Post harvest characterization of three clones of ‘Rocha’ pear
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Abstract

‘Rocha’ pear is the most important pear (Pyrus communis L.) cultivar grown in Portugal. Several clones of this cv. have been selected and their productivity identified. Post harvest characterization and the study of physiological behaviour of these fruits, during cold storage, remains unknown. The goal of the present study was to identify which pear clone maintains the best quality after a long period of cold storage under normal (NA) and controlled atmospheres (CA).

INTRODUCTION

‘Rocha’ pear is the most important cultivar of Portuguese pear (Pyrus communis L.), assuming a socio-economic preponderant role in the West Region, whose soil and climate characteristics make it the highest geographical area of the country for ‘Rocha’ pear production.

Through the program of ‘Rocha’ pear clonal selection, from the Estação Nacional de Fruticultura de Vieira Natividade, Alcobaça, Portugal, resulted a broad range of different clones and rootstocks. Three promising ‘Rocha’ pear clones, installed on the rootstock BA29 (clones 1, 2 and 4C), due to its good agronomic performance were considered for a global characterization.

The complete characterization of these clones, must integrate knowledge about the maturation process, quality standards, suitability for long term-cold storage, at normal and controlled atmospheres and susceptibility to the post harvest decay.

Fruit quality parameters such as visual appearance, skin colour, pulp firmness, soluble solids, titratable acidity and ratio sugar / acid may, together, characterize the fruit ripeness and their internal quality. These parameters allow predict the fruit potential for conservation, ensuring it reaches the consumer with guaranteed quality.

In the wide range of different indicators for the maturation process, the ethylene plays an important role in triggering and coordinating ripening in pear fruit. So, ethylene production may serve as a physiological indicator in screening crop varieties.

McMurchie et al. (1972) introduced a generally accepted concept of a unified model that describes two C2H4 biosynthesis induction mechanisms designed System I and...
System II. This model states that immature fruit have a non-autocatalytic System I \( \text{C}_2\text{H}_4 \) biosynthetic capability, and, when the competency to ripen occurs, an autocatalytic System II \( \text{C}_2\text{H}_4 \) biosynthetic capability is induced. Once the competency to ripen occurs, System I \( \text{C}_2\text{H}_4 \) is thought to bind to a receptor site, thus causing the up regulation of ACC-S and ACC-O.

During cold storage of fruits at controlled atmospheres the suppression of \( \text{C}_2\text{H}_4 \) biosynthesis and action is one of the mechanisms by which atmospheres enriched in \( \text{CO}_2 \) or reduced in \( \text{O}_2 \) extend the storage life of climacteric fruit such as pears. Burg and Burg (1967) demonstrated that elevated \( \text{CO}_2 \) acts as a competitive inhibitor of \( \text{C}_2\text{H}_4 \) action and postulated that \( \text{CO}_2 \) displaces \( \text{C}_2\text{H}_4 \) at a receptor site. This explains why applying elevated \( \text{CO}_2 \) is less effective in inhibiting \( \text{C}_2\text{H}_4 \) biosynthesis when endogenous \( \text{C}_2\text{H}_4 \) biosynthesis rates are high. Burg and Burg (1967) also demonstrated that the presence of \( \text{CO}_2 \) is a prerequisite for the binding of ethylene to a hypothetical receptor and that lowered \( \text{O}_2 \) tensions prevent the binding of \( \text{C}_2\text{H}_4 \) to a receptor. This blocked perception of \( \text{C}_2\text{H}_4 \) by low \( \text{O}_2 \) tensions blocks the feed-forward up regulation of \( \text{C}_2\text{H}_4 \) biosynthesis.

The main diseases that occur in pome fruits during storage correspond, essentially, to the decay caused by the fungi \textit{Penicillium expansum} and \textit{Botrytis cinerea} which are responsible by the blue and grey rots, respectively. The characterization of the clone’s susceptibility to these rots was carried out at different times of cold preservation.

The objective of this study was to characterize and identify which pear clone maintains the best quality, at harvest and after a long period of cold storage under normal and controlled atmospheres.

**MATERIAL AND METHODS**

Fruit from clones 1, 2 and 4C of pear cv. Rocha, installed on the rootstock BA29, were produced in Alcobaça, West of Portugal. After the commercial harvest date, fruits were maintained at normal atmosphere (NA) (1°C temperature; 90-95% RH) and controlled atmosphere (CA) (1°C temperature; 90-95% RH; 2.5 kPa \( \text{O}_2 \); 0.7 kPa \( \text{CO}_2 \)) for 180 days.

Quality was tested and compared in three different moments: at harvest, end of storage period and after one week at room temperature (shelf life period). The following parameters were analysed:

- Flesh firmness, total soluble solids content (RI) and titratable acidity - measured according to Alavoine et al. (1988).
- Skin color - measured using a Minolta chromameter CR-300 (Japan), based on light reflectance of fruit surfaces (Shewfelt et al., 1988). The color values were expressed with the L*-a*-b* axis representing lightness, green-red and blue-yellow respectively. Color parameter (a*+b*) was selected since it was the best indicator to evaluate differences between treatments.
- Ethylene Production - evaluated by the headspace method at 20°C using a Pye Unicam Series 204 gas chromatograph equipped with a Porapak Q column and a flame ionisation detector (FID). The temperatures were set to 90 °C for the oven, room temperature for the injection port, and 150 °C for the detector (Hoffman and Yang, 1980).
- Sensory evaluation - The attributes appearance, texture, flavor and aroma were analysed by a panel composed by 8-10 members. Each treatment was ranked in order of preference according to descriptive tests (Stone et al., 1974) using a hedonic scale varying from 0 to 20. Final classification was the mean obtained from the total scores of sensory preferences.
Storage diseases susceptibility - *Penicillium expansum* and *Botrytis cinerea* were isolated from rotting pear and maintained in culture medium PDA (Difco) with periodic transfers by fruit. The suspensions of conidia were prepared as described previously (Janisiewics & Marchi, 1992). Fruit were inoculated with 20μl of a suspension of fungi and they stayed for 7 days at 22 °C. The assessment of damage was done by the diameter of lesions measurement (mm).

Statistical analysis - An ANOVA test for 95% confidence to evaluate differences among treatments followed by a Tukey test to measure differences between pairs of means.

**RESULTS AND DISCUSSION**

At harvest, fruits from clone 2 presented the skin colour more yellow (higher values of a*+b*) than fruits from clones 1 and 4C, which have similar values (Fig. 1). The evaluation of fruits after 180 days of cold storage showed that, in general, fruits under NA are more yellow than those under CA. After one week at room temperature, all fruit went on becoming more yellow being this evolution more evident in CA fruits. These fruits were in an atmosphere with low O₂ concentration (ca. 3.0 kPa) and low temperature and went for at room temperature and 21.0 kPa O₂. These new conditions are suitable to increase enzyme activities, namely chlorophyllases that contributes to chlorophyll degradation and evidence of yellow pigments (carotenoids and xanthophyls) (Thomas & Janave, 1992).

In what concerns firmness (Fig. 2 A), values maintain constant during all the storage period and are similar to those obtained at harvest. After 1 week at room temperature, fruits under NA showed in general a non significant decrease what may be responsible for a hardening of fruits firmness, unpleasant for the consumers. On the contrary, fruits under CA, presented a significant decrease on firmness values becoming softer, juicy and so, more appreciated by consumers.

Soluble solids (Fig. 2 B) presented the same trend as firmness, during storage both in CA and NA. After 1 week at room temperature, fruits under NA presented a significant decrease on sugar content that was consumed by the respiratory pathway what was not observed on fruits under CA.

At harvest, the acidity (Fig.2C) was lower in fruits from clone 1. At the end of storage there were no differences in both the fruit from CA and NA. In shelf-life, the fruits from clone 2, were slightly more acidic, especially those who were in CA.

On the relationship sugar / acid (Fig.2D), the clone 1 showed, at harvest, higher values. At the end of storage the highest values were obtained in fruits from NA, without appreciable differences between clones in both NA and in CA. At the end of shelf-life, fruits from clone 2 showed lower values of this parameter, especially in CA.

Fruits from clone 2, differently from the others, showed after harvest, at room temperature, a typical curve for the ethylene emission (Fig. 3A). At the exit of cold storage (180 days) (Fig. 3B), the fruit stored in CA showed ethylene production rates higher than those from NA (22, 31 and 89% for clones 1, 2 and 4C, respectively). Comparing these figures with those obtained, after the fruit were kept at NA and a week, in "shelf- life, there was increases of ethylene production of 108, 89 and 50% for the clones 1, 2 and 4C respectively. As for fruits stored in CA, only the clone 2 increased 37% the production of ethylene, suggesting that fruits from this clone were still, at harvest date, in the state of physiological maturity.
In the sensory evaluation of fruits were not detected differences between the three clones. However, the fruits stored in CA were more appreciated by consumers.

In general, the quality standards detected no appreciable differences between the three clones under study. The main differences were detected for storage technologies: normal air / controlled atmosphere.

Storage diseases susceptibility (Fig.4), caused by *P. expansum*, was lower in the case of clones 1 and 2, with particular reference to the clone 2, during the cold storage period. This trend has widened as they prolong the time of storage (3 and 5 months).

For diseases caused by *Botrytis cinerea* no significant differences were observed with regard to the three clones under study.

**CONCLUSIONS**

Apparently the three clones studied did not show distinct characteristics in terms of fruit quality.

Controlled atmosphere extends, in better conditions, fruit quality but, as soon as storage finishes, it will be required a quick process of marketing since senescence process in these conditions is faster than in normal atmosphere. So, during marketing period cold chain must proceed. Another process to keep fruits quality after controlled atmosphere is throughout modified atmosphere packaging with a known and adequate atmosphere composition.

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**References**


Fig. 1 - Fruits colour ($a^*+b^*$) at harvest, after 180 days of storage under normal (NA) and controlled (CA) atmosphere and after one week at room temperature.

Fig. 2 - Firmness (A), sugar content (B) acidity (C) and sugar/acid (D) at harvest, after 180 days of storage under normal (NA) and controlled (CA) atmosphere.

Fig. 3 - (A) Ethylene evolution in pears 24h after harvest and during a period of 13 days at room temperature. (B) Ethylene evolution in pears 24h after 180 days of storage under normal (NA) and controlled (CA) atmosphere and one week at room temperature. Each value represents the mean ± SE (n=3).
Fig. 4 - Sensorial evaluation of fruits stored during 180 days under normal (NA) and controlled (CA) atmosphere, measured after one week at room temperature. Final classification was the mean obtained from the total scores of sensory preferences. Each value represents the mean ± SE (n=8).

Fig. 5 - Susceptibility of ‘Rocha’ Pear clones 1, 2 and 4C for the fungi *P. expansum* and *B. cinerea* after 0, 3 and 5 months of cold storage in air (1ºC, 90% RH).