THE SYNERGISTIC EFFECTS OF A RECOLLECTION AND CONSERVATION METHOD DESIGNED FOR SMALL PRODUCERS ON THE QUALITY PARAMETERS OF THE PRODUCED OLIVE OIL.

Post-harvest impact on olive oil quality (short running title)

Eddy Plasquy[a*], María del Carmen Florido[b], Gregorio Blanco-Roldán[c], José María García Martos[a].

[a] Instituto de la Grasa. Departamento de Bioquímica y Biología Molecular de Productos Vegetales (CSIC). Carretera Sevilla Utrera km 1. Campus de la UPO, Edificio 46, 41013, Seville, Spain.

[b] Departamento de Cristalografía, Mineralogía y Química Agrícola, E.T.S.I.A. Universidad de Sevilla. Carretera Sevilla Utrera km 1, 41013, Seville, Spain.

[c] G.I. AGR 126 “Mecanización y Tecnología Rural”. E.T.S.I.A.M. Universidad de Córdoba. Campus Rabanales, Ed. Leonardo Da Vinci, Ctra. Nacional IV, km. 396. 14014. Córdoba.

* Corresponding author

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ABSTRACT

The production of ‘Premium’ olive oil depends in large part of the quality of the fruit. Small producers see themselves confronted with vast investments and logistic snags when they intend to optimize the recollection. Recently manual devices at an affordable price promises less damaged fruit when compared to the traditional picking with nets while the use of a cooling room on the farm might offer a solution when the picking needs to be stretched out over several days. The effects of picking with a manual inverted umbrella, together with a storage up to 14 days at 5 °C was studied, taking into account ten quality parameters of the produced oil during two years and three cultivars: ‘Arbequina’, ‘Picual’ and ‘Verdial’. The results indicate that such a combination guaranteed the best quality end product as compared with any of the three other ones. The strength of each factor, estimated with the omega-square statistic, varied in time and according to the cultivar. ‘Arbequina’ showed to be the most sensible with a rapid increase of the importance of the conservation factor. ‘Picual’ showed to be the most resistant to deterioration with a lower explanatory value of this factor as compared to the picking method. The study indicates that small producers, even under financial and logistic restrictions, can obtain a high quality end product. Either by combining both methods or by choosing the one that guaranties the best results given the cultivar and the specific storage time they opt to take into account.

KEYWORDS

manual inverted umbrella, cold storage, virgin olive oil, quality parameters, omega square

1. INTRODUCTION

The extension of the Andalusian olive fruit production is with more than 1.500.000 ha not only the core agricultural activity for that region but also the main source of income for more 250 villages (Junta de Andalucía, 2015; Ley Del Olivar, 2011). Lesser-known characteristics are that 60 % of the 170.000 exploitations are smaller than 5 ha and 80 % less than 10 ha and that more than 50 % of the Agricultural Work Units is done in a strictly family context, in particular as non-salary-compensated work (Junta de Andalucía, 2015).

These structural factors have a direct impact on the used recollection methods as they limit the financial possibilities of the small producers. Many of them, already of advanced age (70 % are older than 45 years) of which only 60 % define agriculture as their prime activity, are not inclined to do big investments (Serrano *et al.*, 2012; Colombo and Villanueva, 2017). The impossibility to amortize sophisticated but expensive machinery on the one hand, or to contract specialized recollecting services on the other, explains why many of them still continue to collect their olives in the traditional way, beating the olive tree with sticks with nets put on the ground around it.

This traditional method implies that once a tree is picked, the nets are dragged to the next, where they are spread out again until their weight is too heavy to be lugged any further. At that time the fruit is recollected in plastic barns and emptied in a container or a truck load. The method is speedy and implies low costs but has several inconveniences that may jeopardize the intactness of the fruit. Dragging the fruit on the nets over the ground damage them inevitably, while the pickers cannot avoid stepping on the fallen fruit while beating the branches. The relation between the quality of the fruit and the extracted oil has been the object of many studies and proven to be primordial to obtain an excellent end product (Garcia and Yousfi, 2006; Yousfi *et al.*, 2012; Rallo *et al.*, 2018; Faminiani *et al.*, 2020). However, when one decides to maximize the yield of the production, the quality of the fruit becomes less important compared to the applied extraction techniques.

During the last decade, a growing number of Spanish mills started to produce a so-called AOVE Premium's, instead of the common one-sided attention on maximizing the quantity. The choice for quality instead of quantity goes along with the necessity to evaluate rigorously the quality of the fruit in the reception yard, and an adjusted reimbursement to the producer. More recently, preliminary studies to automatize this evaluation are preceding more stringent quality controls in the near future (Puerto *et al.*, 2015; Navarro Soto *et al*. 2018; Aguilera Puerto *et al.*, 2019).

Meanwhile, a new kind of olive oil producer came to the foreground. Smaller scale and with a clear focus on the production of a high quality. However, these producers do not only face the challenge to optimize their recollection but also confront an additional problem if they do not extract the oil themselves, namely the restrictions that are imposed by the mill that processes their fruit. The necessity to bring in at least several tons of olives in order to process them as a single batch, implies several days of picking when working on a family scale. While it is common knowledge that the olives are ideally processed as soon as possible, the conservation of the picked fruits becomes a core problem for these small producers.

When the olive production is approached from a small producer's point of view, the necessity to improve the recollection is obvious. Not only for the independent farmer who seeks to obtain his proper oil at the best quality possible, but also for the member of the local cooperative who will be reimbursed not only on the yield but also on the quality of the fruit. A growing amount of economic picking devices is coming on the market that specifically addresses these small producers. Their basic structure consists in a foldable umbrella that is mounted on the movable structure which is provided with a system to collect the fallen fruit.

Once the Manual Inverted Umbrella (MIU) is placed around the trunk, the fruit are picked by means of branch shakers or shaker rakes and once fallen on the canvas they roll into a box. The use of such a MIU turned out to be competitive when compared with the traditional picking method while the quality of the picked fruit was significantly better (Plasquy *et al.*, 2019).

In order to maintain the fruit at its best, conservation at 5°C is extensively studied and proven since more than 25 years (García and Streif, 1991; García *et al.*, 1994; Canet and García, 1999; Pereira *et al.*, 2002). These studies were mainly focused on prolonging the use of the extraction lines and thus envisioned conservation up to one month or more (García *et al*., 1996). The benefits of an adequate conservation at a shorter time has not been yet studied, especially when the aim is to produce premium quality virgin olive oil and not just avoid the significant deterioration of its initial quality (Kalua et al., 2008). Nevertheless, it might offer a solution for the individual farmer who seek to keep his picked olives during a limited time on the farm before their transport to the mill. It makes it possible to plan the picking in function of the available workforce, to anticipate bad weather and to organize in advance a convenient transport and time slot in the mill.

Knowing that both methods (recollection and conservation) contribute in a significant way to a better end result does not answer the question which one has the major impact on the quality parameters of the produced olive oil, especially when the storage time is taken into account as a complementary factor. This challenge becomes vital when the economic resources of the farmer are viewed as a limiting factor in the decision process. Under these circumstances one need to know not only whether the new methods will be effective or not, but also which investment will pay off the most in terms of quality, given a specific time frame. In other words, it becomes necessary to calculate the size of the effect of the factors and their interaction over time on the distinct parameters. The effect size is a descriptive statistic indicating the proportion of variability in the observed data that is accounted by the treatments (Maxwell *et al*., 2018).

This can be estimated in various ways, but the calculation of the Omega-Square ($\widehat{\omega}^2$) is preferred because this estimation of the effect size resulted to be less biased as compared to Eta and Partial Eta-Squared, especially when dealing with small samples (Maxwell *et al*., 2018; Yigit and Mendes, 2018).

2. MATERIAL AND METHODS

2.1. Location

The experiment took place in the olive groove of ‘Del Cetino’, situated in Bollullos par del Condado (Huelva). It covers 8 ha and includes 1700 trees, mainly of the varieties ‘Arbequina’, ‘Picual’ and ‘Verdial’, planted between 2005 and 2007 at distances of 6 x 7 m and irrigated on a deficient regimen. The farm disposes of a MIU and a cooling room with a storage capacity of 6000 kg.

2.2. Recollection method and conservation facilities

The recollection was performed with a MIU and with nets as control group (Plasquy et al., 2019). Both methods used branch shakers to detach the fruit from the tree. Each plastic box contained 19 ± 1 kg picked fruit. The storage room on the farm was cooled at 5 °C (± 1 °C). The boxes of the control group were stored outside under a protected roof at ambient temperature. The mean temperatures in October 2017 were 15,4 °C (min) and 29,3 °C (max) and in October 2018, 14,2 °C (min) and 24,7 °C (max).

2.3. Experimental material

The picking took place between the end of September and the beginning of November during two consecutive years (2017-2018) when the majority of the olives were still green (in all cases the Maturity Index of the fruit samples was situated between 1,5 and 2,5). In order to assess the effects of the recollection and conservation method on the produced oil, samples of the ‘Arbequina’, ‘Picual’ and ‘Verdial’ cultivars were collected at the same moments and under the same conditions as those intended for industrial extraction. An equal amount of olives was recollected using branch shakers and the MIU and nets to be used as control group. To evaluate each factor, triplicates of samples of recollected olives of both picking systems were kept during distinct periods (0, 4, 8 and 14 days) each one in 6 boxes of 20 kg, which were previously distributed in the cooling room at 5 °C and outside at ambient temperature. The two types of recollection (R1: with a MIU or R2: Conventional with nets), two types of conservation (C1: 5 °C and C2: ambient temperature) and four distinct conservation periods (T0, T4, T8 and T14), gave rise to 18 different combination of factors for each variety and each year.

2.4. Preparation of the samples

Extraction of the oil was performed in the laboratory using an “Abencor” system, where individual samples of 1.500 g olives, were crushed in the hammer mill. The resulting paste was distributed in two subsamples of 700 g, which were weighed in two stainless steel casserole pots. There, the paste was malaxated in the thermoblender during 30 min at 30 ºC. Afterwards, the malaxated paste of each pot was centrifuged at 1.000 G during 1 min. The resulting solid phase of the paste was discarded and the liquid obtained was placed in a graduated 500 mL test tube for separating the aqueous phase of the lipid phase. The Virgin Olive Oil (VOO) extracted from both subsamples was taken from the lipid phases using a Pasteur pipette, filtered with filter paper and placed in a glass bottle of 250 mL, which was filled with nitrogen and kept at -20 ºC until further examination. The experiment was carried out in triplicate.

2.5. Physico-chemical analysis

Free fatty acidity (FFA), Peroxide value, absorbency at 232 and 270 nm were determined according to the official analytical methods as described in EC regulation 2568:91 and the modifications ECC/796/02 and ECC/1989/03.

The oxidative stability was evaluated using the Rancimat method. The stability was expressed as the oxidation induction time (h) measured with the Rancimat apparatus (Metrohm AG, Herison, Switzerland) at a temperature of 120 °C and an air flow rate of 20 L/h.

The chlorophyll and carotenoid pigment profile was obtained by measuring the spectrophotometric absorbency in ultraviolet, respectively at 470 nm for the carotenoids and at 670 nm for the chlorophyll fraction.

The bitterness index, used to estimate the presence of the attribute ‘bitterness’, was calculated using the formula: $IA = 13{,}33 \times K_{225} – 0{,}837$ (21).

An estimation of the total polyphenols was obtained by the sum of the calculated amount of polyphenols obtained by measuring the spectrophotometric absorbency at 280 and 335 nm using p-hidroxifenil acetic acid and orto-cumaric acid as calibrating patron respectively. Prior measurements revealed a calibration function for p-hidroxifenil acetic acid of $y = 0{,}0585x – 0{,}0007$ and for orto-cumaric acid of $y = 0{,}0218x + 0{,}0001$.

The content of α-tocopherols was determined through high-performance liquid chromatography (HPLC) using the IUPAC method (IUPAC, 1992).

2.6. Statistical data analysis

Statistical data analysis of the physico-chemical parameters was performed using PASW Statistics 18.0 (SPSS). For each individual cultivar, one-way ANOVA determined the effect of the ST, considering independently each combination of the other factors (PM and SM), as well the effect of these four combinations for each ST separately. Similarly for each ST the effect of the PM was studied independently for each SM and vice versa. The effect of the ST and the treatments, defined as the four possible combinations of the PM and SM, was tested with two-way ANOVA. Finally, the effect of three factors (ST, PM and SM) was studied by three-way ANOVA. If a significant effect of one of the factors was detected in a parameter, the Tuckey test was applied to differentiate mean values (P < 0.05) in each variable.

For each ST, the effect size of the different factors and their interaction was determined by calculating the $\widehat{\omega}^2$ value, using the formula:

$$\widehat{\omega}^2 = \frac{SS_{Effect} - df_{\ Effect}\ MS_{Error}}{SS_{Total} + MS_{Error}}$$

The calculation was performed in MS Excell, using the data from the SPSS analysis. Negative values where set to zero. Omega squared measures become positive only when the observed F value exceeds 1,0. Only in these cases the effect accounts for variance in the population.

In order to have a clear idea on how the effect of both methods evolve in time, the different $\widehat{\omega}^2$-values for each parameter were compared at each ST. To estimate the tendency of the overall effect of the methods on the produced olive oil over the course of time the average of the $\widehat{\omega}^2$-values for all the parameters and both years for each ST was calculated. The selection of these parameters is not predetermined as there does not exist to this day any theoretical model that integrate the various parameters and their individual weight into an overall quality appreciation.

3. RESULTS

3.1. Free Fatty Acidity

In all of the three varieties the ST showed to be highly significant in year 1 and 2, although the 'Arbequina' variety turned out to be much more vulnerable when compared to 'Picual' and 'Verdial', since in both years 'Arbequina' showed a highly significant effect of the Picking Method (PM) and of the Storage Method (SM) (Tables 1 and 2). After 4 days there was a clear difference between the oils extracted from fruits picked conventionally and stored at room temperature (R2C2) and the other 3 treatments (R1C1, R1C2 and R2C1). In year 1, the FAA of these samples even exceeded the limit of 0,80 % of oleic acid, and as a consequence could not be classified as 'extra'. In year 2, the effect of the cooling was more prominent when compared with year 1 and let to a clear differentiation between the oils on day 14, with the lowest values for treatment R1C1 (0,12 ± 0,00) and the highest for R2C2 (0,53 ± 0,03) (Tables 1 and 2). The values of the $\widehat{\omega}^2$ presented for both years a similar profile over the period of 14 days. At day 0, the PM turned out to explain the variance slightly above 30 % (Table 3). From day 4 on, the effect of the SM was always greater than the PM. However, in year 1, the interaction between both methods gained importance from day 4 on, indicating that the effects of the storage method depended in large part on the intactness of the fruit. In year 2, the role of this interaction was downplayed with an obvious effect of the SM from day 4, and more than 80 % of the variance explained at day 14.

The 'Picual' variety showed to be more resistant toward an increase in the FFA, with similar tendencies at day 14, however without exceeding the official limits. In both years, a differentiation of R2C2 with regard to the three other conditions was present. However, in year 1, no significant effect of the PM was detected (Tables 1 and 2). Measurement of the effect revealed two different profiles. In year 1, a steep increase of the importance of the interaction between both methods became visible from day 4. The same happened with respect to the effect of the SM from day 8 on. Both balanced each other in importance at day 14, explaining almost 80 % of the variance. In year 2, the importance of the SM was far more important directly after the picking and already responsible for 76 % of the variance. As such, the role of the PM is downplayed, although at day 14, its effect as well as that of the interaction gained in importance in explaining the obtained results.

Over the 2 years, the ‘Verdial’ variety presented a confused image. While the storage time and the treatment were significant in both years, the SM showed to be highly significant and the PM not in year 1, while in the following it was exactly the inverse. With respect to their effect, the result was similar, with an increasing importance of the SM from the day 4 up to almost 60 % at day 14. In year 2, the effect of the SM was absent while the importance of the PM fluctuated between 30 and 60 %.

3.2. Peroxides

The degree of initial oxidation of the three studied cultivars presented similar values when comparing the two years, but showed a clear difference between ‘Arbequina’ and ‘Picual’ on one side, and ‘Verdial’ on the other (Table 1). While oils of the former presented values that where always far below the official maximum of 20 mEq O_2/kg oil, the extracted oils of the latter came close to that threshold in the second year. The ST and PM stood out as a significant factor in all of the 6 different cases, while the SM was only significant in 3, namely both years in ‘Arbequina’ and the first year in ‘Verdial’. In the same way, the interaction between the PM and SM was evaluated (Table 2).

Similar results were obtained with regard to the magnitude of the effect of the different methods (Table 3). In all the cases the PM stood out as the most influential factor in all the cases at day 14. In ‘Arbequina’ an increase from day 4 was present in both years. The effect of the PM was at the most during the first 4 days, in which it was responsible for more than 60 % (year 1) and more than 40 % (year 2). From then on it descended below 5 % at day 14. An effect of the interaction was also involved, although not in the same matter in both years. In year 1, its becomes clearly visible from day 8 where it attained more 30 % at day 14, while in year 2, the effect is at its most 16 % at day 8. For the ‘Picual’ variety the effect of the SM was neglectable over the whole period while the PM-profile differs when one year is compared to the other. For ‘Verdial’, consistent results were obtained, although the effect of the PM fluctuated between 60 and 80 % during year 1 and between 15 and 30 % in year 2.

3.3. K 232 and K 270

The calculated values of the absorbance at 232 nm were only affected by the different factors in one case out of six, namely in year 2 of the ‘Verdial’ cultivar (Table 1). ‘Arbequina’ and ‘Picual’ did not showed a significant difference in PM and SM in neither studied years (Table 2). The ST turned out to be significant in ‘Verdial’ and in year 2 in ‘Arbequina’. With respect to the absorbance at 270 nm the ST turned out to be the only significant factor in all of the 6 cases. The 3 cultivars were comparable with respect to the significance of the factor PM and SM. All showed a significant effect in the second year for the PM; however, the SM showed to be not a significant factor in the Arbequina and ‘Picual’ cases, and only during year 2 in ‘Verdial’ variety.

In year 2, the magnitude of the effect of the PM was substantial in all the 3 varieties. In ‘Arbequina’, it was responsible for 35 % (day 8), in ‘Picual’ for 62 % (day 8) and in ‘Verdial’ for 82 % (day 4) and 72 % (day 8). A notable effect of the SM in the ‘Verdial’ variety started at day 8 (8 %) and attained 55 % at day 14, at the cost of the importance of the PM, which was reduced to 21 % at that time (Table 3).

3.4. Oxidative stability

The levels of oxidative stability, expressed in hours, varied consistently in the 3 studied cultivars over both years. The highest values were measured in 'Picual', within an overall range between 90 and 145 h; 'Verdial' showed values between 60 and 80 h, and Arbequina between 27 and 47 h (Table 1). In Arbequina, there was a clear difference in the distinct treatments and a significant effect on both the PM and SM. In both years there was also a significant effect of the interaction between SM and the ST however only in year 1 an interaction effect between PM and ST was observable (Table 2). In 'Picual', the PM turned out to be highly significant and this in both years, while this was not the case for the SM, except when studied in interaction with the ST. The 'Verdial' cultivar showed a confuse profile when comparing both years. In year 1, the ST, PM and SM were very significant, however, in year 2 neither one of these factors showed a significant effect.

With regard to the impact of the different factors a consistent trend was observable for the three varieties, characterized with a superior impact of the PM up to 4 days, followed by a decrease from then on (Table 3). In the course of the 14 days, the importance of the SM increased, however its maximum and velocity varies: In 'Arbequina' it attained up to almost 80 % at day 14, In 'Verdial' a 40 % and in 'Picual' a 20 %. The results over the 2 years also indicated that the importance of the interaction varies between them. The 'Arbequina' variety, only showed a importance of 20 % at day 4 in year 2. In year 1 of 'Picual', 20 % was explained by the interaction at day 8 and increased up to 40 % at day 14, while in year 2, the highest impact was on day 8 with 12 %. In the 'Verdial' cultivar there was an increase up to 20 % in both years at day 4. However, in year 1, the impact from then on diminished, while in year 2, levels over 20 % were present up to 8 days.

3.5. Photosynthetic pigments

The amount of carotenoids and chlorophils were similar over the two years (Table 4). In both cases, the three cultivars showed a significant effect on both the ST and the treatment. The three varieties diverted slightly on the effect of the PM and SM over the two years (Table 2). Overall a significant effect of these factors was present for both photosynthetic pigment over the two years. In year 2, deviant results were obtained in ‘Arbequina’ and ‘Verdial’ with regard to effect of the PM on the level of carotenoids. In that same year, the ‘Verdial’ cultivar did not demonstrated an effect of the PM on the amount of chlorophils. Finally, the SM was significant in all cases except in case, namely in year 1, with regard to the carotenoids in the ‘Picual’ cultivar.

The measures of effect on both pigments were comparable although they varied between the cultivar (Table 3). In ‘Arbequina’, both years demonstrated the impressive importance of the SM that attended from day 4 up to day 14 values situated around 80 % of the explained variance. In ‘Picual’, the importance of the SM was only visible in year 2, when there was a linear growth from day 0 (0 %) to day 14 (80 %). In year 1, the PM explained the variance with values above 50 % from day 0, only to decent at 28 % at day 14. The ‘Verdial’ cultivar, showed to be highly sensible to the SM. This was the most clear in year 2, where a steep increase was noticeable from day 4 to day 8, explaining more than 90 % of the variance, up to day 14 with approximately 70 %. In year 1, a linear increase started from day 0 to day 8, after which it descended to 8 below 10 %. This decline from day 8, went together with a remarkable increase in the importance of the interaction of the PM and SM explaining at day 14 more than 40 % of the present variance.

3.6. Bitterness Index

With respect to the Bitterness Index, the three cultivars presented distinct trends over the 14 days. In ‘Arbequina’, the ST and Treatment factors induced significant effects in both years, but PM did not show that (Table 1 and 2). The SM as well as its interaction with the ST came to the fore as very significant in both years. The ‘Picual’ oils did not show a significant effect due to ST in year 1, however the effect of the interactions of this factor with PM and SM, respectively, turned out to be very significant. PM and SM separately exerted significant effects on this parameter. In both years, the bitterness index of ‘Verdial’ oils experimented significant effects due to ST and T factors. In year 2, the effects of PM and SM were significant, while in year 1 only SM showed that.

The magnitude of the effects also varied according to the cultivars. While in ‘Arbequina’ the effect of the PM disappears after day 4, the SM gained in importance from that moment on, in year 1, attaining its maximum at day 14 of 71 %, and in year 2, even 83 % at day 8 (Table 3). ‘Picual’ maintained in year 1 a high explanatory power for this factor with a value that fluctuated between 50 and 80 %. In year 2, a value around 60 % was observable up to day 4, after which is sharply descended towards a neglectable value. The SM on the other hand, presented only a slight increase in day 14 up to 30 % in year 1, while in year 2, the values did not exceed 10 %. The ‘Verdial’ cultivar expressed a steady increase of the SM in year 1 attaining a maximum above the 60 % on day 14. In year 2, the same maximum was attained, although interrupted with a slight decline at day 8. The difference between the two years was reflected in reverse when comparing the values of the PM, characterised in year 1 with the disappearance of the effect at day 4 and a rebounding at day 8 in year 2.

3.7. Total polyphenols

The way as the amount of polyphenols was influenced by the PM and SM varied markedly between the 2 years for the ‘Arbequina’ cultivar (Table 4 and 2). While in year 1 there was a clear effect of all the factors studied, in year 2 no effect due to the factor was detected. The ‘Picual’ and the ‘Verdial’ variety showed consistent effects due to ST and T in both years, but diverged in the effect of the PM and the SM. In ‘Picual’ oils PM induced significant effects on polyphenol content in both years, while SM only exerted a significant effect during year 1. In year 2, the PM as well SM induced significant effects on the polyphenol content of ‘Verdial’ oil, however the effect of the PM was absent in year 1.

The three varieties expressed the strength of the various factors in different ways. In year 1, the profile of the ‘Arbequina’ cultivar was marked by a steep increase of the SM from day 8, attaining a maximum of 40 % up to day 14 (Table 3). Meanwhile the PM decreased rapidly from day 4 to 20 % at day 8. In ‘Picual’, the PM clearly came to the fore as the main factor, responsible for explaining between 60 and 80 % during the 14 days, while the impact of the SM was with 7 % far less important in year 1. In year 2, the strength of the PM stayed below the 60 % (day 4) and even disappeared from day 8 on. The ‘Verdial’ variety also presented a confuse result. In year 1, the magnitude of strength of SM was characterised with an increase up to almost 60 % at day 8 and followed by a subsequent decrease, while at year 2, the effect at that moment was absent whilst the impact was reduced to less than 40 % and brought forward to day 4. The PM, with no significant effect in year 1, presented in year 2 a steep increase in day 8 (60 %), only to descent rapidly to a neglectable level at day 14.

3.8. α-tocopherols

During the two assay years ST and PM induced a significant effect on the amount of α-Tocopherols in the oils of the three varieties tested, as well as the interaction of these factors (Tables 4 and 2). In contrast, the effect of the SM was absent in both years for the 'Arbequina' and 'Verdial' oils. In the 'Picual' cultivar the effect of this factor was only significant in year 1, while the second year was detected a significant effect due to the interaction of this factor and ST.

The magnitude of the strength of the PM varies clearly among the two years and the distinct varieties (Table 3). In 'Arbequina' there was a clear difference at day 0 (both years 60 %), followed by a descent to 0 % at day 8 and a renewed increase up to almost 80 % in year 1 but only 14 % in year 2. In 'Picual', the same high values during day 0 were present, although the profile was clearly different when compared with 'Arbequina'. At day 4 the effect faded away, only to rise up to 75 % at day 8 after which it once again descended towards a neglectable value at day 14. During both years, the 'Verdial' variety showed no effect of the PM at day 0, but expressed from day 4 a profile that was comparable with 'Picual' at year 1, with a steady increase in day 8 (60-80%) after which a descent was set in towards values below 10 %.

3.9. Overall effect of the factors

The means of the obtained $\widehat{\omega}^2$-values for both years and all parameters, were used to express the tendency of the magnitude of strength that characterized the different factors along the ST of the olives (Figure 1). In 'Arbequina' the profile of the three factors under study, namely the PM, the SM and the interaction between both, was characterised by a rapid decrease of the initial importance of the PM towards day 4 (60 %) after which its explanatory share settled around 15 % for the rest of the studied period. At day 4, the SM became responsible for more than 30 % and further increased to almost 40 % at day 14 (Figure 1). The interaction of both factors was situated at 15 % on day 4 after which it slightly felt down around 10 %. The descending importance of the PM and the increasing one of the SM became equal around day 3 after which the SM started to exert a major effect on the final result. In ‘Picual’, the PM was clearly the most important factor in explaining the variance (Figure 1). Despite a moderate decrease from day 1 (55%) to day 4, the value on this day and day 8, were situated around 30 %. From then on the value descended further to less than 15 %. The SM on the contrary did not attained a level above 15 % until day 14 where it surpassed the impact of the PM and attained about 25 %. The effect of the interaction came only into play at day 8 with values slightly above the 10 %. The ‘Verdial’ cultivar presented a similar profile as ‘Picual’ with regard to the PM, although with a lesser present importance at day 0 (25 %) and overall lower values when compared to the latter (Figure 1). The same can be observed with respect to the SM, although its effect gained more importance from day 8 (25 %) up to day 14 (30%). The steeper inclination of both curves advanced the crossing point to an earlier moment in time. When in ‘Picual’ this took place around day 13, it occurred in ‘Verdial’ around day 10. In a similar way as in ‘Arbequina’, the interaction factor exerted his influence at his maximum (15 %) around day 4, after which it decreased to values below 10 %.

4. DISCUSSION

The positive correlation of the conservation temperature on the level of FAA as well as the combined effect of a mechanized recollection and the SM was confirmed in the three varieties, as well as the fact that the effect of these factors varied between the cultivars tested.

The observed degree of oxidation (Peroxides, K_{232} and K_{270}) demonstrated no consistent tendencies for the PM and the SM over the studied years. It is only in year 2 that a significant effect was observed for the Peroxides and the K_{270} in all of the three varieties, while only in the 'Arbequina' and 'Verdial' cultivar with regard to the K_{232}. Yousfi *et al*. (2012) mention values of Peroxides, K_{232} and K_{270} that were significantly higher when 'Arbequina' is recollected mechanically and relate this to the internal ruptures as a consequence of the received blows during the recollection. The results in year 2 supported this hypothesis, indicating a slight difference between the oils from 'Arbequina' and 'Verdial' olives in front of 'Picual' oils.

With respect to the oxidative stability, the total amount of polyphenols and the Bitterness Index, a clear distinction is present between the varieties. The results support the hypothesis that the reduction of the oxidation time is not only related to the progress of ripening but also to an aggressive recollection method, especially when picking 'Arbequina' variety. In the same way, the presence and the evolution of the α-tocopherols are genetic related. The hypothesis of Yousfi *et al.* (2012) that a mechanized recollection and a conservation at 18 °C favours the degradation of these compounds is not confirmed as the 'Arbequina' cultivar shows an inverse relation in both years.

The photosynthetic pigments (K_{470} and K_{670}) evolved in a consistent way in the three varieties. However, the calculated strength of the present factors underlines the increasing importance of the SM in explaining the observed differences, especially with respect to the 'Arbequina' and 'Verdial' oils.

While various parameters indicate the importance of the genetic factor when evaluating the effect of the PM and the SM on the various parameters, it is only when the magnitude of the strength of these factors are taken together and compared that their full impact comes to the fore. The obtained results points to the critical interrelation that exist between the two factors and their interaction, and demonstrate the differences between the 3 cultivars as the ST increases. The vulnerability of the ‘Arbequina’ towards deterioration as compared to the ‘Picual’, and in a lesser degree to the ‘Verdial’, is obvious when taking the crossing point of the two curves (PM- and SM-strength) as point of reference. The curious rebounding of the PM-strength in the ‘Picual’ and ‘Verdial’-cultivars at day 8, may indicate that the effects of a produced damage due to more detrimental picking method, can be constrained during the first week due to the cooling of the fruit. However, this initial compensating effect loses power in the course of the following week.

5. CONCLUSIONS

The study underlines the importance of the used PM and the usefulness of an optimal conservation of the fruit before their processing and confirms the presence of a genetic predisposition. The use of the MIU and the consequent storage of the picked olives at 5 °C do effect the majority of the parameters in a significant way when compared with a traditional recollection and a storage at ambient temperature. Especially in a more sensible variety as ‘Arbequina’ as compared with ‘Picual’ or ‘Verdial’. The calculation of the magnitude of strengths makes it possible to discern the explanatory weight of each of the factors, to illuminate the differences between the varieties with respect to the factors and to underline the need to take into account the ST when evaluating its importance. As such, the statistic offers the farmer crucial information to decide which solution fits him the best, given the specific working conditions he is confronted with.

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Table 1. Some quality parameters and oxidative stability noted in the 'Arbequina', 'Picual' and 'Verdial' olive oils extracted from fruit, picked with a Manual Inverted Umbrella (PM1) and in a traditional way (PM2) and stored during 0, 4, 8 and 14 days at 5 °C (SM1) and at ambient temperature (SM2)[a].

ST(days); PM (1,2); SM (1,2)	FFA (% oleic acid) year 1	FFA (% oleic acid) year 2	PV (mEq O2/ kg oil) year 1	PV (mEq O2/ kg oil) year 2	K_{232} year 1	K_{232} year 2	K_{270} year 1	K_{270} year 2	OXIDATIVE STABILITY (h) year 1	OXIDATIVE STABILITY (h) year 2
ARBEQUINA										
0; 1; 1	0,14 ± 0,01 **B**	0,12 ± 0,00 x	5,14 ± 0,52 **B**	6,96 ± 0,43 **A** x	1,51 ± 0,02 x	1,77 ± 0,16 x	0,12 ± 0,01 x	0,11 ± 0,00	46,84 ± 1,05 **A**	37,50 ± 3,53
0; 1; 2	0,14 ± 0,01 **B**	0,12 ± 0,00 **C** x	5,14 ± 0,52 **B**	6,96 ± 0,43 **A** x	1,51 ± 0,02 x	1,77 ± 0,16 **AB** x	0,12 ± 0,01 x	0,11 ± 0,00 **B**	46,84 ± 1,05	37,50 ± 3,53
0; 2; 1	0,15 ± 0,01 **B**	0,13 ± 0,01 **B** y	5,17 ± 0,09 **C**	5,70 ± 0,62 y	1,47 ± 0,03 y	1,48 ± 0,08 **B** y	0,14 ± 0,01 **A** y	0,11 ± 0,01 **B**	45,87 ± 1,82 **A**	33,99 ± 2,17 **B**
0; 2; 2	0,15 ± 0,01 **C**	0,13 ± 0,01 **D** y	5,17 ± 0,09 **C**	5,70 ± 0,62 **B** y	1,47 ± 0,03 y	1,48 ± 0,08 **B** y	0,14 ± 0,01 **AB** y	0,11 ± 0,01 **B**	45,87 ± 1,82 **A**	33,99 ± 2,17 **A**
4; 1; 1	0,15 ± 0,00 **B** c x α	0,12 ± 0,00 c x α	10,37 ± 0,74 **A** a α	6,37 ± 0,24 **AB** b x α	1,47 ± 0,15	1,75 ± 0,11a	0,12 ± 0,01	0,12 ± 0,00 b x	40,37 ± 2,58 **B** x	42,78 ± 2,31 x α
4; 1; 2	0,17 ± 0,03 **B** ab x β	0,18 ± 0,04 **BC** b x β	7,79 ± 0,27 **A** bc β	7,00 ± 0,85 **A** ab x β	1,66 ± 0,06	1,50 ± 0,02 **B** b	0,12 ± 0,00	0,11 ± 0,00 **B** b x	39,64 ± 6,11 x	30,08 ± 3,47 x β
4; 2; 1	0,16 ± 0,02 **B** ab y α	0,13 ± 0,01 **B** bc y α	9,18 ± 0,75 **A** ab α	6,19 ± 0,27 b y α	1,55 ± 0,06	1,57 ± 0,09 **AB** ab	0,12 ± 0,00 **B**	0,11 ± 0,01 **AB** b y	34,88 ± 5,03 **B** y	32,86 ± 0,21 **B** y α
4; 2; 2	0,22 ± 0,03 **C** a y β	0,27 ± 0,01 **C** a y β	7,57 ± 0,29 **A** c β	8,76 ± 1,10 **A** a y β	1,48 ± 0,04	1,64 ± 0,11 **B** ab	0,12 ± 0,01 BC	0,14 ± 0,01 **A** a y	32,82 ± 1,93 **B** y	31,90 ± 0,67 **AB** y β
8; 1; 1	0,17 ± 0,03 **AB** b x α	0,13 ± 0,01 c x α	6,52 ± 0,56 **B** ab α	5,09 ± 0,82 **BC** b x α	1,48 ± 0,34	1,59 ± 0,13 b x	0,12 ± 0,01	0,10 ± 0,00 x	47,26 ± 2,30 **A** x	38,17 ± 0,60 a α
8; 1; 2	0,20 ± 0,00 **B** b x β	0,21 ± 0,02 **B** b x β	5,16 ± 0,15 **B** c β	5,06 ± 0,33 **B** b x β	1,44 ± 0,31	1,62 ± 0,11 **B** b x	0,10 ± 0,04	0,11 ± 0,00 **B** x	45,04 ± 9,10 x	31,98 ± 2,94 b β
8; 2; 1	0,18 ± 0,02 **B** b y α	0,15 ± 0,03 **AB** c y α	7,60 ± 0,42 **B** a α	5,48 ± 0,89 b y α	1,68 ± 0,15	1,87 ± 0,02 **B** a y	0,12 ± 0,00 **B**	0,12 ± 0,01 **AB** y	41,28 ± 1,10 **AB** y	39,36 ± 2,76 **A** a α
8; 2; 2	0,42 ± 0,06 **B** a y β	0,33 ± 0,01 **B** a y β	6,30 ± 0,63 **B** bc β	7,41 ± 0,52 **AB** a y β	1,46 ± 0,24	1,62 ± 0,05 **B** b y	0,10 ± 0,00 **C**	0,11 ± 0,00 **B** y	33,89 ± 4,59 **AB** y	27,30 ± 0,81 **B** b β
14; 1; 1	0,22 ± 0,03 **A** b x α	0,12 ± 0,00 d x α	5,90 ± 0,32 **B** a	4,91 ± 0,45 **C** b x	1,65 ± 0,02	1,67 ± 0,11 b α	0,12 ± 0,00 ab	0,12 ± 0,01	47,96 ± 2,73 **A** a x α	38,68 ± 3,93 ab α
14; 1; 2	0,30 ± 0,04 **A** b x β	0,37 ± 0,05 **A** b x β	4,67 ± 0,29 **B** b	5,87 ± 0,51 **AB** ab x	1,53 ± 0,01	1,91 ± 0,09 **A** ab β	0,11 ± 0,01 b	0,12 ± 0,00 **A**	37,66 ± 0,84 c x β	30,62 ± 2,41 c β
14; 2; 1	0,28 ± 0,03 **A** b y α	0,20 ± 0,01 **A** c y α	6,04 ± 0,43 **C** a	6,59 ± 0,26 a y	1,50 ± 0,17	1,81 ± 0,24 **AB** ab α	0,09 ± 0,00 **C** c	0,13 ± 0,01 **A**	44,37 ± 3,43 **A** b y α	40,30 ± 0,43 **A** a α
14; 2; 2	1,42 ± 0,04 **A** a y β	0,53 ± 0,03 **A** a y β	6,51 ± 0,22 **B** a	6,69 ± 0,34 **B** a y	1,62 ± 0,08	2,04 ± 0,02 **A** a β	0,14 ± 0,01 **A** a	0,12 ± 0,01 **AB**	27,17 ± 1,05 **B** d y β	31,52 ± 3,54 **AB** bc β
PICUAL										
0; 1; 1	0,17 ± 0,01	0,14 ± 0,00 **B** b x	5,45 ± 0,15 **A** x	7,75 ± 0,77	1,75 ± 0,17	1,45 ± 0,19	0,17 ± 0,01 **A**	0,12 ± 0,01 **A** b x	133,16 ± 4,89 **B** a x	110,37 ± 4,11 b y
0; 1; 2	0,17 ± 0,01	0,14 ± 0,00 **C** b x	5,45 ± 0,15 **A** x	7,75 ± 0,77	1,75 ± 0,17	1,45 ± 0,19	0,17 ± 0,01 **A**	0,12 ± 0,01 **A** b x	133,16 ± 4,89 **A** a x	110,37 ± 4,11 **A** b y
0; 2; 1	0,17 ± 0,03	0,16 ± 0,00 **B** a y	5,98 ± 0,36 **A** y	8,57 ± 0,53 **AB**	1,59 ± 0,17	1,57 ± 0,11	0,17 ± 0,09	0,15 ± 0,00 **A** a y	121,49 ± 2,10 b y	125,65 ± 1,69 **A** a x
0; 2; 2	0,17 ± 0,03 BC	0,16 ± 0,00 **C** a y	5,98 ± 0,36 **A** y	8,57 ± 0,53 **AB**	1,59 ± 0,17 **AB**	1,57 ± 0,11	0,17 ± 0,09 **A**	0,15 ± 0,00 **A** a y	121,49 ± 2,10 **A** b y	125,65 ± 1,69 **A** a x
4; 1; 1	0,16 ± 0,02	0,16 ± 0,00 **B** b α	2,98 ± 0,14 **B**	7,39 ± 0,54 b x	1,72 ± 0,06 a α	1,48 ± 0,12	0,15 ± 0,00 **B** b x α	0,12 ± 0,01 **A** x	145,26 ± 5,55 **A** a x	109,12 ± 3,18 x
4; 1; 2	0,16 ± 0,03	0,19 ± 0,01 **B** a β	2,84 ± 0,04 **B**	7,23 ± 0,66 b x	1,63 ± 0,02 ab β	1,38 ± 0,10	0,16 ± 0,01 **A** a x β	0,11 ± 0,00 **B** x	137,05 ± 3,87 **A** a x	111,20 ± 5,18 **A** x
4; 2; 1	0,15 ± 0,03	0,16 ± 0,00 **B** b α	3,05 ± 0,27 **B**	7,90 ± 0,37 **AB** ab y	1,68 ± 0,13 ab α	1,83 ± 0,39	0,12 ± 0,00 c y α	0,13 ± 0,01 **B** y	119,40 ± 4,26 b y	110,92 ± 3,00 **AB** y
4; 2; 2	0,15 ± 0,03 **C**	0,19 ± 0,01 **B** a β	3,02 ± 0,39 **B**	9,02 ± 0,05 **B** a y	1,51 ± 0,03 **B** b β	1,55 ± 0,03	0,12 ± 0,01 **B** c y β	0,13 ± 0,02 **AB** y	120,93 ± 2,92 **A** b y	111,90 ± 2,77 **B** y
8; 1; 1	0,19 ± 0,03 ab	0,15 ± 0,01 **B** b α	2,90 ± 0,23 **B** x	7,53 ± 0,85	1,61 ± 0,04	1,54 ± 0,42	0,13 ± 0,00 **B** x α	0,09 ± 0,00 **B** b x α	135,66 ± 1,27 **AB** a x α	97,02 ± 3,94
8; 1; 2	0,15 ± 0,02 b	0,19 ± 0,01 **B** a β	2,53 ± 0,14 **B** x	8,85 ± 1,09	1,67 ± 0,22	1,25 ± 0,04	0,14 ± 0,00 **B** x β	0,10 ± 0,00 **C** ab x β	122,04 ± 0,48 **B** b x β	92,44 ± 4,94 **B**
8; 2; 1	0,16 ± 0,01 b	0,16 ± 0,01 **B** b α	3,20 ± 0,15 **B** y	9,09 ± 0,84 **A**	1,64 ± 0,10	1,27 ± 0,04	0,11 ± 0,01 y α	0,10 ± 0,01 **C** ab y α	114,54 ± 5,78 b y α	101,89 ± 7,72 **B**
8; 2; 2	0,22 ± 0,02 **B** a	0,19 ± 0,00 **CB** a β	3,18 ± 0,04 **B** y	8,56 ± 0,32 **AB**	2,00 ± 0,31 **A**	1,39 ± 0,19	0,12 ± 0,00 **B** y β	0,11 ± 0,00 **BC** a y β	118,98 ± 0,87 **A** b y β	111,06 ± 6,08 **B**
14; 1; 1	0,19 ± 0,00 b α	0,20 ± 0,01 **A** c x α	2,77 ± 0,08 **B** x	7,70 ± 0,56	1,89 ± 0,40	1,40 ± 0,03	0,13 ± 0,02 **B**	0,11 ± 0,00 **AB** ab α	136,92 ± 4,59 **AB** a x	111,20 ± 8,85 α
14; 1; 2	0,20 ± 0,05 b β	0,23 ± 0,01 **A** b x β	2,93 ± 0,41 **B** x	7,36 ± 0,14	1,91 ± 0,34	1,69 ± 0,33	0,13 ± 0,01 **B**	0,10 ± 0,01 **C** b β	130,80 ± 5,18 **AB** a x	107,03 ± 8,97 **AB** β
14; 2; 1	0,15 ± 0,02 b α	0,21 ± 0,00 **A** bc y α	3,35 ± 0,34 **B** y	7,24 ± 0,66 **B**	1,80 ± 0,23	1,58 ± 0,29	0,12 ± 0,01	0,12 ± 0,01 **BC** a α	114,95 ± 4,65 b y	111,75 ± 8,76 **AB** α
14; 2; 2	0,31 ± 0,01 **A** a β	0,29 ± 0,01 **A** a y β	3,10 ± 0,07 **B** y	7,71 ± 0,31 **A**	1,66 ± 0,07 **AB**	1,45 ± 0,01	0,13 ± 0,00 **B**	0,10 ± 0,01 **C** b β	111,48 ± 1,97 **B** b y	93,97 ± 1,93 **A** β
VERDIAL										
0; 1; 1	0,20 ± 0,01 **B**	0,37 ± 0,04 x	12,14 ± 0,22 **A** x	14,43 ± 1,38 x	1,56 ± 0,19	2,04 ± 0,16	0,14 ± 0,02	0,16 ± 0,01 **B** x	64,64 ± 1,91 **B**	69,92 ± 3,07
0; 1; 2	0,20 ± 0,01 **C**	0,37 ± 0,04 x	12,14 ± 0,22 **AB** x	14,43 ± 1,38 x	1,56 ± 0,19	2,04 ± 0,16	0,14 ± 0,02	0,16 ± 0,01 x	64,64 ± 1,91	69,92 ± 3,07
0; 2; 1	0,21 ± 0,01 **C**	0,42 ± 0,00 **B** y	11,24 ± 0,49 **A** y	16,11 ± 0,96 **B** y	1,58 ± 0,12 **B**	2,17 ± 0,11 **A**	0,13 ± 0,03	0,20 ± 0,02 **AB** y	67,69 ± 3,96 **B**	73,11 ± 4,50
0; 2; 2	0,21 ± 0,01 **D**	0,42 ± 0,00 **B** y	11,24 ± 0,49 y **A**	16,11 ± 0,96 y	1,58 ± 0,12 **B**	2,17 ± 0,11 **A**	0,13 ± 0,03	0,20 ± 0,02 **AB** y	67,69 ± 3,96 **B**	73,11 ± 4,50
4; 1; 1	0,30 ± 0,01 **A** b x	0,36 ± 0,01 x	10,34 ± 0,24 **B** b x	16,47 ± 1,03	1,90 ± 0,13	2,10 ± 0,07	0,17 ± 0,02	0,16 ± 0,01 **B** b x	71,17 ± 1,58 **A** a x α	67,41 ± 1,58 ab x
4; 1; 2	0,34 ± 0,00 **B** a x	0,37 ± 0,05 x	13,07 ± 0,77 **AB** a x	17,20 ± 0,89	1,91 ± 0,23	1,97 ± 0,11	0,16 ± 0,01	0,16 ± 0,00 b x	62,83 ± 3,07 b x β	64,36 ± 4,57 b x
4; 2; 1	0,31 ± 0,01 **B** b y	0,40 ± 0,03 **B** y	8,76 ± 0,16 **B** c y	16,49 ± 0,70 **B**	1,84 ± 0,01 **A**	2,04 ± 0,09 **AB**	0,16 ± 0,02	0,18 ± 0,01 **B** a y	75,06 ± 1,91 **A** a y α	68,39 ± 3,34 ab y
4; 2; 2	0,26 ± 0,01 **C** c y	0,41 ± 0,01 **B** y	7,19 ± 0,51 **B** d y	15,77 ± 0,29	1,80 ± 0,07 **A**	2,03 ± 0,17 **AB**	0,17 ± 0,01	0,19 ± 0,00 **AB** a y	76,45 ± 2,14 **A** a y β	75,20 ± 4,01 a y
8; 1; 1	0,30 ± 0,02 **A** b α	0,37 ± 0,02 b x	11,74 ± 1,08 **AB** a x	16,22 ± 3,40 x	1,77 ± 0,45	2,00 ± 0,04 a x	0,17 ± 0,00 x	0,19 ± 0,00 **A** ab x α	70,47 ± 2,17 **A** b x α	67,56 ± 5,23
8; 1; 2	0,36 ± 0,01 **B** a β	0,40 ± 0,02 ab x	13,53 ± 0,59 **A** a x	15,59 ± 1,51 x	1,40 ± 0,82	1,75 ± 0,05 b x	0,20 ± 0,05 x	0,17 ± 0,01 c x β	62,97 ± 0,72 c x β	74,09 ± 3,13
8; 2; 1	0,35 ± 0,02 **A** a α	0,41 ± 0,02 **B** ab y	8,73 ± 0,66 **B** b y	20,18 ± 1,68 **A** y	1,76 ± 0,01 **A**	2,14 ± 0,05 **A** a y	0,15 ± 0,01 y	0,23 ± 0,01 **A** a y α	76,03 ± 1,46 **A** a y α	70,75 ± 4,59
8; 2; 2	0,34 ± 0,00 **B** a β	0,42 ± 0,00 **B** a y	7,36 ± 0,19 **B** b y	18,50 ± 3,12 y	1,64 ± 0,05 **AB**	2,19 ± 0,17 **A** a y	0,15 ± 0,01 y	0,22 ± 0,02 **A** ab y β	72,98 ± 1,82 **AB** ab y β	66,30 ± 5,07
14; 1; 1	0,33 ± 0,04 **A** b α	0,41 ± 0,02 b x	11,04 ± 0,58 **AB** ab x α	15,16 ± 1,21	1,82 ± 0,13	1,92 ± 0,10 α	0,15 ± 0,02	0,19 ± 0,00 **A** ab x α	69,50 ± 1,05 **A** α	76,73 ± 2,92 α
14; 1; 2	0,40 ± 0,01 **A** a β	0,43 ± 0,03 ab x	11,84 ± 0,57 **B** a x β	14,72 ± 2,01	1,81 ± 0,03	1,78 ± 0,08 β	0,17 ± 0,00	0,16 ± 0,00 b x β	66,44 ± 2,14 β	67,28 ± 4,01 β
14; 2; 1	0,37 ± 0,01 **A** ab α	0,49 ± 0,02 **A** a y	9,12 ± 0,30 **B** c y α	15,02 ± 0,85 **B**	1,77 ± 0,05 **A**	1,92 ± 0,02 **B** α	0,16 ± 0,03	0,20 ± 0,01 **AB** a y α	72,84 ± 2,68 **AB** α	76,59 ± 4,68 α
14; 2; 2	0,42 ± 0,03 **A** a β	0,48 ± 0,03 **A** ab y	9,98 ± 0,83 **A** bc y β	16,22 ± 2,59	1,69 ± 0,02 **AB**	1,78 ± 0,06 **B** β	0,15 ± 0,01	0,17 ± 0,01 **B** b y β	67,00 ± 4,18 **B** β	68,81 ± 4,92 β

[a] In each variable the values of different treatments followed by different letters are significantly different according to the Tukey test ($P < 0.05$). Absence of letters means no significant effect due to treatment according to one-way ANOVA ($P < 0.05$). In each column, values at different storage times (ST) and the same picking method (PM) and storage method (SM), followed by different upper bold case letters are significantly different; four values at each ST, followed by different lower case letters (a, b, c, d) are different; two values at the same ST and same storage method (SM), but different picking method (PM), followed by lower case letters (x or y), are different; two values at the same ST and same PM, but different SM, followed by different Greek letters are significantly different. Each value is the mean ± SD of 3 replicates.

Table 2. Photosynthetic pigment contents, Bitterness Index, total phenolic and α-tocopherol content noted in the ‘Arbequina’, ‘Picual’ and ‘Verdial’ olive oils extracted from fruit, picked with a Manual Inverted Umbrella (PM 1) and in a traditional way (PM2) and stored during 0, 4, 8 and 14 days at 5 °C (SM1) and at ambient temperature (SM2)[a].

ST(days); PM (1,2); SM (1,2)	K_{470} (mg/kg)		K_{670} (mg/kg)		BITTERNESS INDEX		TOTAL POLIFENOLS (mg/kg)		α-TOCOFEROLS (mg/kg)	
	year 1	year 2	year 1	year 2	year 1	year 2	year 1	year 2	year 1	year 2
					ARBEQUINA					
0; 1; 1	8,48 ± 0,33 **C** x	8,49 ± 0,79 **C** b x	9,67 ± 0,93 **B** b x	12,48 ± 1,70 **B** x	1,55 ± 0,00 x	1,58 ± 0,40 **AB** x	189,74 ± 0,00 **B** x	257,58 ± 49,31 x	228,67 ± 8,24 **A** x	185,49 ± 17,49 x
0; 1; 2	8,48 ± 0,33 **A** x	8,49 ± 0,79 **A** b x	9,67 ± 0,93 **A** b x	12,48 ± 1,70 **B** x	1,55 ± 0,00 x	1,58 ± 0,40 **A** x	189,74 ± 0,00 **B** x	257,58 ± 49,31 x	228,67 ± 8,24 **A** x	185,49 ± 17,49 x
0; 2; 1	9,60 ± 0,36 y **AB**	9,61 ± 0,27 a y	12,64 ± 0,90 **AB** a y	15,16 ± 0,51 y	1,82 ± 0,00 y	1,09 ± 0,22 y	193,34 ± 0,00 **C** y	195,33 ± 20,31 y	256,90 ± 16,94 **A** y	212,31 ± 4,15 **A** y
0; 2; 2	9,60 ± 0,36 **A** y	9,61 ± 0,27 **A** a y	12,64 ± 0,90 **A** a y	15,16 ± 0,51 **A** y	1,82 ± 0,00 **A** y	1,09 ± 0,22 **A** y	193,34 ± 0,00 **B** y	195,33 ± 20,31 **B** y	256,90 ± 16,94 **A** y	212,31 ± 4,15 **AB** y
4; 1; 1	9,82 ± 0,6 **BC** a x	9,07 ± 0,50 **BC** a α	12,80 ± 1,75 **AB** ab α	11,70 ± 0,14 **B** x α	1,38 ± 0,65	2,00 ± 0,12 **B** α	313,00 ± 18,47 **A** x	243,46 ± 10,43 x	209,43 ± 7,29 **B** x	197,03 ± 6,14 ab x
4; 1; 2	6,29 ± 0,57 **B** b x	6,35 ± 0,46 **B** b β	8,60 ± 1,08 **AB** c β	10,11 ± 0,69 **B** x β	1,47 ± 0,65	0,77 ± 0,13 **B** β	265,80 ± 23,88 **A** x	205,80 ± 23,89 x	211,53 ± 10,46 **B** x	194,31 ± 5,90 b x
4; 2; 1	10,62 ± 0,07 **A** a y	10,52 ± 1,07 a α	14,24 ± 0,88 **A** a α	16,84 ± 2,51 y α	1,43 ± 0,48	1,36 ± 0,39 α	206,59 ± 18,51 **C** y	244,91 ± 16,16 y	226,28 ± 6,44 **B** y	208,20 ± 4,35 **A** a y
4; 2; 2	7,25 ± 0,48 **BC** b y	6,27 ± 0,26 **C** b β	10,47 ± 1,32 **AB** bc β	9,85 ± 0,05 **B** y β	1,27 ± 0,31 **AB**	1,09 ± 0,09 **A** β	236,79 ± 24,23 **B** y	291,25 ± 24,58 **A** y	227,97 ± 14,50 **AB** y	198,81 ± 1,17 **AB** ab y
8; 1; 1	10,33 ± 0,38 **A** a x α	10,40 ± 0,68 **AB** a α	13,87 ± 1,12 **A** a x α	17,87 ± 1,58 **A** a α	2,60 ± 0,98	1,26 ± 0,27 **B** a α	307,25 ± 25,13 **A** a x α	195,13 ± 61,16	237,67 ± 3,52 **A** α	182,35 ± 4,95
8; 1; 2	5,95 ± 0,17 **B** c x β	5,63 ± 0,37 **B** b β	7,80 ± 0,40 **AB** b x β	9,69 ± 0,71 **B** b β	2,04 ± 0,39	0,51 ± 0,17 **B** b β	259,70 ± 3,53 **A** b x β	176,10 ± 34,74	232,37 ± 15,49 **A** β	174,26 ± 6,66
8; 2; 1	10,48 ± 0,92 **A** a y α	9,96 ± 1,25 a α	14,35 ± 1,56 **A** a y α	17,76 ± 2,23 a α	2,15 ± 0,53	1,47 ± 0,22 a α	271,64 ± 15,49 **B** ab y α	202,76 ± 25,40	240,60 ± 1,91 **AB** α	183,71 ± 9,41 **B**
8; 2; 2	7,49 ± 0,42 **B** b y β	5,89 ± 0,04 **C** b β	11,92 ± 1,39 **AB** a y β	10,60 ± 0,27 **B** b β	1,09 ± 0,52 **AB**	0,49 ± 0,06 **B** b β	246,62 ± 16,07 **B** b y β	204,07 ± 7,18 **B**	220,03 ± 3,62 **B** β	183,89 ± 12,24 **B**
14; 1; 1	9,10 ± 0,37 **BC** a	11,35 ± 0,67 **A** a α	11,31 ± 1,00 **AB** a α	20,22 ± 0,97 **A** a x α	2,75 ± 0,71 a α	0,98 ± 0,27 **B** α	319,27 ± 21,76 **A** ab x α	170,18 ± 41,96	234,75 ± 1,73 **A** a x	205,75 ± 3,23
14; 1; 2	5,29 ± 0,54 **B** b	8,93 ± 0,57 **A** c β	6,00 ± 1,64 **B** b β	15,85 ± 1,22 **A** b x β	1,22 ± 0,13 bc β	0,79 ± 0,35 **B** β	260,67 ± 3,65 **A** b x β	271,43 ± 72,37	236,23 ± 3,18 **AB** a x	191,96 ± 3,25
14; 2; 1	8,95 ± 0,48 **B** a	10,35 ± 0,51 ab α	10,57 ± 1,17 **B** a α	17,30 ± 1,38 ab y α	2,21 ± 0,42 ab α	1,36 ± 0,66 α	335,73 ± 11,49 **A** a y α	204,89 ± 124,56	227,19 ± 2,82 **B** b y	200,87 ± 4,25 **A**
14; 2; 2	6,15 ± 0,65 **C** b	8,98 ± 0,29 **B** bc β	8,96 ± 1,39 **B** ab β	14,25 ± 1,09 **A** b y β	0,92 ± 0,10 **B** c β	0,37 ± 0,14 **B** β	313,39 ± 39,37 **A** ab y β	210,91 ± 28,86 **B**	225,80 ± 2,24 **B** b y	237,63 ± 35,73 **A**
					PICUAL					
0; 1; 1	9,22 ± 1,07 **A** a x	8,60 ± 0,87 b x	4,31 ± 0,70 **B** a x	13,08 ± 1,73 b x	5,16 ± 0,27 **B** x	3,55 ± 0,42 **A** x	389,07 ± 52,02 **AB**	265,05 ± 41,82 **B**	222,08 ± 1,10 **A** a x	154,47 ± 9,65 b x
0; 1; 2	9,22 ± 1,07 **A** a x	8,60 ± 0,87 **A** b x	4,31 ± 0,70 **B** a x	13,08 ± 1,73 **A** b x	5,16 ± 0,27 x	3,55 ± 0,42 **A** x	389,07 ± 52,02 **AB**	265,05 ± 41,82 **B**	222,08 ± 1,10 a x	154,47 ± 9,65 **B** b x
0; 2; 1	6,30 ± 0,43 **AB** b y	11,44 ± 0,35 **A** a y	2,64 ± 0,30 **B** b y	18,53 ± 0,70 **A** a y	4,49 ± 0,26 y	4,34 ± 0,21 **A** y	371,69 ± 13,68 **A**	355,18 ± 88,86 **A**	210,55 ± 1,58 b y	182,48 ± 0,65 **A** a y
0; 2; 2	6,30 ± 0,43 **AB** b y	11,44 ± 0,35 **A** a y	2,64 ± 0,30 **B** b y	18,53 ± 0,70 **A** a y	4,49 ± 0,26 **A** y	4,34 ± 0,21 **A** y	371,69 ± 13,68 **A**	355,18 ± 88,86 **A**	210,55 ± 1,58 **B** b y	182,48 ± 0,65 a y
4; 1; 1	7,96 ± 0,58 **AB** ab x	8,37 ± 1,21 b x α	3,54 ± 0,08 **B** bc x α	13,28 ± 2,10 b x α	6,11 ± 0,31 **AB** a x	3,59 ± 0,03 **A** b x	413,03 ± 9,25 **A** bc x	356,64 ± 19,95 **A** c x	229,38 ± 6,89 **A**	178,66 ± 3,64 α
4; 1; 2	8,38 ± 0,40 **AB** a x	7,23 ± 0,40 **B** b x β	4,11 ± 0,26 **B** a x β	10,80 ± 1,02 **AB** b x β	5,95 ± 0,54 a x	3,57 ± 0,16 **A** b x	429,81 ± 32,12 **A** c x	390,41 ± 12,29 **A** bc x	241,66 ± 23,38	174,75 ± 3,56 **AB** β
4; 2; 1	7,43 ± 0,46 **A** ab y	11,66 ± 1,33 **A** a y α	2,96 ± 0,29 **B** c y α	19,32 ± 2,77 **A** a y α	4,35 ± 0,08 b y	4,08 ± 0,15 **AB** a y	348,64 ± 2,93 **AB** bc y	435,18 ± 12,40 **A** a y	222,16 ± 25,82	190,79 ± 8,75 **A** α
4; 2; 2	6,97 ± 0,43 **A** b y	8,65 ± 0,61 **B** b y β	3,28 ± 0,22 **B** c y β	14,26 ± 0,96 **B** b y β	3,76 ± 0,86 **AB** b y	3,81 ± 0,11 **B** ab y	366,46 ± 12,96 **A** c y	410,10 ± 10,87 **A** ab y	222,82 ± 6,16 **A**	166,19 ± 17,89 β
8; 1; 1	8,98 ± 0,22 **A** a x α	7,46 ± 1,11 b x α	3,90 ± 0,21 **B** a x	13,12 ± 2,97 b x α	5,79 ± 0,80 **AB** a x	2,77 ± 0,26 **B**	440,13 ± 28,78 **AB** a x	198,85 ± 17,61 **C**	235,48 ± 10,39 **A** a x	169,97 ± 14,68
8; 1; 2	7,73 ± 0,20 **AB** b x β	5,50 ± 0,27 **C** c x β	3,77 ± 0,28 **B** a x	9,46 ± 0,86 **B** b x β	5,67 ± 1,03 ab x	2,47 ± 0,08 **B**	374,73 ± 8,70 **AB** ab x	197,89 ± 13,45 **B**	242,33 ± 6,73 a x	195,13 ± 17,47 **A**
8; 2; 1	5,93 ± 0,13 **B** c y α	10,88 ± 0,40 **AB** a y α	2,06 ± 0,19 **A** c y	18,92 ± 0,68 **A** a y α	3,99 ± 0,34 bc y	2,72 ± 0,07 **B**	322,00 ± 18,86 **BC** b y	188,90 ± 20,06 **B**	205,82 ± 5,47 b y	202,74 ± 19,72 **A**
8; 2; 2	5,63 ± 0,24 **B** c y β	6,49 ± 0,26 **C** bc y β	2,82 ± 0,13 **A** b y	11,09 ± 1,03 **C** b y β	3,62 ± 0,26 **AB** c y	2,70 ± 0,18 **C**	347,78 ± 16,00 **A** a y	228,11 ± 18,10 **C**	215,43 ± 6,23 **AB** b y	198,99 ± 12,82
14; 1; 1	7,19 ± 0,27 **B**	7,92 ± 0,67 a x α	3,00 ± 0,21 **A**	12,48 ± 1,71 a α	7,20 ± 0,94 **A** a x α	3,17 ± 0,16 **AB** b	422,91 ± 23,05 **B** a x α	319,05 ± 7,99 **AB** b x	193,56 ± 5,70 **B** b α	174,72 ± 18,87 a x
14; 1; 2	7,28 ± 0,06 **B**	5,46 ± 0,20 **C** b x β	3,40 ± 0,22 **A**	8,02 ± 0,37 **B** b β	4,39 ± 0,48 b x β	3,32 ± 0,30 **A** ab	309,49 ± 19,60 **B** b x β	353,05 ± 28,19 **A** ab x	229,75 ± 17,31 a β	172,53 ± 2,92 **AB** a x
14; 2; 1	6,76 ± 0,65 **AB**	9,11 ± 0,62 **B** a y α	2,60 ± 0,74 **A**	13,57 ± 1,59 **B** a α	3,97 ± 0,12 b y α	3,93 ± 0,37 **A** a	295,12 ± 4,15 **B** b y α	398,11 ± 24,83 **A** a y	216,01 ± 4,25 ab α	140,66 ± 4,16 **B** b y
14; 2; 2	6,31 ± 0,78 **AB**	5,96 ± 0,49 **C** b y β	3,40 ± 0,53 **A**	8,68 ± 0,82 **D** b β	3,21 ± 0,28 **B** b y β	3,07 ± 0,21 **C** b	309,17 ± 6,49 **B** b y β	379,71 ± 12,94 **A** a y	219,64 ± 1,43 **AB** a β	173,14 ± 13,12 a y
					VERDIAL					
0; 1; 1	8,55 ± 0,53 **B**	13,88 ± 1,22 **A**	2,17 ± 0,10 **C**	23,35 ± 3,10 **AB**	6,11 ± 0,48 x	7,67 ± 0,41 b x	342,48 ± 5,90 **B**	479,43 ± 29,25 x	192,55 ± 1,15 **B**	106,10 ± 10,33
0; 1; 2	8,55 ± 0,53 **B**	13,88 ± 1,22 **A**	2,17 ± 0,10 **B**	23,35 ± 3,10 **A**	6,11 ± 0,48 **AB** x	7,67 ± 0,41 **A** b x	342,48 ± 5,90	479,43 ± 29,25 **A** x	192,55 ± 1,15 **BC**	106,10 ± 10,33 **B**
0; 2; 1	8,90 ± 0,90 **B**	14,32 ± 1,05	2,63 ± 0,50 **B**	24,23 ± 2,28	5,19 ± 0,38 **B** y	8,85 ± 0,38 **A** a y	337,06 ± 5,13 **C**	546,78 ± 22,39 **A** y	196,97 ± 14,17 **AB**	106,67 ± 4,09
0; 2; 2	8,90 ± 0,90 **B**	14,32 ± 1,05 **A**	2,63 ± 0,50 **B**	24,23 ± 2,28 **A**	5,19 ± 0,38 y	8,85 ± 0,38 **A** a y	337,06 ± 5,13 **B**	546,78 ± 22,39 **A** y	196,97 ± 14,17 **A**	106,67 ± 4,09 **B**
4; 1; 1	12,11 ± 1,10 **A** b x α	11,48 ± 0,92 **B**	4,49 ± 0,64 **A** ab x α	18,51 ± 1,97 **B**	7,81 ± 0,28	7,58 ± 0,36 α	446,11 ± 35,11 **A** x α	481,42 ± 33,43 a α	210,74 ± 4,99 **A**	105,95 ± 12,59
4; 1; 2	11,39 ± 0,41 **A** b x β	12,26 ± 1,00 **AB**	3,77 ± 0,23 **A** b x β	18,90 ± 1,77 **AB**	6,98 ± 0,44 **A**	6,41 ± 0,29 **B** β	387,16 ± 20,88 x β	411,96 ± 12,16 **AB** b β	218,89 ± 4,76 **A**	115,86 ± 10,83 **AB**
4; 2; 1	14,29 ± 0,32 **A** a y α	13,54 ± 0,95	5,71 ± 0,29 **A** a y α	22,32 ± 2,26	7,19 ± 0,65 **A**	7,06 ± 0,78 **B** α	473,78 ± 13,70 **A** y α	452,49 ± 31,43 **B** ab α	223,41 ± 16,62 **A**	107,88 ± 6,80
4; 2; 2	11,34 ± 0,85 **A** b y β	11,63 ± 0,54 **B**	4,36 ± 0,69 **A** b y β	17,65 ± 1,46 **B**	6,91 ± 0,92	6,77 ± 0,46 **B** β	452,76 ± 18,41 **A** y β	438,45 ± 16,89 **B** ab **β**	196,96 ± 9,55 **A**	105,17 ± 8,37 **B**
8; 1; 1	12,20 ± 0,59 **A** ab α	14,45 ± 0,74 **A** a α	4,34 ± 0,21 **A** b x α	24,85 ± 1,35 **A** a α	7,64 ± 1,28	7,11 ± 0,21 ab x	467,82 ± 5,94 **A**	422,45 ± 12,22 ab x	215,12 ± 6,06 **A** a x	113,45 ± 4,72 ab x
8; 1; 2	11,16 ± 0,24 **A** bc β	11,06 ± 0,30 **B** b β	4,19 ± 0,30 **A** b x β	16,37 ± 0,57 **B** b β	5,53 ± 0,07 **B**	6,22 ± 0,55 **B** b x	364,55 ± 45,76	403,66 ± 43,13 **B** b x	209,62 ± 5,82 **AB** a x	121,85 ± 1,92 **AB** a x
8; 2; 1	13,24 ± 0,40 **A** a α	14,84 ± 0,45 a α	5,26 ± 0,20 **A** a y α	27,54 ± 1,49 a α	7,75 ± 0,82 **A**	8,33 ± 0,47 **AB** a y	423,88 ± 7,63 **B**	514,73 ± 18,44 **A** a y	178,03 ± 11,24 **B** b y	105,08 ± 2,20 b y
8; 2; 2	10,39 ± 0,95 **AB** c β	10,58 ± 0,70 **B** b β	4,13 ± 0,39 **A** b y β	14,91 ± 0,18 **B** b β	5,95 ± 1,80	7,75 ± 1,14 **AB** ab y	381,76 ± 37,74 **AB**	492,88 ± 53,13 **AB** ab y	167,04 ± 11,58 **B** b y	103,89 ± 4,91 **B** b y
14; 1; 1	10,84 ± 0,93 **A** b x α	16,14 ± 0,63 **A** a α	3,26 ± 0,28 **B** c x	27,92 ± 2,03 **A** a α	7,07 ± 0,35 a	7,42 ± 0,75 a α	353,46 ± 16,86 **B**	490,98 ± 39,72 ab α	176,51 ± 7,74 **C**	124,04 ± 3,44
14; 1; 2	12,04 ± 0,49 **A** b x β	11,50 ± 0,19 **B** b β	4,36 ± 0,23 **A** b x	16,77 ± 1,24 **B** b β	5,61 ± 0,71 **B** ab	5,86 ± 0,41 **B** b β	354,33 ± 24,03	384,89 ± 20,47 **B** c β	186,43 ± 14,65 **C**	126,23 ± 2,94 **A**
14; 2; 1	14,33 ± 0,34 **A** a y α	14,22 ± 1,15 a α	5,54 ± 0,30 **A** a y	24,75 ± 2,28 a α	7,21 ± 0,77 **A** a	7,94 ± 0,39 **AB** a α	391,15 ± 24,74 **B**	512,43 ± 20,39 **AB** a α	183,20 ± 5,22 **B**	118,35 ± 6,40
14; 2; 2	11,31 ± 0,80 **A** b y β	11,98 ± 0,89 **B** b β	4,59 ± 0,55 **A** ab y	18,76 ± 1,34 **B** b β	4,96 ± 0,77 b	6,51 ± 0,62 **B** ab β	367,48 ± 71,95 **AB**	410,70 ± 38,78 **B** bc β	180,00 ± 3,47 **AB**	123,11 ± 5,27 **A**

[a] In each variable the values of different treatments followed by different letters are significantly different according to the Tukey test (P <0.05). Absence of letters means no significant effect due to treatment according to one-way ANOVA (P <0.05). In each column, values at different storage times (ST) and the same picking method (PM) and storage method (SM), followed by different upper bold case letters are significantly different; four values at each ST, followed by different lower case letters (a, b, c, d) are different; two values at the same ST and same storage method (SM), but different picking method (PM), followed by lower case letters (x or y), are different; two values at the same ST and same PM, but different SM, followed by different Greek letters are significantly different. Each value is the mean ± SD of 3 replicates.

Table 3. Levels of significance of the factors Storage Time, Treatment, Picking Method, Storage Method as presented in Table 1 and 2, and with respect to the following parameters: Free Fatty Acidity, Peroxides, K_{232} and K_{270}, oxidative stability, photosynthetic pigments (K_{460} and K_{670}), bitterness index, total phenolic amount and the total amount of α-tocoferol.

	FFA		**PV**		**K_{232}**		**K_{270}**		**OXIDATIVE STABILITY**		**K_{460}**		**K_{670}**		**BITTERNESS INDEX**		**TOTAL POLIFENOLS**		**α-TOCOFEROL**	
year	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**
ARBEQUINA																				
Storage Time (ST)	,000	,000	,000	,000	,559	,000	,003	,000	,000	,414	,000	,000	,000	,000	,037	,000	,000	,077	,000	,000
Treatment (T)	,000	,000	,000	,000	,915	,986	,066	,000	,000	,000	,000	,000	,000	,000	,001	,000	,000	,832	,032	,001
ST x T	,000	,000	,000	,000	,414	,000	,001	,005	,000	,000	,000	,000	,002	,000	,011	,002	,002	,093	,001	,045
Picking Method (PM)	,000	,000	,009	,004	,912	,852	,138	,000	,014	,010	,000	,099	,000	,036	,097	,103	,000	,802	,007	,000
Storage Method (SM)	,000	,000	,000	,000	,669	,765	,950	,559	,000	,000	,000	,000	,000	,000	,000	,000	,000	,378	,320	,917
ST x PM	,000	,000	,000	,000	,537	,000	,067	,287	,000	,065	,280	,016	,274	,000	,087	,102	,082	,060	,000	,119
ST x SM	,000	,000	,000	,018	,471	,003	,003	,353	,020	,000	,000	,000	,000	,000	,002	,005	,000	,385	,212	,310
PM x SM	,000	,000	,012	,034	,579	,901	,024	,301	,002	,386	,028	,878	,008	,314	,642	,908	,122	,934	,401	,072
ST X PM x SM	,000	,018	,075	,012	,210	,022	,005	,000	,080	,002	,245	,079	,119	,010	,797	,009	,629	,163	,727	,030
PICUAL																				
Storage Time (ST)	,000	,000	,000	,003	,149	,108	,004	,000	,000	,000	,001	,000	,035	,000	,424	,000	,000	,000	,008	,000
Treatment (T)	,000	,000	,000	,007	,793	,528	,387	,000	,000	,009	,000	,000	,000	,000	,000	,000	,000	,001	,000	,120
ST x T	,000	,000	,384	,066	,199	,173	,970	,027	,001	,000	,000	,000	,003	,001	,000	,006	,007	,345	,015	,000
Picking Method (PM)	,093	,000	,000	,001	,324	,233	,102	,000	,000	,001	,000	,000	,000	,000	,000	,000	,000	,000	,001	,028
Storage Method (SM)	,000	,000	,250	,198	,930	,425	,600	,331	,074	,261	,133	,000	,005	,000	,000	,021	,008	,480	,009	,402
ST x PM	,077	,000	,199	,129	,128	,222	,603	,028	,038	,000	,000	,012	,000	,005	,005	,007	,004	,103	,005	,000
ST x SM	,000	,000	,778	,725	,195	,438	,984	,052	,014	,017	,284	,000	,302	,000	,001	,352	,411	,935	,175	,022
PM x SM	,000	,089	,928	,875	,875	,717	,953	,967	,000	,938	,705	,005	,268	,053	,267	,083	,002	,423	,108	,588
ST X PM x SM	,000	,004	,285	,022	,543	,110	,885	,316	,005	,036	,208	,170	,321	,332	,026	,015	,033	,347	,198	,012
VERDIAL																				
Storage Time (ST)	,000	,000	,000	,005	,041	,000	,007	,000	,000	,087	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000
Treatment (T)	,000	,000	,000	,101	,775	,001	,228	,000	,000	,687	,000	,000	,000	,000	,000	,000	,002	,000	,001	,029
ST x T	,000	,863	,000	,260	,916	,038	,397	,024	,002	,009	,002	,000	,001	,000	,061	,015	,016	,001	,000	,455
Picking Method (PM)	,430	,000	,000	,015	,869	,002	,066	,000	,000	,346	,001	,695	,000	,343	,166	,000	,110	,000	,001	,012
Storage Method (SM)	,000	,310	,017	,702	,316	,022	,649	,003	,000	,552	,000	,000	,001	,000	,000	,000	,001	,000	,213	,196
ST x PM	,000	,417	,000	,042	,745	,007	,118	,044	,004	,166	,114	,213	,039	,677	,330	,012	,047	,003	,000	,134
ST x SM	,000	,833	,277	,718	,624	,484	,837	,010	,070	,012	,005	,000	,003	,000	,008	,021	,015	,001	,310	,899
PM x SM	,000	,287	,000	,829	,838	,096	,399	,476	,057	,646	,000	,570	,000	,376	,972	,306	,258	,418	,022	,233
ST X PM x SM	,009	,869	,000	,698	,864	,306	,467	,869	,024	,039	,008	,010	,022	,012	,736	,771	,262	,595	,151	,490

Table 4. Values of $\widehat{\omega}^2$ (omega square), as a measure of the effect of the factor recollection, conservation and the interaction between both, for each of the 4 storage times during year 1 and 2. Negative values are set to ,00.

Storage Time (days)	**0**						**4**						**8**						**14**					
Factor	**R**		**C**		**R x C**		**R**		**C**		**R x C**		**R**		**C**		**R x C**		**R**		**C**		**R x C**	
year	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**
ARBEQUINA																								
FFA	,26	,40	,00	,00	,00	,00	,17	,17	,33	,64	,03	,08	,27	,17	,40	,66	,22	,10	,35	,14	,37	,82	,28	,02
PV	,00	,61	,00	,00	,00	,00	,06	,08	,71	,42	,02	,14	,31	,34	,46	,15	,00	,16	,44	,60	,05	,09	,32	,05
K232	,38	,59	,00	,00	,00	,00	,00	,00	,02	,09	,30	,42	,00	,24	,00	,11	,00	,23	,00	,09	,00	,37	,27	,00
K270	,62	,09	,00	,00	,00	,00	,07	,28	,00	,02	,00	,41	,00	,35	,14	,00	,00	,06	,00	,24	,26	,00	,57	,00
Oxidative Stability	,03	,25	,00	,00	,00	,00	,34	,13	,00	,41	,00	,30	,34	,01	,07	,76	,00	,07	,18	,00	,70	,69	,04	,00
K470	,75	,49	,00	,00	,00	,00	,05	,02	,88	,83	,00	,03	,04	,00	,86	,91	,02	,00	,00	,03	,89	,71	,01	,04
K670	,75	,56	,00	,00	,00	,00	,09	,15	,65	,49	,00	,18	,15	,00	,57	,89	,09	,00	,03	,20	,52	,57	,13	,00
Bitterness Index	1,00	,38	,00	,00	,00	,00	,00	,01	,00	,57	,00	,22	,14	,00	,21	,83	,00	,00	,04	,00	,71	,30	,00	,11
Total polifenols	1,00	,42	,00	,00	,00	,00	,59	,36	,00	,00	,18	,34	,17	,00	,42	,00	,01	,00	,21	,00	,30	,04	,03	,01
α-tocoferols	,55	,55	,00	,00	,00	,00	,41	,30	,00	,16	,00	,02	,00	,02	,32	,00	,08	,00	,77	,14	,00	,01	,00	,24
PICUAL																								
FFA	,00	1,00	,00	,00	,00	,00	,00	,00	,00	,76	,00	,00	,07	,00	,00	,72	,60	,00	,05	,27	,44	,54	,34	,09
PV	,51	,27	,00	,00	,00	,00	,00	,48	,00	,06	,00	,13	,59	,05	,08	,00	,06	,18	,28	,00	,00	,00	,05	,11
K232	,13	,08	,00	,00	,00	,00	,11	,21	,37	,09	,00	,00	,09	,00	,15	,00	,04	,12	,01	,00	,00	,00	,00	,13
K270	,00	,93	,00	,00	,00	,00	,80	,29	,03	,00	,09	,00	,73	,62	,14	,13	,05	,00	,15	,07	,00	,33	,07	,08
Oxidative Stability	,00	,87	,00	,00	,00	,00	,74	,00	,04	,00	,00	,00	,58	,43	,03	,00	,22	,12	,35	,05	,21	,26	,35	,07
K470	,79	,84	,00	,00	,00	,00	,48	,39	,00	,29	,07	,04	,87	,27	,08	,57	,03	,08	,28	,07	,00	,81	,00	,00
K670	,73	,83	,00	,00	,00	,00	,55	,44	,21	,27	,00	,01	,81	,22	,03	,54	,08	,06	,00	,01	,25	,78	,00	,00
Bitterness Index	,64	,62	,00	,00	,00	,00	,77	,59	,01	,08	,00	,05	,69	,00	,00	,13	,00	,08	,47	,06	,31	,15	,10	,35
Total Polifenols	,74	,29	,00	,00	,00	,00	,82	,60	,01	,00	,03	,20	,52	,00	,07	,15	,28	,17	,83	,56	,03	,00	,00	,12
α-tocoferols	,96	,83	,00	,00	,00	,00	,05	,00	,00	,27	,00	,11	,75	,17	,05	,02	,00	,08	,01	,19	,38	,15	,24	,21
VERDIAL																								
FFA	,17	,55	,00	,00	,00	,00	,43	,35	,00	,00	,51	,00	,07	,31	,22	,12	,43	,03	,06	,58	,54	,00	,00	,00
PV	,61	,33	,00	,00	,00	,00	,71	,10	,01	,00	,23	,11	,83	,29	,00	,00	,09	,00	,65	,00	,11	,00	,00	,00
K232	,00	,17	,00	,00	,00	,00	,01	,00	,00	,00	,00	,00	,00	,56	,00	,05	,00	,14	,25	,00	,02	,48	,00	,00
K270	,00	,56	,00	,00	,00	,00	,00	,82	,00	,00	,02	,00	,31	,72	,00	,08	,00	,00	,00	,13	,00	,55	,21	,00
Oxidative Stability	,16	,72	,00	,00	,00	,00	,59	,00	,08	,30	,17	,07	,59	,45	,27	,10	,04	,00	,03	,07	,36	,60	,00	,00
K470	,00	,00	,00	,00	,00	,00	,13	,05	,43	,01	,14	,31	,00	,00	,64	,92	,12	,01	,20	,02	,08	,74	,50	,08
K670	,28	,00	,00	,00	,00	,00	,27	,02	,36	,15	,01	,22	,15	,00	,36	,93	,20	,03	,51	,00	,00	,80	,33	,06
Bitterness Index	,56	,66	,00	,00	,00	,00	,00	,00	,11	,35	,00	,13	,00	,62	,42	,00	,00	,00	,00	,02	,65	,73	,00	,00
Total Polifenols	,16	,00	,00	,00	,00	,00	,34	,30	,24	,00	,03	,20	,00	,00	,55	,00	,07	,23	,02	,00	,00	,53	,00	,00
α-tocoferols	,00	,00	,00	,00	,00	,00	,00	,00	,07	,00	,37	,02	,82	,67	,02	,03	,00	,07	,00	,12	,00	,05	,06	,00