noble, A. 1986b. Sensory and mechanical attributes of gel texture - II Gelatin, sodium alginate and kappa-carrageenan. J. Texture Studies 17: 17-36.

Valentini, N., Me, G., Vallania, R. and Zeppa, G. 2001. New hazelnut selections for direct consumption. Acta Hort. 556: 103-108.

Valentini, N., Zeppa, G. and Rolle, L. 2003. Applicazione della colorimetria, della "Texture analysis" e dell'analisi sensoriale nella caratterizzazione delle nocciole italiane. Frutticoltura 10: 54-57.

Zeppa, G., Valentini, N., Me, G., Rolle, L.and Gerbi, V. 2000. Applicazione dell'analisi sensoriale alla caratterizzazione di nuove selezioni di nocciolo. Industrie Alimentari 11: 1249-1257.

Tables

Table 1. Texture parameters measured on cultivars used for table consumption.

Cultivar	Hardness (H) N	Hardness work done (HWD) J	1st Fracture deformation (FD) mm	Modulus deformability (MD) N/mm	1st Fracture% deformation (FD%) %
B6	427 C	0.41 A	1.95 A	255 B	8.6 A
Barcelona	584 AB	0.32 A	1.14 B	619 A	5.9 BC
Ennis	636 A	0.40 A	1.10 B	556 A	4.9 C
L35	428 C	0.42 A	1.96 A	234 B	8.3 A
L39	508 BC	0.42 A	1.68 A	361 B	7.6 AB
Tonda Giffoni	432 C	0.36 A	1.71 A	281 B	9.1 A

For each column mean value followed by a letter in common are not significantly different at p= 0.01.

Table 2. Texture parameters measured on cultivars used for table consumption. Values are divided for each dimension considered.

Cultivar	Hardness (H) N	Hardness work done (HWD) J	1st Fracture deformation (FD) mm	Modulus deformability (MD) N/mm	1st Fracture% deformation (FD%) %
LENGTH					
B6	535 BC	0.46 AB	1.90 AB	386 B	8.0 A
Barcelona	654 AB	0.30 BC	0.90 C	779 A	4.4 B
Ennis	769 A	0.54 A	1.31 BC	623 A	5.1 B
L35	359 D	0.26 C	1.62 AB	252 B	6.9 AB
L39	464 CD	0.45 ABC	2.03 A	242 B	8.7 A
Tonda Giffoni	427 CD	0.38 ABC	1.87 AB	248 B	9.5 A
WIDTH					
B6	327 C	0.30 AB	1.77 A	182 C	7.7 A
Barcelona	561 A	0.23 B	0.70 B	707 A	3.4 B
Ennis	523 AB	0.29 AB	0.96 B	492 B	4.3 B
L35	415 BC	0.44 A	2.01 A	210 C	8.0 A
L39	369 C	0.38 AB	1.95 A	194 C	8.9 A
Tonda Giffoni	366 C	0.31 AB	1.63 A	218 C	8.0 A
THICKNESS					
B6	426 C	0.47 A	2.18 A	197 C	10.0 A
Barcelona	518 ABC	0.51 A	2.09 A	267 BC	11.8 A
Ennis	642 AB	0.38 A	1.06 C	567 A	5.2 B
L35	504 BC	0.55 A	2.22 A	242 BC	9.9 A
L39	676 A	0.42 A	1.09 BC	630 A	5.4 B
Tonda Giffoni	503 BC	0.41 A	1.66 AB	373 B	9.9 A

For each column mean value followed by a letter in common are not significantly different at p= 0.01.

Table 3. Main nut characteristics measured on cultivars used for table consumption.

Cultivar	Shape index	Shell thickness mm	Nut weight g	Percent kernel %
B6	0.95 B	1.07 C	3.42 BC	0.46 AB
Barcelona	0.95 B	1.62 A	3.33 C	0.41 C
Ennis	0.82 D	1.22 BC	3.74 AB	0.43 ABC
L35	0.99 A	1.19 BC	3.88 A	0.42 BC
L39	0.89 C	1.09 C	3.51 ABC	0.42 BC
Tonda Giffoni	0.97 AB	1.26 B	2.86 D	0.47 A

For each column mean value followed by a letter in common are not significantly different at p=0.01.

Table 4. Correlation between texture parameters and nut characteristics.

	Shape index	Shell thickness	Nut weight	Percent kernel
Hardness [-]	-0.446***	0.371***	0.274***	-0.146
Hardness work done	-0.100	0.037	0.237**	0.159*
1st Fracture deformation	0.284***	-0.236***	0.109	0.158*
Modulus of deformability	-0.353***	0.432***	0.138***	-0.221
1st fracture % deformation	0.231**	-0.09	0.07	0.199**

- Significant level: *** p=0.001; ** p=0.01; * p=0.05.

Figures

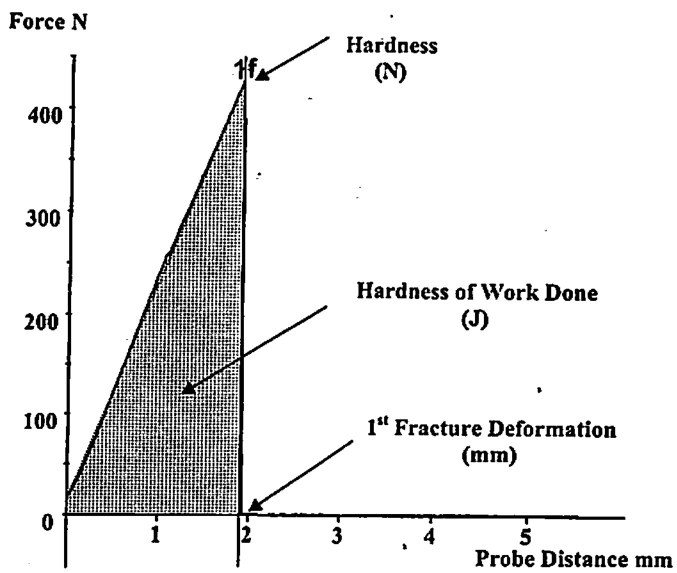

Fig. 1. Force-deformation curve revealed by Texture Analyser TA.XT2*i*®.