

Conference Paper

Postharvest Quality Parameters Evolution in ‘Golden Delicious’, ‘Gala’ and ‘Starking’ Apple

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Abstract

Portugal has the ideal conditions for the production of apples. The climate of the region is highly favorable for the biochemical processes of maturation. The high levels of sunshine ensure maximum photosynthetic activity and a better color of the fruits, while the warm temperature is ideal for ripening processes, facilitating the development of strong organoleptic elements. In this work, the Golden Delicious, Gala and Starking varieties, cultivated by different producers in the region of Viseu, were harvested during commercial maturation and analyzed in the postharvest phase. In the second phase of this work, the varieties were kept in normal atmosphere (NA) and analyzed weekly. The evolution parameters related to quality are based on the determination of firmness; the determination of Brix; and the determination of the presence of starch. The study suggests that the Gala variety, is the only variety where firmness is not significantly influenced throughout the storage. With regards to sugar content, the Golden Delicious strain is the only variety that is not influenced by storage. Finally, during storage, Starking develops the highest starch values.

Keywords: Apples, postharvest, varieties, storage, normal atmosphere

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1. Introduction

Portugal has ideal conditions for the production of apple fruit. The climate of the national fruit regions is highly favorable to the development of biochemical processes of maturation. The extremes of temperature and solar radiation, in more equatorial climates, burn the foliage and scallion less sheltered trunks and branches. However, the broad luminosity, without dangerous excesses, ensures the full efficiency of photosynthetic activity and a better color of the fruits, warm enough for the ripening process to proceed under ideal conditions and to provide the maximum organoleptic qualities [1].

Apple's composition comprises various sugars, proteins, vitamins (C and E), potassium and iron. In addition to these, pectin, organic acids, tannins, flavonoids and boron make this fruit suitable for various conditions ranging from high blood pressure, constipation,

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arteriosclerosis, diabetes among others. Although not the most cultivated fruit, the apple is considered the queen of the fruit given its culinary and medicinal properties [2].

The composition at the level of the mineral elements present in the apple is dependent on many factors, such as: means of production, varieties, climate and state of ripeness of the fruit. Thus, for example, the potassium content varies greatly depending on the dose of potassium fertilizer that was administered to each tree [3].

Fruit ripening is associated with physiological changes inherent to increased respiratory rate and ethylene production [4]. During the development and maturation period of the fruit, changes in chemical composition are clear. These changes are translated by changes in the sensory level, as well as the increase in sugar content, total soluble solids and decrease in organic acid content. Also according to [5], there is biosynthesis of compounds responsible for the aroma, the texture of the fruit becomes less firm by enzymatic hydrolysis of structural macromolecules. The apple is a climacteric fruit and is characterized by accumulating starch during fruit growth. The starch accumulated in apple increasing the sweetness of the fruit, making its taste more pleasant. This is a process that requires a lot of energy consumption and is related to an increase of the respiration rate of the fruits until it reaches its maximum at the end of the ripening (climatic peak). This process is accelerated after fruit harvesting, especially if there is no adequate control of environmental factors [6].

Apple is harvested for a short period [7]. The suitability of fruit for cold storage is influenced by factors such as: variety; the soil; climate and agricultural practices in the countryside [8]. The storage period depends on the product, storage conditions, marketing circuit and market opportunities [9].

During preservation and commercialization, the fruits sometimes present alterations that significantly decrease their quality. These can reach the pulp deeply as soft and dry rot or only manifest as small epidermal necrosis [10]. The cold preservation that allows to control the microbiological proliferation or inhibiting it, as well as chemical or enzymatic reactions [11].

The normal atmosphere is limited mainly by the effect of atmospheric oxygen and the growth of altering aerobic microorganisms, which promote changes in odor, taste, color and texture, leading to loss of quality [12].

The modified and controlled atmosphere refers to a change in the composition of gases (oxygen, nitrogen and carbon dioxide) in food packaging. This atmosphere allows to inhibit the growth of microorganisms and the release of ethylene, thus increasing the shelf life of fruits [11].

According to a study by [13] in which it was found that the effect of moisture on 'Gala' apples stored for 8 months in a controlled atmosphere would affect the loss of flesh firmness. It can be verified that at the end of a period of 7 days, in a controlled atmosphere, this did not affect the firmness.

Thus, the objective of this work we intend to observe which apple variety is best suited for storage, and was to evaluate the evolution of postharvest quality parameters in the Golden Delicious, Gala and Starking apples harvested on different dates and from 11 different producers.

In this study, we sought information on the behavior of fruits of different varieties in some qualitative parameters (texture, acidity, sugars, occurrence of physiological changes). In a first phase of this work, the Golden Delicious, Gala and Starking varieties, cultivated in the Viseu region, and harvested at commercial maturation were analyzed at harvest. In the second phase of the work the varieties were kept for 3 months in normal atmosphere (NA) and were analyzed weekly.

2. Methodology

Apples harvested at commercial ripeness were stored in Normal Atmosphere (0,5 °C and 90% RH) and analyzed weekly by taking a sample from each producer where quality parameters, such as firmness, soluble solids and starch presence were evaluated. There were 25 apples from 11 producers and 3 different apple varieties (Golden, Gala and Starking).

2.1. Firmness

The firmness of the fruit depends on its degree of ripeness. The measurement is made with a penetrometer (mod FT 327). To improve the homogeneity of results, by convention firmness is measured in the equatorial zone and on the less colored face of the fruit. An 11 mm diameter probe was used.

2.2. Soluble solids content

The measurement was made with the help of a manual refractometer (NT-032ATC). The methodology used was hail, mishandling, scale, cracks and deformations.

2.3. Statistical analysis

The data obtained were statistically treated with the SPSS program. The values were statistically analyzed using the ANOVA test, and in cases where the difference was significant ($p < 0.05$), the Duncan mean comparison test was used.

3. Analysis, and Discussion of Results: Evolution of Quality Parameters By Variety

3.1. Golden Delicious

3.1.1. Firmness

In Figure 1, we can observe the evolution of firmness along the storage of the different producers. As we can see in this Figure, the Golden Delicious apples firmness was not significantly influenced by the storage times, except for producer 368, which at days 0 and 75 after harvest, presented higher firmness values.

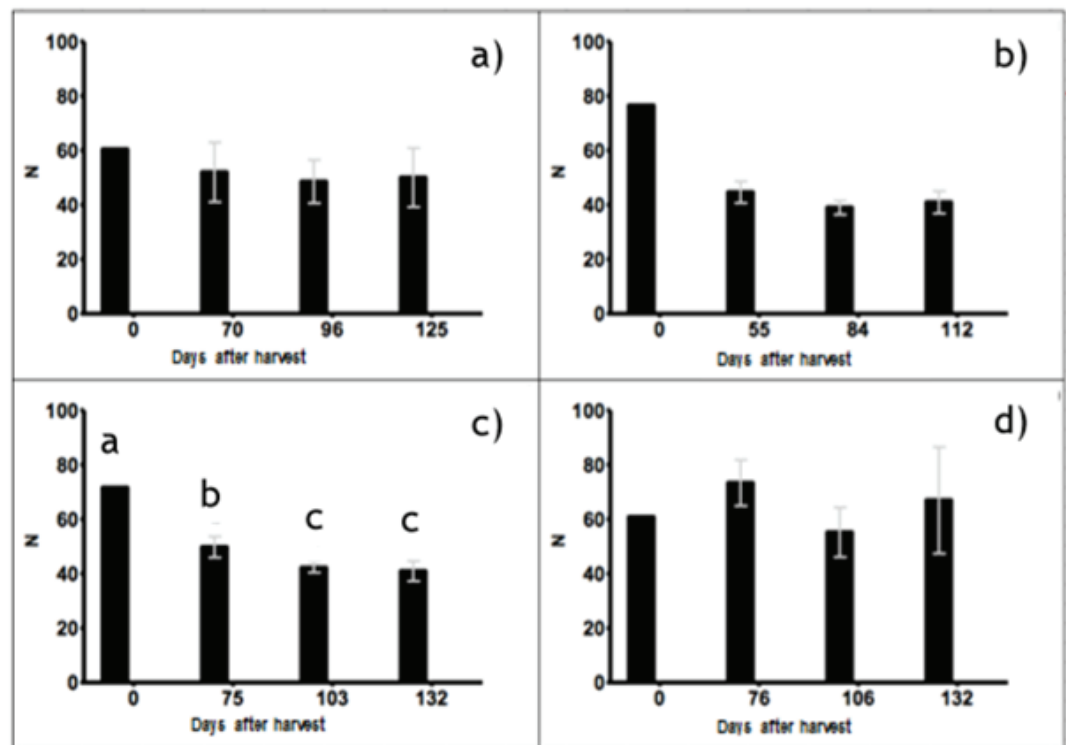


Figure 1: Evolution of Firmness during storage for different producers a) 319; b) 395; c) 368 and d) 377.

3.1.2. Soluble solids

In Figure 2, we can observe the evolution of soluble solids content during storage of different producers. As we can see in the Figure the Golden Delicious apples °Brix was not significantly influenced during storage.

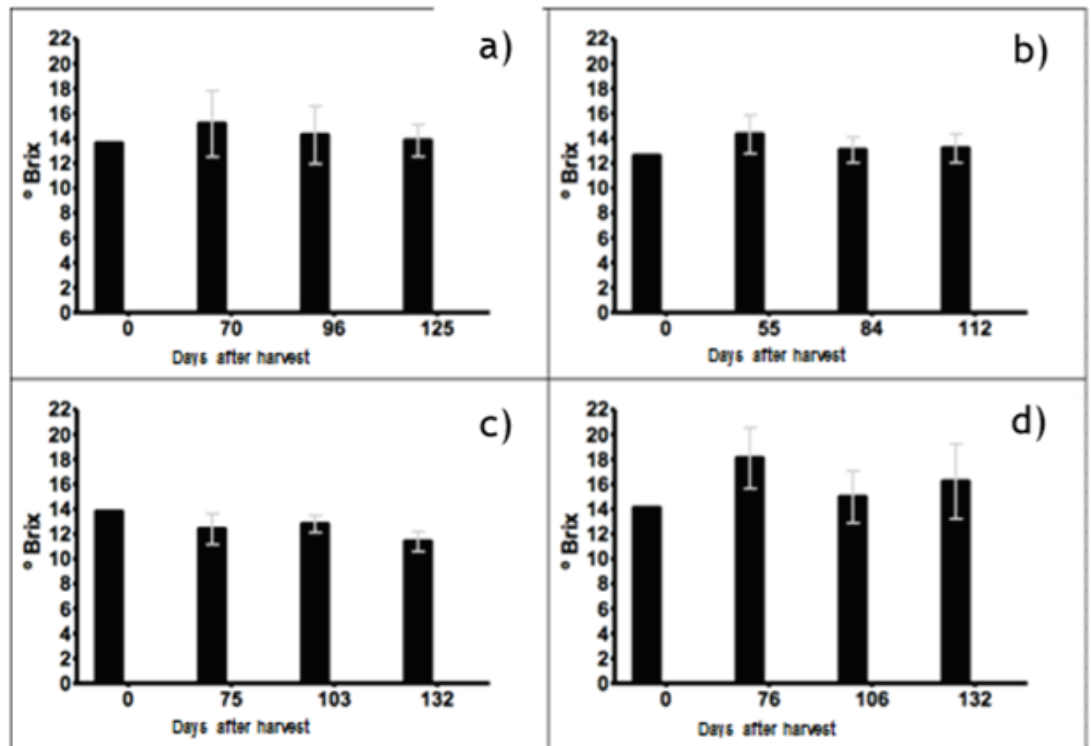


Figure 2: Evolution of soluble solids content during storage for different producers a) 319; b) 395; c) 368 and d) 377.

3.1.3. Starch Index

In Figure 3, we can observe the evolution of the starch index during the storage of the different producers. As we can see in the Figure the presence of Golden Delicious apples starch was not significantly influenced by the storage duration in the producers 395 and 377. According to [6], how apple starch is hydrolyzed to monosaccharides, glucose and fructose during ripening. This causes this value to increase over time and it is possible to verify this.

3.2. GALA

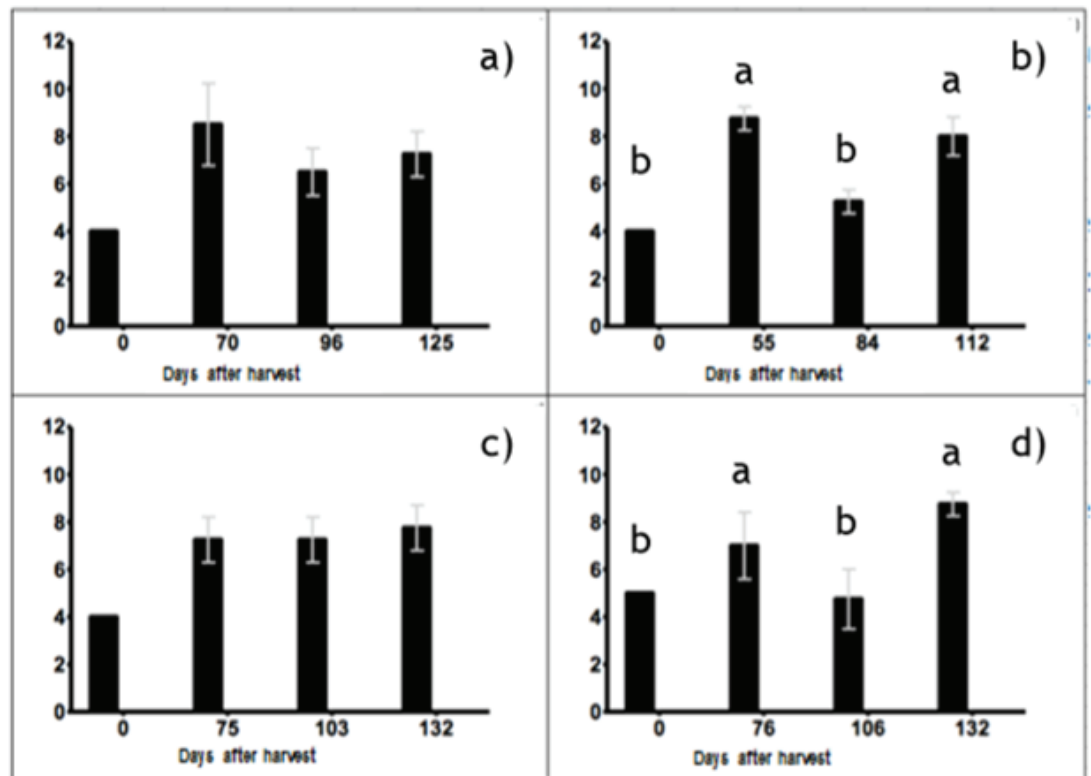


Figure 3: Evolution of starch iodine index during storage for different producers a) 319; b) 395; c) 368 and d) 377.

3.2.1. Firmness

In Figure 4, we can observe the evolution of firmness along the storage of the different producers. As we can see in the Figure, the firmness of Gala apples was not significantly influenced by the storage duration.

3.2.2. Soluble solids

In Figure 5, we can observe the evolution of soluble solids content during storage of different producers. As we can see in the Figure, the °Brix of Gala apples was not significantly influenced by storage times, except for producer 69, due to higher values on day 126. Ethylene is the hormone that triggers the ripening process. Which leads to increased sugar content.

3.2.3. Starch Index

In Figure 6, we can observe the evolution of the starch index during the storage of the different producers. As we can see in the Figure, the evolution of the starch index of

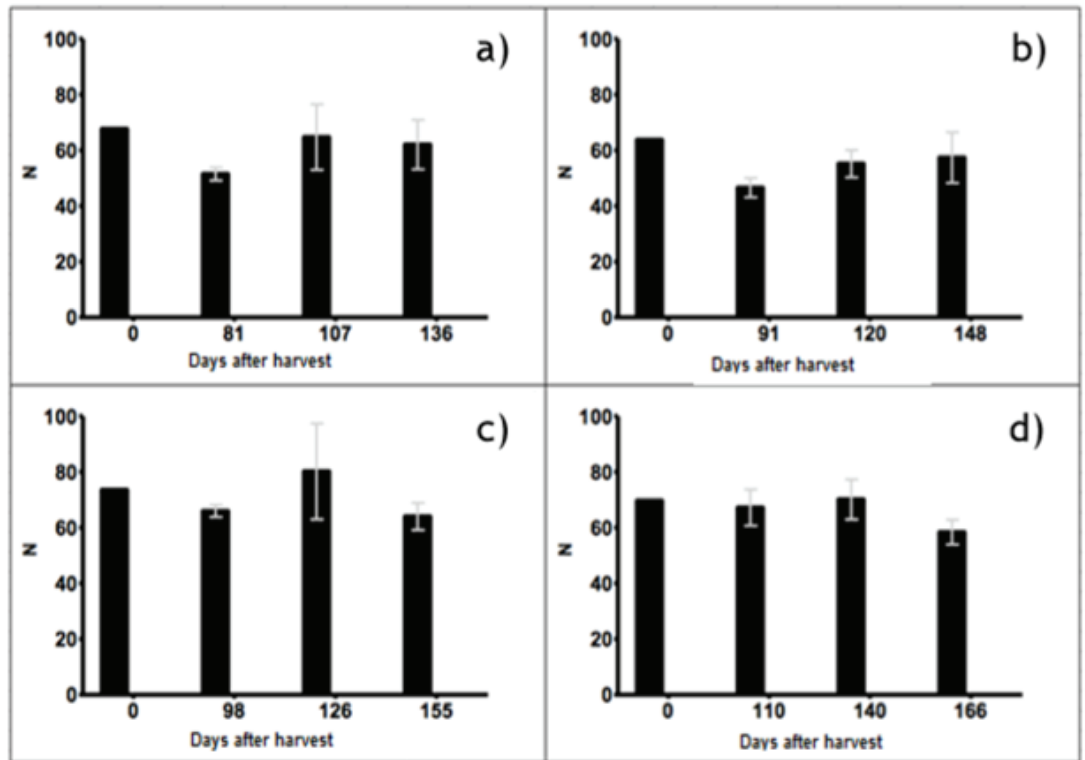


Figure 4: Evolution of firmness during storage for different producers a) 263, b) 288, c) 69 and d) 392.

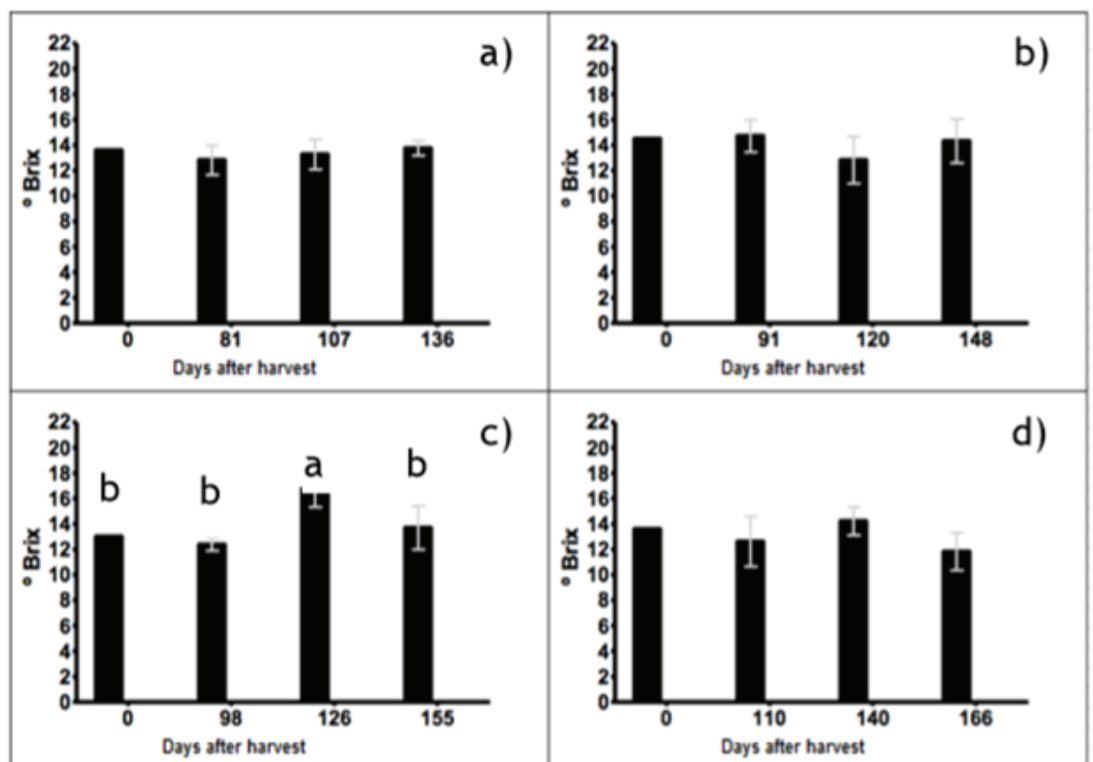


Figure 5: Evolution of soluble solids content during storage for different producers a) 263, b) 288, c) 69 and d) 392.

Gala apples was significantly influenced by the storage duration for producers 263, 69 and 392. During storage, this is hydrolyzed to glucose and fructose leading to higher values in the starch iodine index.

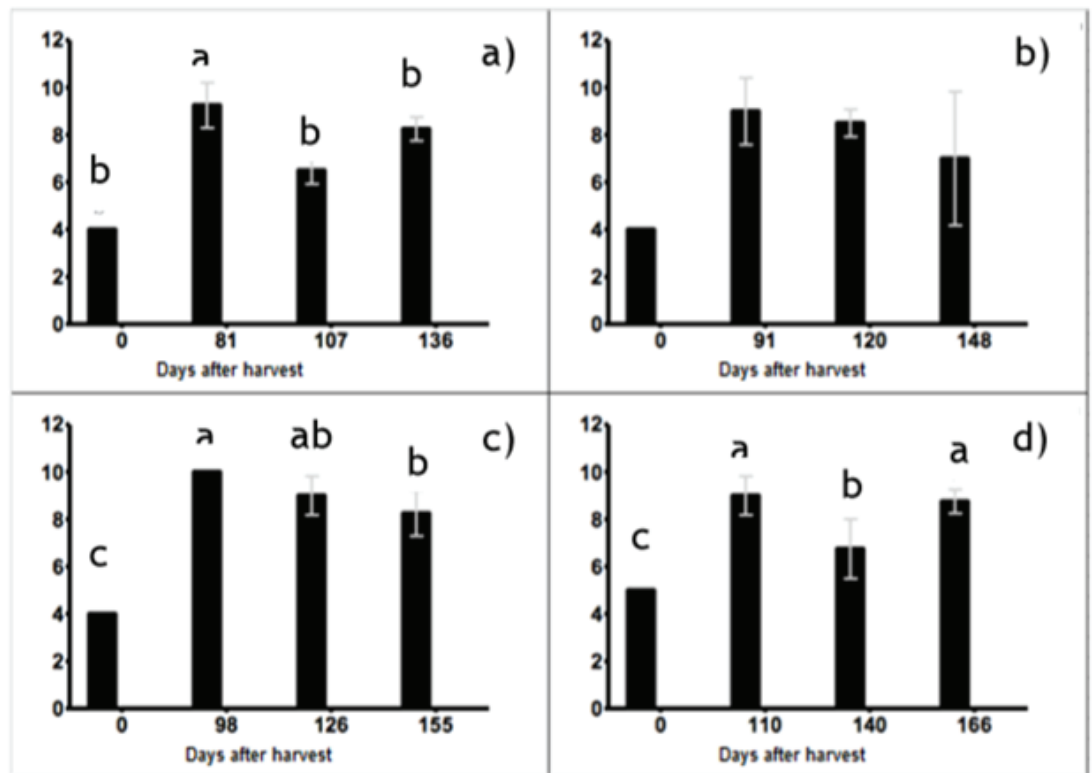


Figure 6: Evolution of Starch Iodine Index during storage for different producers a) 263, b) 288, c) 69 and d) 392.

3.3. STARKING

3.3.1. Firmness

In Figure 7, we can observe the evolution of firmness during storage for different producers. As can be seen in the Figure, the firmness of Starking apples was not significantly influenced during storage for producer 383. On harvest day, apples had higher values. According [14] and [15], it is due to the fact that the fruit loses water that leads, on the one hand, to weight loss and, on the other, to loss in appearance (wilting) and texture (softening, loss of crunchy property, loss of juice).

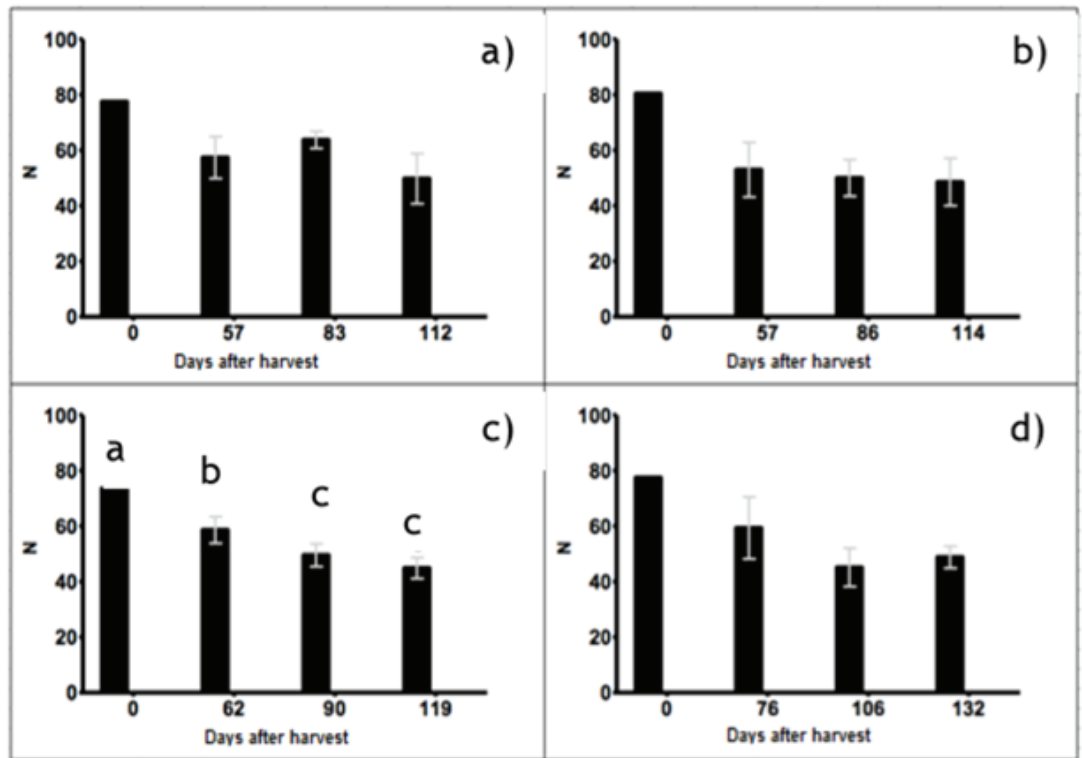


Figure 7: Evolution of firmness during storage for different producers a) 319, b) 291, c) 383 and d) 359.

3.3.2. Soluble solids

In Figure 8, we can see the evolution of soluble solids content during storage for different producers. As we can see in the Figure, the °Brix of Starking apples was significantly influenced by the storage duration, for producer 383, who presented the lowest °Brix on harvest day and 62 days after harvest. During ripening the sugar content in the fruit increases, a factor that we can observe until day 119 after harvest.

3.3.3. Starch Index

In Figure 9, we can observe the evolution of the starch iodine index during storage for different producers. As we can see in the Figure, the evolution of the Starking apples starch index was not significantly influenced during storage, except for producer 319 where we observed that the starch iodine index value is lower at harvest as it is to be expected since this value indicates a higher starch content which decreases over the course of ripening due to its hydrolysis in fructose and glucose.

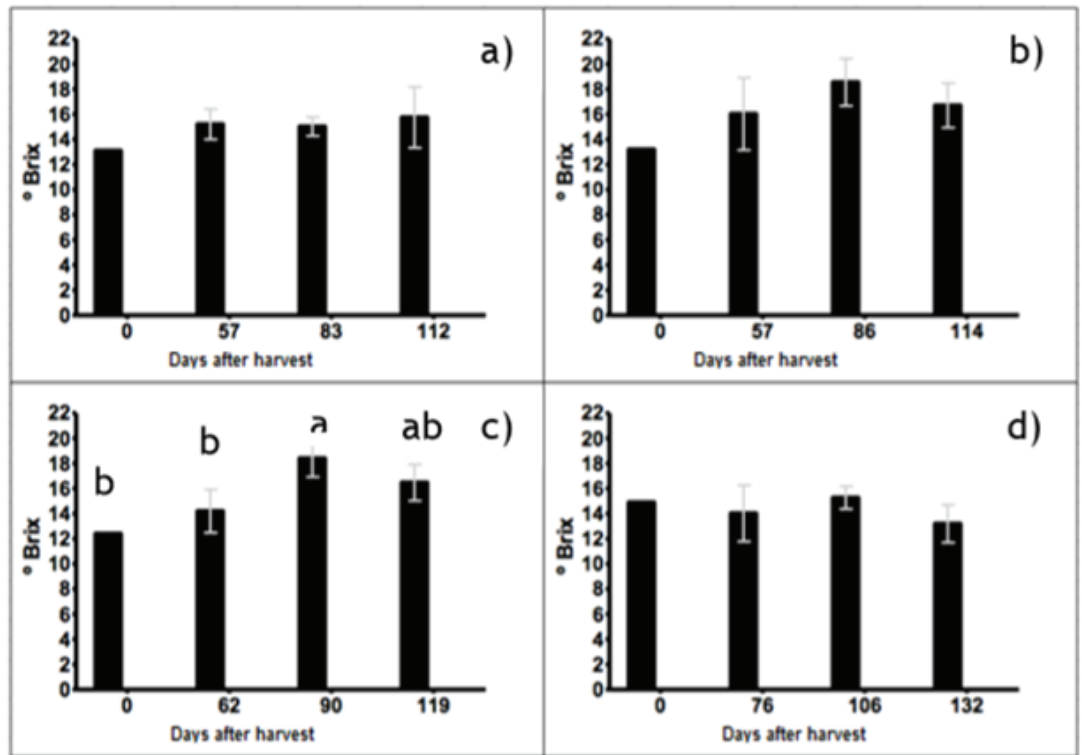


Figure 8: Evolution of soluble solids content during storage for different producers a) 319, b) 291, c) 383 and d) 359.

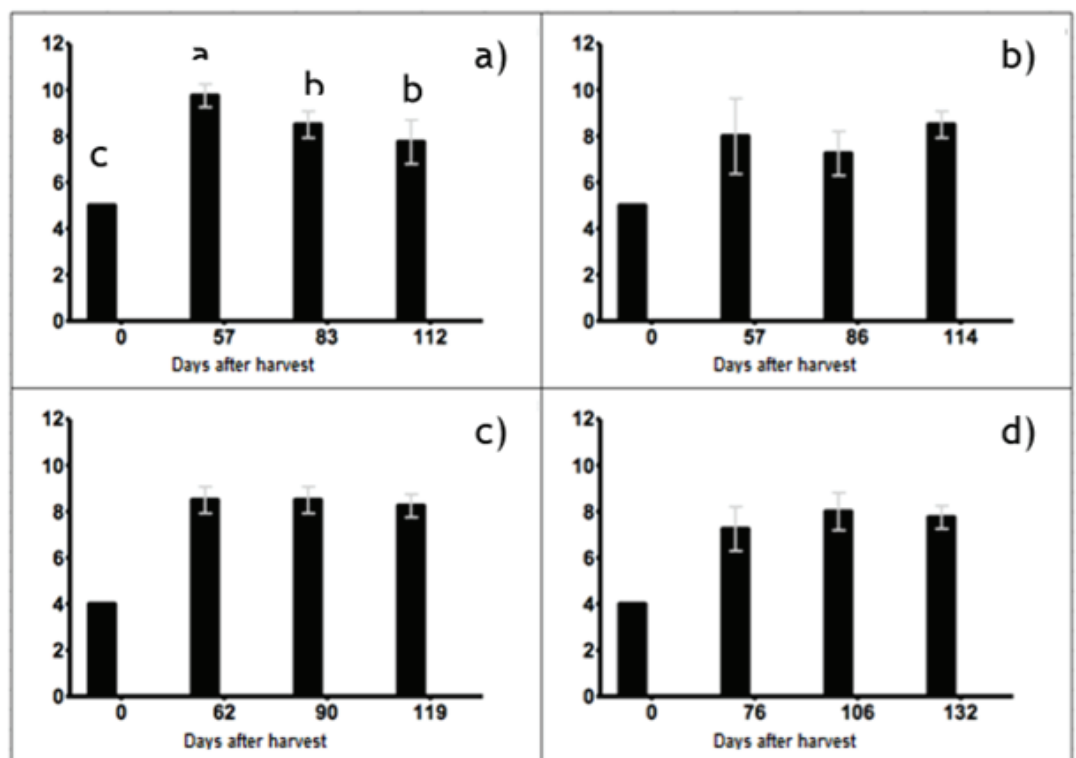


Figure 9: Evolution of starch iodine content during storage for producers a) 319, b) 291, c) 383 and d) 359.

4. Conclusions

This study allowed to observe the evolution of some quality parameters in the postharvest period, verifying the behavior of different cultivars in relation to the external characteristics of ripeness and to determine the internal and external quality of the fruits through laboratory analysis (soluble solids, firmness, starch iodine and quantification of defects).

During storage the fruits lose the firmness of the pulp, due to the process of maturation evolution. In conclusion to the analysis of the quality parameters related to fruit firmness, it was found that the Golden Delicious and Starking varieties were significantly influenced over the storage time for 3 producers, which is not the case with the Gala variety. The Gala apple is the variety that presented the lowest average firmness at the harvest. Starking being the variety with the highest average firmness at harvest, followed by the Golden Delicious variety. What was found in general was that both firmness over the storage time since harvest and starch iodine are decreasing, but the soluble solids content is increased. Climate change is having its effects on the texture and taste of apples due to the fact that “early flowering and high temperatures” during the growing phase.

This work may be a contribution to further studies in order to understand, in the long run, the behavior of both varieties in the three different stocks.

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