Quality assurance systems in the production and marketing of fresh peaches

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Abstract

Due to the fast rate of peach post-harvest ripening, damage due to mechanical handling, externally appreciated as bruises and soft areas, is a real problem that leads to an early harvesting and poor quality of the fruits, as perceived by the consumers. More and more, the European consumer asks for good taste and freshness of fruits and vegetables, and these quality factors are not included in standards, nor in most of the producers' practices. Fruit processing and marketing centres (co-operatives) are increasingly interested in adopting quality controls in their processes. ISO 9000 procedures are being applied in some food areas, primarily milk and meat processors, but no generalised procedures have been developed until the present time to be applied to fresh product processes.
All different peach and nectarine varieties that are harvested and handled in Murcia co-operatives and sold in a large supermarket in Madrid were analysed during the whole 1997 season (early May to late August). A total number of 78 samples of 25 fruits (co-operative) or 10 fruits (market), were tested in the laboratory for mechanical, optical, chemical and tasting quality. The variability and relationships between all these quality parameters are presented and discussed, and sampling unit sizes which would be advisable for quality control are calculated.
Keywords : tasting quality, consumers, measurement techniques

1. Introduction

The aim for establishing a quality system is, in the first step of its development, to guarantee a quality level, which may be international standards, standards specified by a client, or any other. After that, the aim is to improve the processes gradually in order to attain client satisfaction. An organisation system, the responsibilities and activities which make possible to assure the completion of quality standards, constitute a Quality System. (Novotec, 1994 ; Various authors, 1992, 1994).

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Quality systems include all processes implied in the quality of the product, in this case fresh market peaches, from the orchard to the final market. Quality controls or quality assurance systems may or may not based on ISO 9000 standards.

In the described aim, the first consideration is to know the product and the consumers requirements. Sampling procedures for inspection are the first step to be established to implement quality controls. In this paper we investigate the actual situation of peaches in a market (which we consider as representative of typical consumers), and its evolution along the commercial season, to know the sample size needed for each quality parameter, with the aim to establish a sampling procedure.(Bruhn et al., 1991 ; Duran Torrallardona,1993).

2. Objective

The objective of this work was to characterise the relevant quality parameters of fresh market peaches, and their values and their variability in order to establish sampling procedures, as a first step of a quality assurance system.

3. Materials and Methods

In both sampling points fruits were chosen randomly in order to obtain the maximum variability and best representation of the actual commercial product.

Market samples were purchased twice a week in a large supermarket. Size of samples was 10 fruits. Co-operative samples fruits were harvested by trained pickers during commercial harvest, and sent to our Laboratory the same day, Isolated boxes with ice bags to keep temperature low were used for transportation. Size of these samples was 25 fruits. The varieties , in order of harvesting time were (Table1) : Maycrest, Springcrest, Merrill, Royal Glory, Caterina, BabyGold6, Vesubio, Sudanell and Miraflores. Total amount of fruits tested : 290 fruits (12 samples equiv. to harvest dates corresponding to 9 different varieties) in Co-operative ; 612 fruits in the Market (66 samples in four groups of varieties : Yellow (21 samples), Red (18), White Flesh nectarines (WFN, 7); Yellow Flesh nectarines (YFN, 20). At the market, some samples were unlabeled for variety (which is against our market standards).

The selection of the relevant quality parameters was based on our experience and on the (non-standard) recommendations of different European Institutions Alavoine et al. 1982 : Toll et al. 1990). These were :

Weight, in kg ;
Size : equatorial diameter, in m ;
Optical properties : visible spectrum was measured using a Minolta CM-50i spectrometer ; in this paper, only values of the reflectance percentage at 680 nm (**R680**) and 450 nm (**R450**) are used. These wavelengths are correlated with the amount of chlorophyll and red/yellow carotenoid pigments : when R680 is high, chlorophyll is less and the fruit is riper ; when R450 is high, pigments are less, and the fruit is less coloured (can be riper or not) ;
Mechanical properties : Magness-Taylor penetration test, carried out using a Texture Analyser XT2 on whole fruit. ; an 8mm dia. rod was used (=0,5 cm2), at 20mm/min speed. Following parameters were registered :Maximum penetration force (MT, in N), called firmness ; force/deformation ratio within the straight-line behaviour (FD, in N/mm), called hardness ;
Soluble solids (**SS**) measured by a digital refractometer ATAGO PR-101 ;
Titratable total acidity (**AC**), using NaOH 0.1N, in meq/l.
Taste evaluation was performed in all fruits by an expert, on the same side were firmness was measured, and scored :1=bad ; 2=medium ; 3=good ; 4=very good. All peaches were analysed on the most coloured side.
Selling price was registered for all market samples.
All data were analysed by Statistica 4.5 for Windows.

In order to establish the sampling procedure for the quality assurance system, the size os the sample will be calculaed, in a first approach, and for every parameter, applying the variance method (Snedecor & Cochran, 1978 ; Statistics Dept. 1996) and supposing that the distributions were Normal. Being CV the coefficient of variation, $1 - \alpha = 0.90$, $Z_{\alpha/2} = 1.96$, with P=10%, then

$$n \geq \frac{C.V^2 . \bullet Z_{\frac{\alpha}{2}}^{\ 2}}{P(\%)^2}$$

4. Results and Discussion

Parameters will be analysed for each sampling group according to variability, and the relationship between some values will be discussed.

Mechanical Tests
Inside-sample variability is very high for these parameters. Coefficients of variation (CV) are from 30 to 130% (Table2). In most cases, MT firmness is more variable than FD hardness. Riper samples show higher CV's than greener samples, and red varieties higher than yellow varieties. Values for all parameters are presented for each of the six varietal groups encountered. Nevertheless, the correct analysis of the data should be carried out for every variety separately, and so is being done.

Co-operative Yellow:	*Firmest*	*Softest*
MT (N)	30.6	12
F/D (N/mm)	7	2.4

Co-operative Red :		
MT (N)	32.7	6.1
F/D (N/mm)	8.4	1.05

Market Yellow :		
MT (N)	49	5.2
F/D (N/mm)	8.7	1.94

Market Red :		
MT (N)	41.5	2.5
F/D (N/mm)	9.4	0.64

YF Nectarine		
MT (N)	58	2.5
F/D (N/mm)	10.22	0.96

WF Nectarine		
MT (N)	38.1	3.9
F/D (N/mm)	8.3	1.6

Firmness and hardness show a gradual decrease during the advance of the summer, and a sudden increase at the end of the season, related to the entry of new varieties, and of cold-stored greener varieties.

Most samples showed an average MT between 10 and 30 N (although, it can be seen that individual fruits show a much wider range). 20 N has been described as the upper limit in the Co-operative for safe handling. In the market, most samples vary between 2 and 6 N/mm in F/D. This parameter shows CV's from 23 to 70%, much lower than MT, which suggests the possibility to use other, better, parameters for measuring firmness than penetrometer force readings. Usually, lower firmness values correspond to higher taste scores, as expected.

<u>Weight and Size</u>

Both parameters show a low CV, lower the size. Co-operative fruits show CV values below 20% in most cases for weight, and below 10% for size. At harvest, size seems to be the main criterion for picking.

Weight and size seem to be mostly related to cultivar (i.e. variety). Varieties get larger as summer progresses

Co-operative Y: *Largest* *Smallest* Co-operative R:

Weight (kg)	0.18	0.105
Diameter (m)	0.1	0.06

Weight (kg)	0.148	0.098
Diameter (m)	0.064	0.056

Market Yellow :

Weight (kg)	0.237	0.114
Diameter (m)	0.08	0.06

Market Red :

Weight (kg)	0.294	0.118
Diameter (m)	0.08	0.06

YF Nectarine

Weight (kg)	0.200	0.123
Diameter (m)	0.07	0.06

WF Nectarine

Weight (kg)	0.192	0.150
Diameter (m)	0.07	0.06

Soluble solids and Acidity

Co-operative Y:	*Souresttt*	*Sweetest*
SS (°Brix)	10.5	12.6
AC (meq/l)	100	74

Co-operative R		
SS (°Brix)	10.4	12.1
AC (meq/l)	219	48

Market Yellow :

SS (°Brix)	8.8	15
AC (meq/l)	154	46

Market Red :

SS (°Brix)	8.1	12.8
AC (meq/l)	212.8	77.5

:YF Nectarine

SS (°Brix)	8.6	12.9
AC (meq/l)	242	100

WF Nectarine

SS (°Brix)	8.7	11.2
AC (meq/l)	148	111.6

All values of °Brix lie inside the ranges indicated by the present recommendations. Variability is low, below 20% for both chemical components.

It is to mention that very few market samples showed sugar values recommended for best quality : 12°Brix or higher. Fig.1 shows the scatter plots (averages and standard deviations) of sugar content, acidity and sensory Taste score for all red market peaches. Apart from the study of possible statistical correlation, and being taste score highly variable, it can be seen that better taste corresponds to higher sugar content in this group of peaches. Acidity is

high in early season, and then lower and less variable from the 5th week on, where it plays a role : highest score of all in this group of varieties is for the sample in week 10, which is high in sugar (12.5 °brix) and not too low in acid (120 meq/l). Other comparisons can be drawn in these graphs, also for the rest of the variety groups.

Taste : (scores 1 - 4)

Co-operative Y:	*Worst*	*Best*
Taste score	2.4	3.6

Co-operative R		
Taste score	1.7	2.4

Market Yellow:		
Taste score	1.7	3.1

Market Red :		
Taste score	1.5	3.2

YF Nectarine:		
Taste score	1.7	2.8

WF Nectarine		
Taste score	1	2.8

Although these values have to be seen as only an approach to sensory taste evaluation, they are interesting to be compared with other data. (See also Fig.1). Variability is around 35-40 % in these samples.

Optical Properties

Reflectance percentages (maximum and minimum values) for 680 and 450 nm for the six different groups of varieties are the following (higher reflectance = lower quantity of chlorophyll and pigments respectively) :

Co-operative Y	*Greenest*	*Highest coloured*
RF680	43	57.8
RF450	8.6	11.5

Co-operative R:		
RF680	30	51.5
RF450	7.2	6.3

Market Yellow :		
RF680	39	56
RF450	8	13

Market Red :		
RF680	32	45.3
RF450	6.8	11.3

:YF Nectarine

WF Nectarine

RF680	18.4	43	RF680	26	37
RF450	4.7	8.5	RF450	6.5	16.5

Highest chlorophyll is present in nectarines, lowest in yellow peaches. Lowest pigment content in White flesh nectarines. Further study of these values and of other areas in the spectra will be carried out, in order to relate this parameter with other relevant quality characteristics of these peaches.

Correlation between the parameters

Correlation (R values) for all pairs of parameters (including taste and price) for average sample values inside every group were calculated. Some observations have been made :

In four of the groups, R680 (low chlorophyll) is highly correlated with low firmness ; in both red peaches groups, it is found that high R680 correlated with soft fruits. The rest of most significant correlations appear predictable : for example, °Brix with low firmness, good taste, low acidity. High acidity correlates negatively with taste and with R680.

For individual variety groups :

In Market Red , high sugars are correlated with low firmness, small size and low price. This means that early peaches show the worst quality and get the highest prices, as has been observed widely in the European market, and is sometimes a problem for summer fruit prices. This type of correlation is also shown in other groups (WF nectarines for example).

In all cases, taste is better for high sugars, softer fruits, high R680, low R450. Price is nevertheless negatively correlated to taste and its components, as described above.

Proposed sampling size

After establishing the values of the main parameters which can be used to characterise peach quality, a sampling procedure should be established for quality control, and this will be calculated on the variability of each parameter.

Table 2 shows the values of standard deviations and of CV for every sample, inside every group varieties. These statistical parameters are the basis for calculating sample size. It can be observed that in all groups, firmness and hardness values show very high variability. The calculation of sample size for these parameters make significant sampling unpractical For measuring firmness, other less variable techniques have to be (and are being) established. On the other hand, being peaches highly climacteric, the individual fruits are subject to a fast evolution and therefore contain higher fruit-to-fruit variability. A different statistical approach (partitioning) should be applied to infer firmness of peaches, and to relate it to the rest of quality parameters..

For the rest of parameters, Table 2 contains approximate sampling size, based on average deviation values of the character in every group. This means, as a summary, that

(leaving apart size and weight), between 5 and 50 fruits would be an adequate sampling unit for quality control in large batches of peaches, depending on the parameter concerned.

Further work is being carried out, in different lines of objectives : optimization of quality procedures; measuring techniques, especially for firmness and sugar content, refinement of sampling procedures and automation of data acquisition and analysis.

6. References

Alvoine , F. Crochon, M., Fady C., Fallot J., Moras Ph., Pech J.-C. 1982. Taste quality in fruit : practical methods of analysis. CEMAGREF, France.

Bruhn, et al. 1991. Consumers perception of quality : apricots, cantaloupes, peaches, pears, strawberries, and tomatoes. Journal of Food Quality 14 : 187-195.

Durán Torrallardona. 1993. Melocotoneros, nectarinas y pavías (Peaches and nectarines). Fundación La Caixa.

Novotec Consultores. 1994. Quality system documentation. 1 Congreso de la Calidad de la Comunidad Valenciana.

Department of Statistics of UP Valencia. 1988. Personal communication. Fruit sampling., E.T.S.I.I., Polytechnic University of Valencia.1988.

Snedecor G.and W. Cochran. 1978. Statistical Methods. Iowa State Press.

Toll H. et al. 1990. El melocotonero. Referencias y técnicas. (Peach. References and Techniques). Ediciones Técnicas Europeas.

Various authors. 1992. Normas de calidad para frutas y hortalizas. (Quality normative for fruits and vegetables). Spanish Ministry of Agriculture (Ministerio de Agricultura, Pesca y Alimentación, Secretaría General de Alimentación). Madrid.

Various authors.1994. Quality systems. Model for quality assurance in design, development, production, installation and servicing. (ISO 9001 :1994).AENOR. Madrid.

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