

Woolliness assessment in peaches. Comparison between human and instrumental procedures and results

Farinosité des pêches. Comparaison entre les mesures humaines et instrumentales

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Abstract: Woolliness, a negative attribute of sensory texture, is characterised by the lack of juiciness without variation of the tissue water content and an incapacity of ripening although there is external ripe appearance. In this study, peaches cv Springcrest (early and soft flesh peaches) and Miraflores (late and hard flesh peaches) corresponding to three different maturity stages at harvest, stored 0, 1, 2, 3 and 4 weeks at 1 and 5°C have been tested by instrumental and sensory means. An instrumental classification of woolliness has been compared to the sensory assessment. For Springcrest peaches the sensory results match with those found for the instrumental procedure. In this case, Woolliness appears after 2 weeks of storage at 5°C, changing abruptly from crispy to woolly. Miraflores peaches did not develop woolliness during storage. After comparing with sensory results, it is shown that a common instrumental scale may be appropriate to classify for woolliness all peach varieties.

Résumé : La farinosité, attribut négatif de la texture, est caractérisée par le manque de jutosité, sans variation de la teneur en eau du tissu et une incapacité à mûrir alors que l'apparence externe est mûre. Dans cette étude, des pêches Springcrest (précoces et à chair molle) et Miraflores (tardives et à chair ferme) correspondant à 3 stades de maturité à la récolte et stockées, 0, 1, 2, 3 et 4 semaines à 1° et 5°C ont été testées sensoriellement et par des appareils. Les classifications faites à partir de l'analyse sensorielle et instrumentale ont été comparées. Pour les Springcrest, l'analyse sensorielle correspond aux résultats trouvés par la procédure instrumentale. Dans ce cas la farinosité apparaît après 2 semaines de stockage à 5°C, avec un changement abrupt de croquant à farineux. Les Miraflores n'ont pas montré de farinosité. Après comparaison des résultats sensoriels, il a été montré qu'une échelle instrumentale commune pouvait être appropriée pour classer toutes les variétés de pêches en fonction de la farinosité.

1. Introduction

The results shown in this paper are involved in the European project FAIR CT 0302 'Mealiness in fruits: consumers perception and means for detection'.

Mealiness is a negative attribute of sensory texture, characterised by the lack of juiciness without variation of the tissue water content (Harker and Hallet, 1992). Peach mealy textures are also known as «woolliness» and «leatheriness». Besides the lack of juiciness and flavour, that characterises mealy fruits, in peaches it is associated with internal browning near the stone and incapacity of ripening although there is external ripe appearance (Kailasapathy and Melton, 1992). It is considered as a physiological disorder that appears in stone fruits combined with an unbalanced pectolitic enzyme activity during storage. Mealiness is characterised by a dissolution of the middle lamella, a separation of cells, some irregular thickening of the primary wall and a plasmolysis of the cells located in the mesocarp parenchyma (Luza et al, 1992). In woolly textures, the lack of juiciness is caused by gel structures that retain the water molecules. These gel structures are characterised by a high molecular weight combined with many ramifications which cause the woolly sensation (Kailasapathy and Melton, 1992). In peaches mealiness is associated with fruits under cold storage combined with low maturity stage at harvest (Snowdon, 1990).

Consumers and retailers from California consider mealy peaches a problem that should be specifically addressed (Bruhn, 1994). Also a survey on Madrid consumers retailers showed how mealiness was considered a negative attribute, which reduced sales and price, (Lopez et al, 1995). When studying sensory appreciation of mealiness in apples, lack of crispness, hardness and juiciness have been pointed out to be the major causes for the mealiness sensation (Institute of Agrochemistry and Food Research Eighteen Months Report, 1997).

Up to date there is a first proposal for defining woolliness in *Springcrest* peaches (Ortiz et al, 1997) although it has to be compared to a trained sensory panel as a reference.

2. Objective

To develop an instrumental method to quantify mealiness by comparison to trained sensory assessors.

3. Materials & methods

Two varieties of peaches, early soft flesh peaches (Cv. *Springcrest*) and late hard flesh peaches (Cv. *Miraflores*), have been used for the study. Peaches were grown

in Murcia and split in samples within a factorial experimental design. These activities which have been performed at the production area were carried out by the Institute of Soil Science and Biology (CEBAS, CSIC, Murcia).

The experimental design can be summarised as:

maturity stage: three different stages at harvest were selected by experts, in a batch of fruits harvested on the same date in the same orchard, and according mainly to visual references

- 1st maturity stage (reflectance at 680 nm 34,6%),
- 2nd maturity stage (reflectance at 680 nm 41,4%),
- 3rd maturity stage (reflectance at 680 nm 43,5%),
- storage temperature: two different storage temperatures were tested under non-controlled atmosphere :+1° and +5°C;
- storage period: five different modalities were tested for this factor: at harvest, and weekly for a month period : 0, 1, 2, 3 and 4 weeks.

This design was searched in order to achieve as wide mealiness/woolliness range as possible. A total amount of 27 samples were sent to the Institute of Agrochemistry and Food Research (IATA, Valencia) for sensory assessment (by a expert sensory panel) and to the Physical Properties Laboratory (LPF, UPM, Madrid) for instrumental assessment.

The total amount of fruits used at LPF for the experiment was 270 (10 fruits per sample).

The fruits were stored in the CEBAS in Murcia and sent the night before the measurements were carried out. Isolated boxes with ice bags were used for transportation.

In this paper the results from the LPF are shown. Further analysis needs to be developed comparing LPF and IATA results.

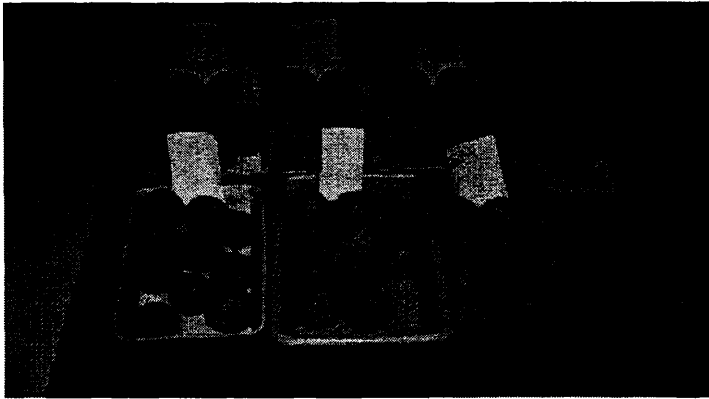


Figure 1: Peaches used for the instrumental and sensorial assessment

The tests carried out on these samples can be summarised as follows:

- weighting of samples,
- mechanical tests:

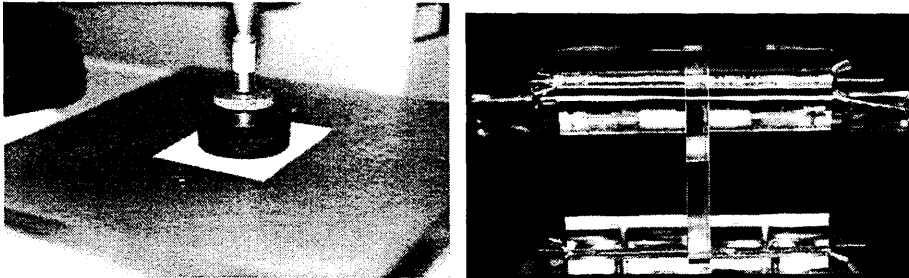
- Magness-Taylor penetration test: Carried out with a Texture Analyser XT2 on whole fruits. Magness-Taylor flesh penetration test was performed with a 8mm diameter rod. A maximum penetration of 8mm was applied at 20 mm/min speed rate. The maximum penetration force was registered and will be used as Magness-Taylor firmness (N).

- Confined compression test: It was carried out with the same Texture machine on cylindrical probes of 1.4 cm height and 1.4 cm diameter (see Figure 2). Probes were confined in a disc of 1.4 cm height, with a hole of the same diameter as the probe. A maximum deformation of 2.0 mm was applied at 20 mm/min speed rate (0.017 m/m.s). The rod used in this test had a 12.5 mm diameter in order to avoid rod/disc contacts during compression. Deformation was immediately removed at the same speed rate; one repetition was made per fruit. The following parameters were registered through these tests:

- force/deformation ratio within the elastic behaviour (N/mm),
- juice area (mm²) of the spot accumulated in a filter paper placed underneath the probe during the test, and this magnitude will be used as compression juiciness (Paoletti, 1993),
- shear rupture test : To perform this test a special device developed in 1992 by Jaren and Ruiz-Altisent was used (see Figure 3). It is formed by a metacrilate cubic box (8cm wide), with a hole in the centre of a rectangular piece (3x8x0,7 cm). In

that hole a piece of 3x9x0.7 cm can be placed. Both the rectangular piece and the cube have a transversal cylindrical hole where a fruit probe is placed in order to be cut by the rectangular piece when pushed by the Texture machine. Two cylindrical plastic pieces joint together by a rubber band compress the probe to maintain it in a fixed position during the test.

This test was carried out on probes of 1.4 cm diameter and 2.0 cm height. In this test an increasing deformation was applied at a 20mm/min speed rate until probe rupture was achieved; one repetition was carried out per fruit. The maximum force at the shear rupture point was registered, which will be used as shear crispness (N), (Paoletti, 1993).



Figures 2 and 3: Confined compression and shear rupture tests

Chemical tests:

- solid soluble content, measured by a digital refractometer PR-101 ATAGO,
- titratable or total acidity using NaOH valoration 0,1 N, carried out by a titration system, Titrator TR 85 and automatic burete T80 (Schott Gerate equipment) attached to a pHmeter, calculating meq/l.

The samples were assessed for texture disorders at LPF by an expert who tasted each peach and classified it into woolly or not woolly. Further information on texture and flavour was also registered

4. Results

4.1 Characterisation of the samples

When comparing Magness-Taylor force (N) for the two varieties, *Springcrest* peaches show a wider variation range (mean values from 43.0 N to 29.2 N) than *Miraflores* (mean values from 40.3N to 31.6 N), see Figure 4. For both varieties there is a gradual decrease of this parameter for increasing maturity stage from 1 to 3.

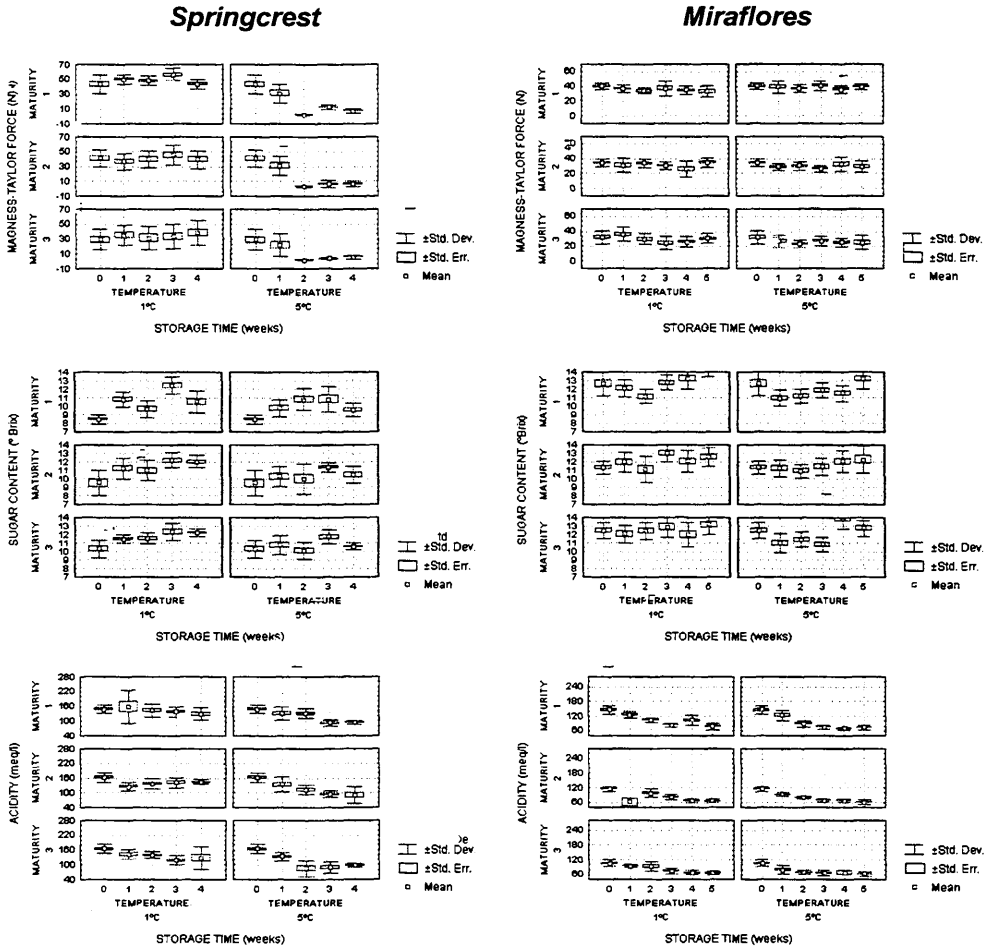


Figure 4: Magness-Taylor Force, sugar content and acidity evolution during cold storage at 1°C and 5°C

Sugar content at harvest for *Springcrest* peaches is lower than for *Miraflores*. In *Miraflores* there is not a clear increase in sugar content when increasing maturity stage, the third maturity stage has less sugar values than the second maturity stage (12.6, 11.3 and 12.5 °Brix, maturity stages from 1 to 3 respectively). In spite of *Springcrest* where there is a gradual increase there is a gradual increase in sugar content (8.5, 9.5 and 10.3 °Brix, as increasing maturity stage from 1 to 3).

Acidity follows a different pattern when comparing both varieties. Although, for the first maturity stage at harvest both varieties have similar acidity values, for *Miraflores* acidity decreases when increasing maturity stage (from 145.2 to 106.2 meq/l) and in *Springcrest* it tends to increase (148.7, 162.7 and 164.2 meq/l, for the 1, 2 and 3 maturity stages).

4.2 Sensory assessment of woolliness

Table 1 shows the main result of this sensory assessment for *Springcrest*. In this case the UPM assessor did not doubt whenever classifying a woolly peach, that is, woolliness can be easily recognised. The identification of woolly peaches made by the sensory assessor indicates the onset of woolliness after 2 weeks of storage under 5°C.

This feature has also been pointed by the sensory panel at IATA (2nd Year Report of the EC Project FAIR CT960302, 1998), as it shows a very high increase of woolliness in peaches stored at 5°C in spite of those stored at 1°C, which do not show an increase in sensory woolliness. Also sensory denseness, hardness and crispness evaluated by IATA panel, show a deep decrease after 2 weeks of storage at 5°C. Again peaches stored at 1°C maintain their values during storage.

For *Miraflores* peaches, the UPM assessor has large difficulties to recognise woolliness as not all the attributes conforming a mealy fruit (lack of crispness, hardness and juiciness) appear at the same time. This textural disorder does not start at a certain storage time and at a specific storage temperature. *Miraflores* peaches have an intermediate woolliness stage, where fruits are soft but still juicy and not woolly. Again this features matches with the sensory woolliness evaluated by the IATA expert sensory panel. For *Miraflores* peaches woolliness does not appear to increase neither at 1°C nor at 5°C. In the same way crispness, hardness and denseness maintain their values during storage, though they have lower values in the beginning than *Springcrest* peaches.

Storage period	Maturity at harvest	Sensory mealy peaches	
		1°C	5°C
0 weeks	Lowest	0	0
	Medium	0	0
	Highest	0	0
1 week	Lowest	0	0
	Medium	0	0
	Highest	0	0
2 weeks	Lowest	0	4
	Medium	0	1
	Highest	0	3
3 weeks	Lowest	0	10
	Medium	1	8
	Highest	0	6
4 weeks	Lowest	0	9
	Medium	0	10
	Highest	0	10

Table 1: UPM sensory assessor woolliness classification for Springcrest peaches

4.3 Instrumental procedures

Up to date there is already a proposal for woolliness assessment by instrumental means (Ortiz et al, 1997). To do so, In this study a combination of instrumental crispness and juiciness assessed by shear rupture test and confined compression test respectively is used. According to the procedure establish there, *Springcrest* and *Miraflores* have been classified into four woolliness categories : *crispy*, *non crispy-high juiciness*, *non crispy-medium juiciness* and *non crispy-low juiciness*. A clustering procedure based on the shear rupture force (N) and the confined compression force deformation ratio (N/mm) has been used to categorise fruits into crispy and non-crispy, and then categorised into different degrees of juiciness within the «non crispy cluster», based on the confined compression juiciness (mm²). In

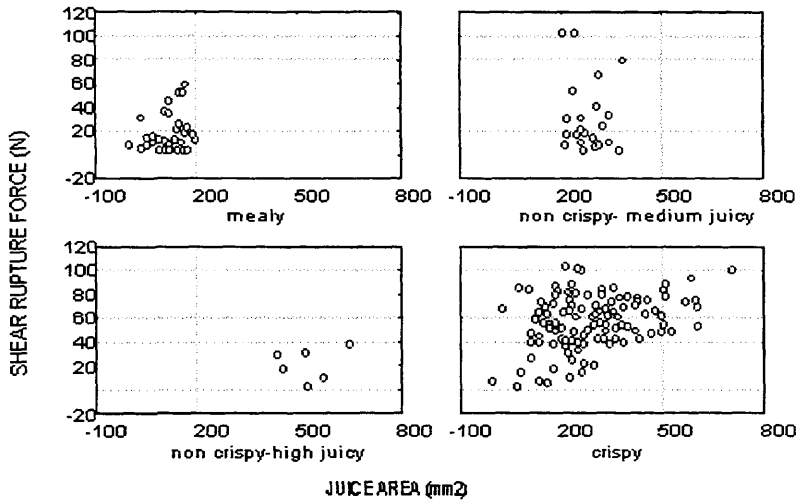


Figure 5: Instrumental segregation of woolly peaches by clustering procedure in Springcrest peaches

Figure 5. Shows that *Springcrest* peaches are mainly classified in the crispy and the mealy (woolly) . There are no many intermediate fruits. However, *Miraflores* peaches are distributed gradually in the four woolliness categories, see Figure 6. Also, it is shown how *Miraflores* peaches have a lower shear rupture force and less variation range of compression juiciness.

Tables 2 and 3 show woolliness onset related to the experimental factors. Crispy and woolly fruits correspond to those shown in Figure 5 and 6. labelled as crispy and mealy clusters. Intermediate clusters in Figure 5 & 6 are not shown in Tables 2 & 3. However, as each sample (each row of tables) is formed by 10 fruits the number of fruits within the intermediate clusters correspond to those missing until 10. For *Springcrest* peaches, fruits labelled as «woolly» appear mainly for 5°C of storage temperature. The starting point for mealiness onset is 2 weeks. At that point nearly a 50% of the fruits show woolly characteristics for 5°C storage confirming that this disorder does not appear at the same time for all the fruits.

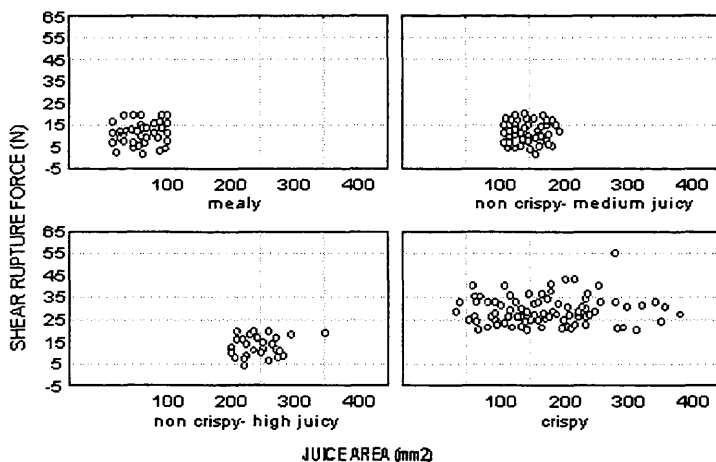


Figure 6: Instrumental segregation of woolly peaches by clustering procedure in Miraflores peaches.

Storage period	Maturity stage at harvest	1°C		5°C	
		Crispy	Woolly non crispy, low juicy	Crispy	Woolly non crispy, low juicy
0 weeks	Lowest	10	0	10	0
	Medium	6	0	6	0
	Highest	2	1	2	1
1 weeks	Lowest	10	0	8	1
	Medium	10	0	4	0
	Highest	2	1	0	0
2 weeks	Lowest	10	0	5	4
	Medium	9	0	0	4
	Highest	6	0	0	5
3 weeks	Lowest	10	0	0	8
	Medium	7	1	0	7
	Highest	5	0	0	1
4 weeks	Lowest	10	0	0	7
	Medium	6	0	0	8
	Highest	6	0	3	3

Table 2: Springcrest instrumental classification of woolly peaches

However, in *Miraflores*, fruits classified as woolly by the instrumental procedure do not correspond to the sensory classification (no woolly peaches were identified). Also instrumental classification does not start to detect woolliness at a certain time and at a certain temperature storage as it was in *Springcrest* (see Table 3).

4.4 Comparison between sensory and instrumental results: Conclusions

Springcrest (early and soft flesh peaches) classified as woolly by instrumental means correspond to those defined as woolly by the UPM sensory assessor. *Woolliness appears after 2 weeks of storage at 5°C, peaches change abruptly from crispy to woolly.* This feature has also been pointed by the sensory panel at IATA (2nd Year Report of the EC Project FAIR CT960302, 1998) where the evaluation of woolliness made by an expert sensory panel shows that peaches stored at 5°C have a strong increase in sensory woolliness and a strong decrease in sensory denseness, hardness and crispness, after two weeks of storage. These sensory results correspond to those find out with the instrumental procedure.

Storage period	Maturity stage at harvest	1°C		5°C	
		Crispy	Woolly non crispy, low juicy	Crispy	Woolly non crispy, low juicy
0 weeks	<i>Lowest</i>	10	0	10	0
	<i>Medium</i>	7	1	8	0
	<i>Highest</i>	7	0	7	0
1 weeks	<i>Lowest</i>	9	0	8	0
	<i>Medium</i>	7	0	4	0
	<i>Highest</i>	8	0	7	0
2 weeks	<i>Lowest</i>	6	0	4	0
	<i>Medium</i>	4	1	5	0
	<i>Highest</i>	6	0	6	0
3 weeks	<i>Lowest</i>	6	1	7	1
	<i>Medium</i>	6	1	9	1
	<i>Highest</i>	4	3	4	2
4 weeks	<i>Lowest</i>	3	6	3	0
	<i>Medium</i>	5	0	3	0
	<i>Highest</i>	5	1	7	0

Table 3: *Miraflores* instrumental classification of woolly peaches

On the other hand, along the storage time, Miraflores (late and hard flesh peaches) have not been classified as woolly by the UPM assessor. They *maintain an intermediate degradation stage* (between crispy and woolly), they had lower shear rupture force and less wide compression juiciness range. Sensory woolliness, hardness, crispness and denseness assessed by the IATA panel maintain their levels during storage (2nd Year Report of the EC Project FAIR CT960302, 1998). They are in a middle stage between crispy and woolly, remain soft but still juicy and do not become woolly during the storage conditions studied. These results do not correspond to those find out with the instrumental procedure. Comparing with *Springcrest*, data it is shown how *Miraflores* peaches start storage with lower crispness (shear rupture force (N)) and have less variation range of juiciness (compression juiciness (mm²)). *Miraflores* peaches, stored at 5°C during 4 weeks, are not really woolly when comparing with *Springcrest* peaches. According to this it can be conclude that the *clustering analysis enlarge the woolliness scale and classify as crispy and woolly peaches which are in an intermediate degradation stage*.

These results indicate different degradation patterns in both types of varieties. After comparing with sensory results, it is shown that a common instrumental scale may be appropriate to classify for woolliness all peach varieties.

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