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Enhancing 'Mirlo Rojo' Apricot (*Prunus armeniaca* L.) Quality Through Regulated Deficit Irrigation: Effects on Antioxidant Activity, Fatty Acid Profile, and Volatile Compounds

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Abstract: Water scarcity is a significant global risk affecting health, food security, economic development, social stability, environmental sustainability, and climate change adaptation. Implementing deficit irrigation strategies can improve water efficiency and agricultural resilience. Spain, particularly the Region of Murcia, has pioneered apricot cultivation, with the 'Mirlo Rojo' variety known for its high productivity, Sharka virus resistance, and exceptional organoleptic qualities. This study evaluates the effects of regulated deficit irrigation (RDI) on the quality, antioxidant activity, fatty acid profile, and volatile compounds of 'Mirlo Rojo' apricots. Four irrigation treatments (100% ETc, 60% ETc, 33% ETc, and 0% ETc) were tested during the final growth stages in May 2023. Results showed no adverse effects on the evaluated parameters. RDI treatments increased total soluble solids, glucose, and fructose content, improving maturity and sweetness indices. RDI also enhanced phenolic content and antioxidant activity, optimizing water use without compromising fruit quality and bioactive compounds.

Keywords: sustainable irrigation; bioactive compounds; fruit quality; water saving; stone fruit

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1. Introduction

Agriculture in semi-arid regions faces a pressing challenge of water scarcity, especially in areas dedicated to cultivating vegetables and fruit trees along the Mediterranean. These regions are increasingly vulnerable to severe droughts intensified by climate change. The global issues of freshwater availability and scarcity require immediate action, urging Spanish agriculture and other Mediterranean regions to implement strategies to improve resilience against water shortages [1–3]. Globally, the agriculture sector accounts for 70% of all surface and groundwater withdrawals, mainly for irrigation [4]. The Region of Murcia (Spain) is considered among the driest areas in the European continent, with a

mean annual precipitation of 226.6 mm in 2023 [5,6], and this situation of water scarcity has been exacerbated by the increasing impact of climate change, rising industrial demand for water resources, and recent changes in water allocation regulations, particularly the Tajo-Segura transfer [7].

In Spain, apricot cultivation covers 18,430 hectares and yielded 80,870 tonnes in 2022, representing 2.0% of global production [8]. This country has been a pioneer in apricot cultivation, focusing on production in the autonomous communities along the Mediterranean coast, particularly in the Region of Murcia, which contributes 50.4% (40,778 tonnes) of the national apricot production [9]. 'Mirlo Rojo' is among the main apricot varieties cultivated in this area, which stands out for its resistance to Sharka virus, high productivity, high organoleptic quality, and early harvesting. The fruit is notable for its high firmness and light orange colour with red blush [10].

Growth curves in apricots, based on weight or fruit volume, have previously been described as a double sigmoid pattern [11,12]. This pattern comprises three stages: phase I is characterised by cell division; phase II involves the physiological process of pit hardening; and phase III is characterised by peak fruit expansion, which includes significant cell enlargement and enhancement of intercellular spaces [13]. In apricot trees and other stone fruits, phase III and the early postharvest period, which involves the induction and floral differentiation of buds that ensure the harvest for the following year, are classified as critical stages in which irrigation limitations can lead to significant production losses. While the importance of phase III for apricot yield is well recognised, further research is needed to understand how water stress during critical phases affects apricot fruit quality. With the increasing frequency of water resource shortages, particularly during periods in which the potential production of the crop may be compromised, it is important to explore alternative strategies. A potential approach for adding value could be through indicators that account for improvements in nutritional quality using sustainable practices.

In this sense, HydroSOS products are derived from plants subjected to water stress, known for their higher levels of bioactive compounds and other beneficial properties. Many studies have recommended deficit irrigation strategies (DI) to improve water productivity in crops, while improving its organoleptic and functional quality. As a result, a new generation of sustainable food products known as HydroSOS has emerged [14–19].

The need to reduce water usage in agricultural activities is especially critical in dry areas, particularly for the cultivation of stone fruits. Understanding the optimal level of deficit irrigation is essential for effectively applying the Horner model under water stress conditions. This model, which describes fruit growth dynamics, depends on physiological parameters that are significantly influenced by water availability. By identifying the appropriate deficit irrigation level, growers can balance water conservation with the plants' physiological needs, ensuring critical processes like cell enlargement and nutrient uptake are sustained. This knowledge not only maximizes yield and improves fruit quality but also mitigates the negative effects of water stress during critical growth stages [20,21]. As water scarcity becomes increasingly prevalent, optimizing irrigation strategies through this understanding promotes sustainable agricultural practices and enhances crop resilience. The primary aim of this study is to evaluate the effect of water restriction at different levels applied during a specific phenological stage on several quality parameters of the 'Mirlo Rojo' apricot. Furthermore, considering the potential of water restriction strategies to save water and improve fruit quality, this work investigates the impact of different regulated deficit irrigation strategies on the quality and bioactive compounds of 'Mirlo Rojo' apricots.

2. Materials and Methods

2.1. Plant Material, Growing Conditions, and Experimental Design

The fruit of the apricot var. 'Mirlo Rojo' was used for the study. The cultivation of 'Mirlo Rojo' apricots was carried out in Cieza, Región de Murcia (38°18′37.8″ N, 1°31′21.8″ W). The plant material consisted in 8-year-old apricot (*Prunus armeniaca* L. var. 'Mirlo Rojo') planted at 4 m × 2 m. The soil of the experimental orchard has a clay loam

texture, very low electrical conductivity, high lime content, low organic matter content, and low contents of potassium and phosphorus. The irrigation water had an electrical conductivity of 0.8–1.1 dS m^{-1}.

The climate of the area is strictly Mediterranean, with mild winters, low annual rainfall, and hot and dry summers. During the experimental period (40–130 DOY, day of the year), the average daily maximum and minimum air temperatures were 25 and 9 °C, respectively, while the mean daily air vapor pressure deficit (VPDm) ranged from 0.2 to 1.7 kPa, and the reference crop evapotranspiration (ETo) [22] was 319 mm, which was used to establish the different treatments (Figure 1). Total pre-harvest rainfall was only 11.4 mm, of which 2.3 mm fell on DOY 60 and 3.4mm on DOY 64. Crop irrigation requirements (crop evapotranspiration, ETc) were determined according to daily ETo and a crop factor based on the time of the year [23] and the percentage of ground area shaded by the tree canopy [24]. Apricot plants were drip irrigated every night, using one lateral pipe parallel to the tree row and one emitter every 50 cm, each delivering 2 L h^{-1}.

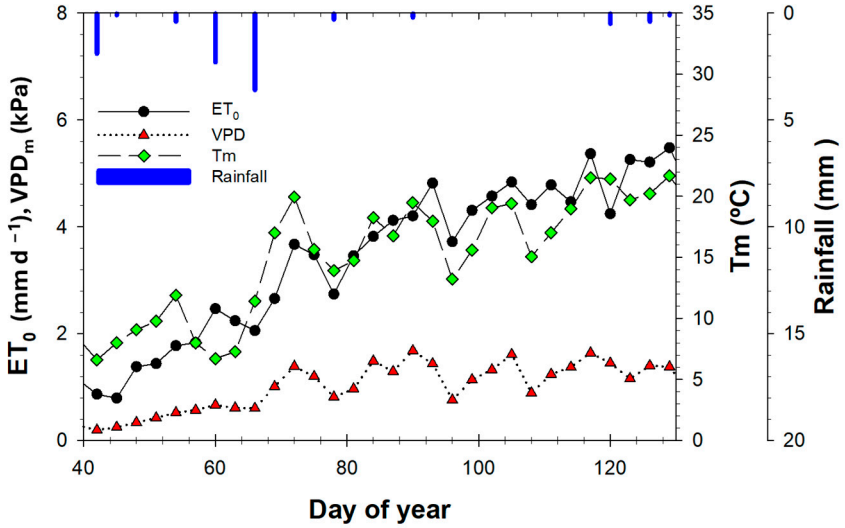

Figure 1. Evolution of reference evapotranspiration (ET_0, mm d^{-1}), daily mean vapor pressure deficit (VPDm, kPa), daily mean temperature (T_m, °C), and rainfall (mm) during the study period.

All trees were irrigated at 100% ETc to maintain non-limiting soil water conditions from flowering (late February) to the end of pit hardening (early May), fruit growth phases I and II. On 8 May 2023, four experimental irrigation treatments were applied during the last period of fruit growth (fruit growth phase III):

i. TA (control), in which trees were irrigated to 100% of the ETc.
ii. TB, in which trees were irrigated to 66% of the ETc.
iii. TC, in which trees were irrigated to 33% of the ETc.
iv. TD, in which trees were irrigated to 0% of the ETc.

The fruits from all the treatments were harvested during the third week of May 2023. The sample selection was carried out in two stages, field and laboratory. In the field, 180 fruits of each treatment were collected from both the southeast and northwest sides of the trees, and from the top and bottom of the tree on each side, selecting 60 fruits from each tree. Fruits were manually picked at the same ripening stage, and immediately transported to the laboratory.

Once in the laboratory, the 180 fruits per treatment were divided randomly into two groups of 90 fruits each. One group of 90 fruits was used for physical and chemical analyses, while the other group of 90 fruits was reserved for volatile compounds and freeze-dried analyses. In both cases, the 90 fruits per treatment were then randomly divided into three lots per treatment, each serving as a biological replicate.

Entire 'Mirlo Rojo' apricots were used for analysing physical quality parameters (flesh firmness and colour). All the fruits of the batches were used for the measurement of external colour (n = 90 per treatment). Of the 30 fruits of each biological replicate, 15 were selected to measure flesh firmness (n = 45 per treatment). The remaining 15 were used to make the juice, obtained by squeezing the pulp of apricots, for measuring total soluble solids (TSS), titratable acidity (TA) and organic acids and sugars. Two juices were made from each batch (n = 6 per treatment) for the determination of total soluble solids, total acidity, sugars, and organic acids.

Of the 90 remaining fruits, a total of 15 fruits per treatment were frozen and used for the volatile compounds analyses. Once in the laboratory, the fruits were peeled and fruits of each batch were cut, ground for 10 s in a grinder (Taurus Aromatic Ver II; Taurus Group, Barcelona, Spain), and frozen at −80 °C until the time of analysis. Extraction experiments were run in triplicate (n = 9 per treatment). The rest of the fruits (15) were promptly frozen in liquid nitrogen and then freeze-dried in an Alpha 2–4 freeze dryer (Christ Alpha 2–4; Braum Biotech) for 24 h under reduced pressure (0.220 mbar) for the analysis of antioxidant activity, total polyphenols content (TPC), and fatty acid profile. The temperature in the drying chamber was −25 °C, while the heating plate reached 15 °C. Subsequently, the samples were milled to a fine powder and vacuum-packed, with an average of 98.5 g of sample grinded in each batch. Three batches per treatment were obtained from freeze-dried samples. For the antioxidant activity, TPC, and fatty acid profile analyses, the three batches were analysed along with a fourth sample that consisted of a mixture of these three batches (n = 4).

2.2. Physicochemical Quality Parameters

The TSS were measured with a digital Atago refractometer (model N-20; Atago, Bellevue, WA, USA) at 20 °C with values being expressed as degrees Brix (°Brix). TA and pH were determined by acid–base potentiometer (877 Titrino plus, Metrohm ion analyses CH9101, Herisau, Switzerland), using 0.1 mol L^{-1} NaOH up to pH 8.1; the analyses were run in 6 replications and values were expressed as grams of malic acid per litre. The maturity index was calculated as the ratio between the TSS and TA.

External colour parameters of apricot peel were measured in 90 fruits per treatment with a Minolta colourimeter C-300 Chroma Meter (Minolta Corp., Osaka, Japan) by using the CIE L*a*b* system. Measurements were taken at two opposite points on the equatorial zone of each apricot, one with blush and one without blush. The average of these measurements was used for the analysis. Results were expressed as L* (lightness), a* (redness), b* (yellowness), and the objective colour was calculated as chromaticity or chroma ($C^* = ((a^*)^2 + (b^*)^2)^{1/2}$) and hue angle ($H^{\circ *} = \arctan(b^*/a^*)$).

Flesh texture was determined in 45 fruits per treatment with a TX-XT2i Texture Analyzer (Stable Microsystems, Surrey, UK). Two types of tests were run: deformation and penetration tests. The deformation test was carried out according to Batool et al. [25] using a flat aluminium plate 100 mm diameter (P100): firmness was expressed as "maximum force" (N), maximum compressive force applied to cause a 5 mm deformation; "total work" (N mm^{-1}), compressive work needed to cause a 5 mm deformation. The penetration test was carried out using an ebonite probe 10 mm diameter (P10). Calculated parameters were "breaking force" (N) applied to cause peel breakage and "maximum force work" (N mm^{-1}) needed to cause a 10 mm penetration.

2.3. Organic Acids and Sugars

Organic acids and sugars profiles were identified and quantified according to Hernández et al. [26], utilizing the same HPLC conditions, elution buffer, and standards. Sugar and organic acid standards were supplied by Supelco analysis (Bellefonte, PA, USA). Analyses were run in 6 replications and results for both organic acids and sugars were expressed as concentrations g 100 mL^{-1} of juice. The sweetness index (SI) of fruits, an estimate of the total sweetness perception, was calculated based on the relative amount and sweetness properties of each

individual carbohydrate. Thus, the contribution of each carbohydrate to sweetness perception was calculated according to Keutgen and Pawelzik [27] as (1.00 × [glucose concentration]) + (2.30 × [fructose concentration]) + (1.35 × [sucrose concentration]).

2.4. Determination of Antioxidant Activity (AA) and Total Polyphenols Content (TPC)

The extraction procedure for TPC and AA quantification was prepared as described by Wojdyło et al. [28]. The radical scavenging activity was evaluated using the 2,2-diphenyl-1-picrylhydrazyl radical method (DPPH$^{\bullet}$), as previously described [29], while the 2,2-azinobis (3-ethylbenzothiazoline-6-sulfonic acid) radical cation (ABTS$^{\bullet+}$) and ferric reducing antioxidant power (FRAP) methods were measured as previously described [30,31]. These three analyses were run in four replications and results were expressed as mM Trolox of dry matter (DM). Total polyphenols content (TPC) was quantified using Folin–Ciocalteu reagent as previously described [32]. This analysis was conducted in four replications and results were expressed as grams of gallic acid equivalent (GAE) per kilogram DM.

2.5. Volatile Compounds Profile

Two grams of fresh apricot pulp were added to a hermetic vial with a polypropylene cap and PTFE (polytetrafluoroethylene)/silicone septa, along with 1 g NaCl and β-ionone as the internal standard (10 µL of 1000 mg L^{-1}). The extraction of the volatile compounds of the samples was carried out using the headspace solid-phase microextraction (HS-SPME) method, as described by Teruel-Andreu [33] Volatile compounds were determined following the procedure described by Oliveira et al. [34] using a chromatograph Shimadzu GC2030 (Shimadzu Scientific Instruments, Inc., Columbia, MD, USA) for isolation and identification of the volatile compounds. The equipment and the gas chromatographic conditions were described in Teruel-Andreu et al. [33]. The volatile compounds were identified using three methods: (i) retention indices (RI), which were calculated with a commercial alkane standard mixture (C8–24) (Sigma-Aldrich, Steinheim, Germany); (ii) GC–MS retention time of the chemical pure compounds; and (iii) comparison of the compound mass spectrum with those of databases [35]. In addition, the relative intensity of each volatile compound was calculated as the ratio between the area of the specific molecule and the sum of the areas of all identified peaks (peak area normalisation method) in the chromatogram. Compounds with spectral similarity > 90% and with a deviation of less than 10 units of linear retention similarity were considered as correctly identified. Analyses were run in nine replications and results were expressed as mg Kg^{-1}.

2.6. Fatty Acid Profile

The fatty acid profile was determined by the fatty acid methyl ester method (FAME) following ISO-12966-2 [36] and using C13:0 (0.04 mg mL^{-1}) as the internal standard for later quantification. Apricot freeze-dried samples were directly methylated according to Trigueros et al. [37]. After extraction and methylation, for separation and quantification, a gas chromatograph (GC) Shimadzu GC-2030 coupled with a flame ionisation detector (FID) an automatic injector AOC-20i was used. The separation and quantification conditions were as outlined by García-Garví et al. [38]. Analyses were run in four replications and results were expressed as mg Kg^{-1} DM. Additionally, the atherogenic index (AI), thrombogenic index (TI), and hypocholesterolemic/hypercholesterolemic ratio were calculated according to Ulbricht and Southgate [39] and Chen and Liu [40].

2.7. Statistical Analysis

Kruskal–Wallis tests were used for samples comparison and medians were compared using the Dunn test at 95% confidence level. A threshold of $p < 0.05$ was used to define associations as statistically significant. Statistical analysis and figures were performed using XLSTAT software version 9 (Microsoft Corporation, Redmond, WA, USA) [41]. Significant different samples were labelled with different letters to facilitate interpretation of the results.

3. Results

3.1. Physicochemical Quality Parameters

The external colour coordinates of 'Mirlo Rojo' apricots under the studied irrigation treatments are shown in Table 1. Figure 2 presents images of 'Mirlo Rojo' apricots under different irrigation treatments, showing variations in peel colour and external appearance. The L* parameter, which reflects colour luminosity, ranged from 60.19 in the TC treatment to 62.74 in the TB treatment, with the highest values in the TB and TD treatments. No differences were found between treatments in the a* coordinate, which indicates the red-green component of colour; positive values indicate red and negative values indicate green. The b* coordinate, indicating yellow/blue (with +b indicating yellow and -b indicating blue), ranged from 36.32 in the TC treatment to 40.17 in the TB treatment, showed significantly higher values, which indicates a higher yellow content. The C* parameter measures colour saturation, with higher values indicating greater saturation. In 'Mirlo Rojo' apricots, this coordinate ranged from 44.46 in the TC treatment to 47.09 in the TB treatment. No significant differences were found between the TA and TD treatments, but TC showed a significantly lower value in C*, and TB the highest value. The increase of $H^{\circ *}$ in apricots is related to a more reddish colour, and the decrease is related to peel darkening. This parameter ranged from 55.54 in the TC treatment to 58.75 in the TB treatment, with no significant differences between treatments except for the TC treatment, which showed the lowest value. Based on these results, the TB treatment (irrigation at 60% of ETc) presented the most appropriate colour values in terms of quality, as it showed a more intense colouring which is associated with higher consumer acceptance [42].

Table 1. External colour coordinates of 'Mirlo Rojo' apricots under different irrigation treatments.

Treatment	L* (D65)	a* (D65)	b* (D65)	C* (D65)	H°* (D65)
TA	61.17 b [1]	24.51 a	38.74 b	46.12 b	57.45 a
TB	62.74 a	24.21 a	40.17 a	47.09 a	58.75 a
TC	60.19 b	24.42 a	36.32 c	44.46 c	55.54 b
TD	62.33 a	23.63 a	38.37 b	45.72 b	57.89 a

[1] Values (means) followed by the same letter, within the same column, are not significantly different (Kruskal–Wallis $p < 0.05$; Dunn test $p < 0.05$) ($n = 90$). TA = irrigation 100% of ETc; TB = irrigation 60% of ETc; TC = irrigation 33% of ETc; TD = irrigation 0% of ETc. The asterisk (*) in L*, a*, b*, C*, and H°* denotes standard values in the CIE L*a*b* colour space (L* = lightness; a* = chromaticity on the green-red axis; b* = chromaticity in the blue-yellow axis; C* = chroma, calculated as $((a^*)^2 + (b^*)^2)^{1/2}$); H°* = hue angle, calculated as arctan(b*/a*).

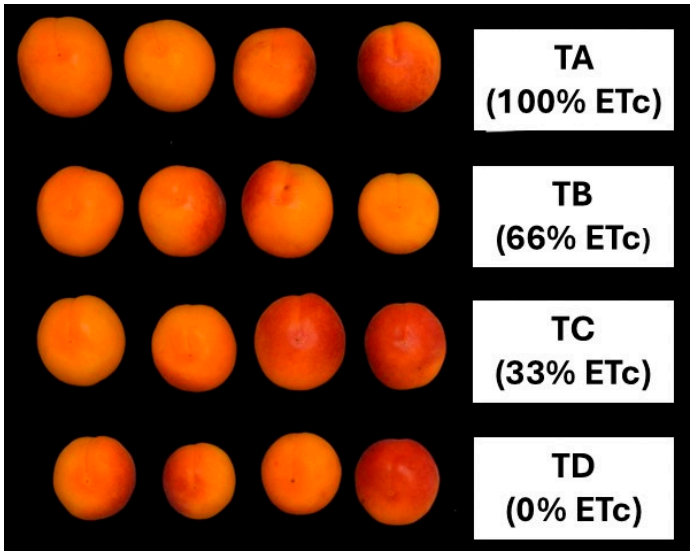

Figure 2. 'Mirlo Rojo' apricot fruits under different irrigation treatments. TA = irrigation 100% of ETc; TB = irrigation 60% of ETc; TC = irrigation 33% of ETc; TD = irrigation 0% of ETc.

Results of flesh firmness in 'Mirlo Rojo' apricots indicate that the TD treatment, corresponding to irrigation suppression, showed the highest firmness values across all measurements. No significant differences were found in breaking force (N) and maximum force work (N mm^{-1}) between the rest of the treatments (TA, TB and TC). In maximum force and total work measurements, TB (irrigation 60% of ETc) and TC (irrigation 33% of ETc) showed similar values without statistical differences. Additionally, no significant differences were observed between TC (irrigation 33% of ETc) and TA (irrigation 100% of ETc) in these measurements (Table 2).

Table 2. Flesh firmness changes in 'Mirlo Rojo' apricots under different irrigation treatments.

Treatment	Maximum Force (N)	Total Work (N mm^{-1})	Breaking Force (N)	Maximum Force Work (N mm^{-1})
TA	16.00 b [1]	32.37 a	22.40 b	82.97 b
TB	10.48 c	20.59 b	17.56 b	72.32 b
TC	13.73 bc	25.48 ab	22.19 b	63.36 b
TD	21.65 a	36.72 a	39.42 a	125.45 a

[1] Values (means) followed by the same letter, within the same column, are not significantly different (Kruskal–Wallis $p < 0.05$; Dunn test $p < 0.05$) ($n = 45$). TA = irrigation 100% of ETc; TB = irrigation 60% of ETc; TC = irrigation 33% of ETc; TD = irrigation 0% of ETc.

As shown in Figure 3 (Supplementary Material Table S1), no significant differences were observed in titratable acidity. However, both the TSS and maturity index showed higher values in the RDI treatments (TB, TC, and TD), significantly surpassing those in the 100% irrigation treatment (TA). There were no significant differences in the TSS and maturity index between the reduced irrigation treatments.

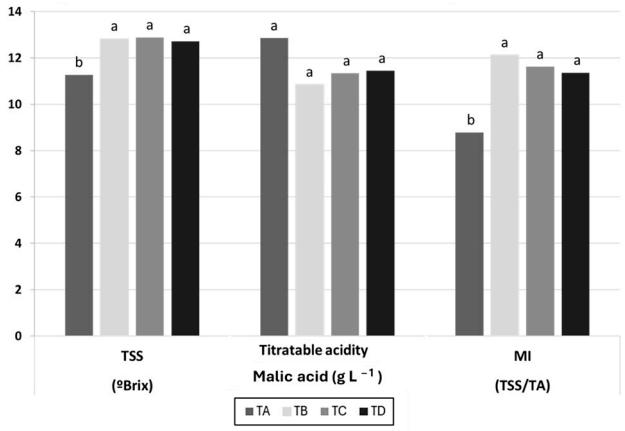

Figure 3. Fruit quality parameters in 'Mirlo Rojo' apricots under different irrigation treatments. Values (means) followed by the same letter are not significantly different (Kruskal–Wallis $p < 0.05$; Dunn test $p < 0.05$) ($n = 6$). TSS = total soluble solids; MI = maturity index; TA = irrigation 100% of ETc; TB = irrigation 60% of ETc; TC = irrigation 33% of ETc; TD = irrigation 0% of ETc.

3.2. Organic Acids and Sugars

The concentration of sugars and organic acids are shown in Table 3. Malic acid predominates, ranging from 1.17 to 1.22 g 100 mL^{-1}, followed by citric and quinic acids. While other organic acids were analysed, only citric, malic, and quinic acids yielded significant results. No significant differences were found between treatments regarding organic acid content. Regarding sugars, sucrose was the dominant sugar, followed by fructose and glucose. Sucrose concentrations ranged from 19.47 to 24.31 g 100 mL^{-1}. TB and TC treatments showed significantly higher glucose levels, while TA exhibited the lowest. All RDI treatments exhibited higher glucose levels than TA, with TB and TD being significantly higher. TD also showed significantly higher fructose levels. The theoretical

sweetness index [27] indicated that the full irrigation treatment had the lowest value, with no significant differences observed among regulated deficit irrigation treatments.

Table 3. Sugars and organic acids in 'Mirlo Rojo' apricots under different irrigation treatments.

Treatment	Sucrose	Glucose (g 100 mL^{-1})	Fructose	Sweetness Index	Citric	Malic (g 100 mL^{-1})	Quinic
TA	19.47 b [1]	0.82 b	1.01 b	31.24 b	0.59 a	1.17 a	0.15 a
TB	24.00 a	1.03 a	1.10 ab	37.96 a	0.63 a	1.22 a	0.17 a
TC	24.31 a	1.00 ab	1.16 ab	38.48 a	0.58 a	1.24 a	0.17 a
TD	22.10 ab	1.07 a	1.22 a	35.72 a	0.57 a	1.30 a	0.16 a

[1] Values (means) followed by the same letter, within the same column, are not significantly different (Kruskal–Wallis $p < 0.05$; Dunn test $p < 0.05$) ($n = 6$). TA = irrigation 100% of ETc; TB = irrigation 60% of ETc; TC = irrigation 33% of ETc; TD = irrigation 0% of ETc.

3.3. Antioxidant Activity (AA) and Total Polyphenols Content (TPC)

The antioxidant activity measured by three methods (DPPH·, ABTS·+ and FRAP) and the total polyphenol content in 'Mirlo Rojo' apricots under various irrigation treatments are shown in Figure 4 (Supplementary Material Table S2). Significant differences were not observed in the DPPH· and FRAP methods. However, in the ABTS·+ method, all deficit irrigation treatments (TB, TC and TD) showed higher values compared to the full irrigation treatment (TA), with no significant differences detected among the deficit irrigation treatments. Regarding total polyphenols content, TC and TD treatments presented higher values compared to TA, whereas TB did not differ significantly from the other treatments.

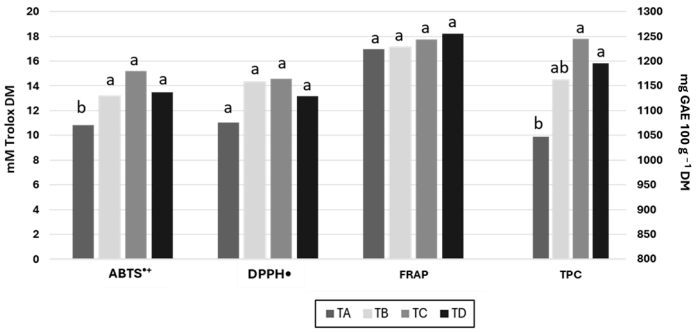

Figure 4. Antioxidant activity (mM Trolox DM) and total polyphenol content (TPC) [mg gallic acid equivalent (GAE) 100 g^{-1} DM] in 'Mirlo Rojo' apricots under different irrigation treatments. Values (means) followed by the same letter are not significantly different (Kruskal–Wallis $p < 0.05$; Dunn test $p < 0.05$) ($n = 4$). TPC = total polyphenols content; TA = irrigation 100% of ETc; TB = irrigation 60% of ETc; TC = irrigation 33% of ETc; TD = irrigation 0% of ETc.

3.4. Volatile Compounds Profile

Thirty-two compounds were isolated, identified, and quantified in the volatile profile of 'Mirlo Rojo' apricots using the HS-SPE technique combined with GC and two detectors (GC-MS and GC-FID). Table 4 presents these compounds, including their retention times, retention indices, and odour descriptors, while Table 5 details their concentrations. The main chemical family was esters ($n = 16$), both in terms of the number of compounds and their concentration. 'Mirlo Rojo' apricots were notably characterised by high levels of esters (Figure 5). TA presented the highest concentration of esters (7.17 mg Kg^{-1}), while TC showed the lowest (3.35 mg Kg^{-1}). Terpenoids ($n = 2$), represented the next most significant family in terms of their concentration, with linalool and cis-geraniol detected, both contributing fruity and apricot-like notes. TB and TC treatments exhibited higher concentrations of terpenoids (3.71 and 3.03 mg Kg^{-1}, respectively) compared to the full irrigation treatment (TA, 1.18 mg Kg^{-1}) and the deficit irrigation treatment (TD, 1.44 mg Kg^{-1}). Other volatile chemical families detected in 'Mirlo Rojo' apricots included ketones ($n = 6$),

aldehydes (n = 4), terpenes (n = 3), alcohols (n = 1), and aromatic hydroxyacids (n = 1). P-cymene, a terpene associated with citrus notes, showed higher concentrations in apricots under the TD treatment. Dodecanal, an aldehyde known for its herbaceous and sweet aroma, exhibited higher values in apricots from the TC and TD treatments. Despite the described differences among treatments, there were no significant differences observed in the total volatile compounds, ranging from 8.14 mg Kg^{-1} in TC to 11.08 mg Kg^{-1} in TB.

Table 4. Aromatic compounds found in 'Mirlo Rojo' fruit pulp using headspace solid phase microextraction (HS-SPME).

Volatile Compound	Chemical Family	RT [1] (min)	Kovats Index (KI) [2] Exp.	Kovats Index (KI) [2] Lit.	Descriptors
1-Hexanol	Alcohols	6.66	873	865	Green, herbaceous, woody, sweet [43]
6-Methyl-5-hepten-2-one	Ketones	11.85	978	986	Oily, herbaceous, green [43]
Butanoic acid butyl ester	Esters	12.51	991	994	Floral [44]
Hexanoic acid ethyl ester	Esters	12.65	994	998	Apple peel, brandy, fruit gum [44]
(E)- 3-Hexen-1-ol acetate	Esters	13.01	1001	1005	Green, floral, fruity [44]
Acetic acid hexyl ester	Esters	13.44	1008	1010	Apple, cherry, floral, pear, sweet [43]
2-Hexen-1-ol acetate	Esters	13.56	1010	1014	Apple, pear, banana, peach, berries [44]
p-Cymene	Terpenes	14.08	1018	1024	Citrus [43]
Limonene	Terpenes	14.37	1022	1027	Lemon, orange, citrus, sweet [43]
Benzeneacetaldehyde	Aldehydes	15.12	1034	1043	Ethereal, coffee, wine-like [43]
Butanoic acid pentyl ester	Esters	18.47	1087	1092	Pear, apricot [43]
Linalool	Terpenoids	18.81	1093	1098	Lemon, orange, floral, citrus, sweet [43]
Terpinen-4-ol	Terpenes	23.95	1169	1177	Chocolate, grapefruit, lemon, lime [43]
(Z)-Butanoic acid 3-hexenyl ester	Esters	24.51	1177	1187	Green [43]
Butanoic acid hexyl ester	Esters	24.98	1184	1190	Apple peel, citrus, fresh [44]
(E)- Butanoic acid 2-hexenyl ester	Esters	25.17	1187	1191	Fruit [44]
Octanoic acid ethyl ester	Esters	25.31	1189	1196	Apricot, floral, pear, pineapple [43]
Decanal	Aldehydes	25.88	1197	1204	Waxy, floral, citrus, sweet [43]
β-Cyclocitral	Aldehydes	26.49	1207	1208	Fruity, minty, green [43]
Butanoic acid 2-methyl-hexyl ester	Esters	27.89	1230	1236	Strawberry [44]
Benzeneacetic acid ethyl ester	Esters	28.03	1232	1229	Honey, floral, green, sweet [43]
cis-Geraniol	Terpenoids	28.69	1243	1239	Apple, apricot, berry, rose, sweet [43]
Salicylic acid	Aromatic hydroxy acids	31.21	1285	1285	Sweet, sour [44]
(Z)-Hexanoic acid 3-hexenyl ester	Esters	35.77	1371	1379	Fruit, prune [44]
Hexanoic acid hexyl ester	Esters	36.09	1378	1381	Apple peel, peach, plum [44]
(E)-Hexanoic acid 2-hexenyl ester	Esters	36.21	1378	1368	Green [44]
Decanoic acid ethyl ester	Esters	36.54	1387	1391	Brandy, grape, pear [44]
Dodecanal	Aldehydes	37.18	1399	1409	Herbaceous, waxy, floral, sweet [43]
Nerylacetone	Ketones	38.91	1432	1438	Floral, fruit [44]
γ-Decalactone	Ketones	39.57	1448	1450	Peach [43]
δ-Decalactone	Ketones	40.71	1476	1471	Butter, coconut, fruity, peach [43]
γ-Dodecanolactone	Ketones	48.35	1666	1671	Apricot, flower, fruit, peach [44]

[1] RT: Retention time. [2] KI: KI (Exp.) = experimental Kovats index; (Lit.) = literature Kovats index.

Table 5. Volatile compound (mg Kg^{-1}) of 'Mirlo Rojo' apricots under different irrigation treatments.

Volatile Compound	TA	TB	TC	TD
Alcohols				
1-Hexanol	0.51 a [1]	0.42 a	0.23 a	0.43 a
Terpenes				
p-Cymene	0.03 b	0.02 b	0.02 b	0.05 a
Limonene	0.46 ab	0.32 bc	0.23 c	0.55 a
Terpinen-4-ol	0.01 a	0.02 a	0.02 a	0.12 a
Terpenoids				
Linalool	1.07 b	3.63 a	2.99 a	1.41 b
cis-Geraniol	0.11 a	0.08 a	0.04 a	0.03 a
Aromatic hydroxy acids				
Salicylic acid	0.05 a	0.05 a	0.04 a	0.04 a
Aldehydes				
Benzeneacetaldehyde	0.04 a	0.06 a	0.04 a	0.05 a

Table 5. *Cont.*

Volatile Compound	TA	TB	TC	TD
Decanal	0.03 a	0.04 a	0.04 a	0.05 a
β-Cyclocitral	0.06 b	0.11 a	0.09 ab	0.05 b
Dodecanal	0.03 b	0.04 b	0.08 a	0.08 a
Esters				
Butanoic acid butyl ester	0.47 ab	0.23 bc	0.16 c	0.54 a
Hexanoic acid ethyl ester	0.58 a	0.89 a	1.01 a	0.77 a
(E)- 3-Hexen-1-ol acetate	0.18 b	0.45 a	0.28 ab	0.34 ab
Acetic acid hexyl ester	0.14 a	0.27 a	0.18 a	0.20 a
2-Hexen-1-ol acetate	0.31 b	0.87 a	0.46 ab	0.62 ab
Butanoic acid pentyl ester	0.11 a	0.05 b	0.04 b	0.09 ab
(Z)-Butanoic acid 3-hexenyl ester	0.46 a	0.16 bc	0.09 c	0.41 ab
Butanoic acid hexyl ester	1.68 a	0.65 b	0.47 b	1.28 ab
(E)-Butanoic acid 2-hexenyl ester	0.92 a	0.30 b	0.11 b	0.99 a
Octanoic acid ethyl ester	0.56 a	0.42 a	0.16 a	0.09 a
Butanoic acid 2-methyl-hexyl ester	0.38 a	0.31 a	0.28 a	0.40 a
Benzeneacetic acid ethyl ester	0.17 a	0.11 a	0.001 a	0.001 a
(Z)-Hexanoic acid 3-hexenyl ester	0.09 a	0.03 b	0.02 b	0.07 abc
Hexanoic acid hexyl ester	0.24 a	0.05 a	0.06 a	0.15 a
(E)-Hexanoic acid 2-hexenyl ester	0.08 a	0.03 b	0.02 b	0.06 ab
Decanoic acid ethyl ester	0.80 a	0.19 a	0.01 a	0.01 a
Ketones				
6-Methyl-5-hepten-2-one	0.04 b	0.07 a	0.05 ab	0.04 b
Nerylacetone	0.05 a	0.08 a	0.06 a	0.07 a
γ-Decalactone	0.53 a	0.87 a	0.64 a	0.30 a
δ-Decalactone	0.04 a	0.07 a	0.05 a	0.03 a
γ-Dodecanolactone	0.06 a	0.09 a	0.07 a	0.03 a
Total (mg Kg^{-1})	10.31 a	10.96 a	8.01 a	9.35 a

[1] Values (means) followed by the same letter, within the same row, are not significantly different (Kruskal–Wallis $p < 0.05$; Dunn test $p < 0.05$) ($n = 9$). TA = irrigation 100% of ETc; TB = irrigation 60% of ETc; TC = irrigation 33% of ETc; TD = irrigation 0% of ETc.

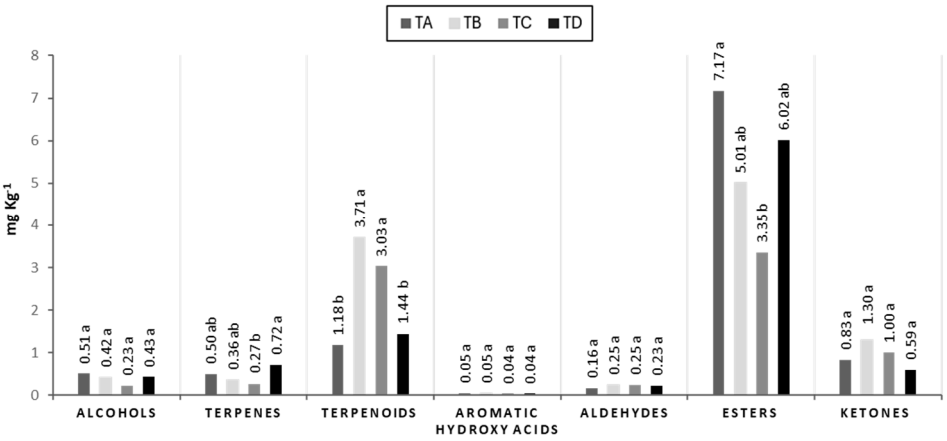

Figure 5. Main chemical families of volatile compounds quantified in 'Mirlo Rojo' apricots under different irrigation treatments. Values (means) followed by the same letter are not significantly different (Kruskal–Wallis $p < 0.05$; Dunn test $p < 0.05$) ($n = 9$). TA = irrigation 100% of ETc; TB = irrigation 60% of ETc; TC = irrigation 33% of ETc; TD = irrigation 0% of ETc.

3.5. Fatty Acid Profile

The fatty acid composition of 'Mirlo Rojo' apricots under different irrigation treatments is shown in Table 6, with results expressed as mg Kg^{-1} DM. Additionally, the table presents the unsaturation ratio (U/S), index of atherogenicity (AI), index of thrombogenicity (TI), the ratio of polyunsaturated fatty acids to saturated fatty acids (PUFA/SFA), and the hypocholesterolemic/hypercholesterolemic ratio (HH). A total of twenty-three

fatty acids were identified and quantified in the edible part of 'Mirlo Rojo' apricots. The most abundant compounds were linolenic (C18:2c9,12/C18:2n6c), palmitic (C16:0), and linoleic (C18:3c9,12,15alpha/C18:3n3) acids. For linolenic acid, the content ranged from 140.17 mg Kg^{-1} DM in apricots under the TA treatment to 153.96 mg Kg^{-1} DM in those under the TD treatment. Palmitic acid content ranged from 74.16 mg Kg^{-1} DM in TA to 84.46 mg Kg^{-1} DM in TD, and linoleic acid ranged from 69.28 mg Kg^{-1} DM in TC to 78.77 mg Kg^{-1} DM in TD. No significant differences were found in the fatty acids profile of apricots under different irrigation treatments, including total fatty acids, total PUFA, total SFA, U/S ratio, AI, TI, PUFA/SFA, and HH indices. Total MUFA levels were lower in TB and TC treatments, with significant differences from TD, which showed the highest values. However, TA did not show significant differences compared to the other treatments. These results demonstrate that the fatty acid profile of 'Mirlo Rojo' apricots subjected to deficit irrigation is not adversely affected by the varying levels of irrigation reduction studied in this research.

Table 6. Fatty acid composition of 'Mirlo Rojo' apricots (mg Kg^{-1} DM).

Fatty Acids (mg Kg^{-1} DM)	TA	TB	TC	TD
Butiric acid (C4:0)	9.48 a [1]	9.46 a	9.54 a	9.45 a
Caprioic acid (C6:0)	2.03 a	2.13 a	1.27 a	2.08 a
Caprilic acid (C8:0)	4.43 a	2.94 a	2.46 a	3.19 a
Capric acid (C10:0)	1.86 a	1.02 a	1.07 a	1.13 a
Undecanoic acid (C11:0)	0.94 a	0.78 a	0.57 a	1.02 a
Lauric acid (C12:0)	1.33 a	1.50 a	1.67 a	1.30 a
Myristoleic acid (C14:1)	0.98 ab	0.92 ab	0.72 b	1.19 a
Pentadecanoic acid (C15:0)	1.06 a	1.02 a	1.03 a	1.08 a
Palmitic acid (C16:0)	74.16 a	79.65 a	83.06 a	84.46 a
Heptadecanoic acid (C17:0)	2.42 ab	2.12 ab	1.86 b	2.91 a
Margaroleic acid (C17:1c10)	0.68 a	0.82 a	0.66 a	0.60 a
Stearic acid (C18:0)	6.71 a	7.48 a	8.34 a	8.47 a
Oleic acid (C18:1t9)	2.30 ab	1.61 ab	1.21 b	3.88 a
Oleic acid (C18:1c9/C18:1n9)	2.65 a	2.75 a	2.85 a	3.06 a
Linolenic acid (C18:2c9.12/C18:2n6c)	140.17 a	148.45 a	153.69 a	153.96 a
Arachidic acid (C20:0)	2.51 a	2.86 a	3.13 a	3.00 a
Linoleic acid (C18:3c6.9.12 gamma/C18:3n6)	1.34 ab	1.40 ab	0.94 b	2.24 a
Linoleic acid (C18:3c9.12.15alpha/C18:3n3)	70.10 a	78.77 a	69.28 a	77.23 a
Eicosenoic acid (C20:1c11/C20:1n9)	3.33 ab	3.12 ab	2.49 b	4.08 a
Behenic acid (C22:0)	1.19 a	1.47 a	1.45 a	1.42 a
Eicosatrienoic acid (C20:3c8.11.14/C20:3n6)	nd b	0.46 a	nd b	0.38 a
Tricosilic acid (C23:0)	0.43 a	0.52 a	0.55 a	0.55 a
Lignociric acid (C24:0)	1.04 a	1.51 a	1.42 a	1.25 a
TOTAL	331.12 a	352.76 a	349.26 a	367.92 a
Total MUFA	9.94 ab	9.22 b	7.93 b	12.81 a
Total PUFA	211.61 a	229.08 a	224.24 a	233.81 a
Total SFA	109.58 a	114.46 a	117.09 a	121.30 a
U/S ratio	2.03 a	2.07 a	1.97 a	2.03 a
AI	0.34 a	0.34 a	0.37 a	0.35 a
TI	0.28 a	0.28 a	0.32 a	0.29 a
PUFA/SFA	1.94 a	1.99 a	1.90 a	1.93 a
HH	2.87 a	2.84 a	2.67 a	2.76 a

[1] Values (means) followed by the same letter, within the same row, are not significantly different (Kruskal–Wallis $p < 0.05$; Dunn test $p < 0.05$) ($n = 4$). Nd = not detected; MUFA = Monounsaturated fatty acid; PUFA = Polyunsaturated fatty acid; SFA = Saturated fatty acid; TI = Thrombogenic index(C14:0 + C16:0 + C18:0)/[0.5 × ΣMUFA + 0.5 × ΣPUFA(n − 6) + 3 × ΣPUFA(n − 3) + (n − 3)/(n − 6)]; AI = Atherogenic index (C12:0 + 4 × C14:0 + C16:0)/[ΣMUFA + ΣPUFA (n − 6) and (n − 3)]; HH = hypocholesterolemic/hypercholesterolemic ratio HH = (cis-C18:1 + ΣPUFA)/(C12:0 + C14:0 + C16:0); TA = irrigation 100% of ETc; TB = irrigation 60% of ETc; TC = irrigation 33% of ETc; TD = irrigation 0% of ETc.

Although no significant differences were observed, an increase in oleic acid (C18:1c9/C18:1n9) could be observed in 'Mirlo Rojo' apricots subjected to RDI treatments. Linoleic acid

(C18:3c6.9.12 gamma/C18:3n6) showed the highest values under full irrigation reduction (TD) in 'Mirlo Rojo' apricots, but there were no significant differences between this treatment and TA and TB.

4. Discussion

In this work, the effects of different irrigation treatments on 'Mirlo Rojo' apricots were studied. Irrigation at 60% of ETc (TB) presented optimal colour values related to higher consumer acceptance, characterised by greater brightness and saturation. The no-irrigation treatment (TD) resulted in the highest pulp firmness, while deficit irrigation treatments (TB and TC) showed no significant differences between them or with full irrigation (TA) in breaking force and maximum force work. Quality parameters such as total soluble solids (TSS), maturity index and sweetness index, were higher in deficit irrigation treatments, which is related to greater acceptance by consumers. Volatile compound analysis revealed that full irrigation treatment (TA) showed the highest concentration of esters, while TB and TC presented the highest terpenoids content, but no significant differences were found in total volatile compounds between treatments no in the total fatty acid content.

Coloured fruit has always been part of the human diet and helps us identify food and evaluate its palatability. In addition to defining the aesthetic value of fruit, colour shapes consumers' expectations of flavour and taste, modulates appetite, and is crucial for the food industry. The CIELab* System (International Commission on Illumination, Vienna) is widely used by the food industry to measure product colour and monitor colour changes during storage [45]. Previous studies have demonstrated the influence of RDI on apricot colour parameters. Pérez-Pastor et al. [46] reported that the a and b coordinates in 'Búlida' apricots shifted towards more reddish values under RDI at 25% ETc during non-critical periods, suggesting advanced maturity, possibly due to increased ethylene release induced by water stress [47]. Pérez-Sarmiento et al. [48] found higher L* values in fruit skin with RDI at 40–60% ETc during non-critical periods, indicating brighter skin colour, which aligns with our findings. Similarly, Torrecillas et al. [3] observed increased C* values in fruits under irrigation withholding during the rapid growth phase (stage III, early May to early June), consistent with our results. Pérez-Sarmiento et al. [48] also reported significantly higher C* values in both skin and pulp under RDI at 40–60% ETc, except in the 2010 harvest, which agrees with our findings. Regarding h°, Pérez-Pastor et al. [46] detected an increase in 'Búlida' apricot skin under RDI at 25–40% ETc during non-critical periods. While 'Búlida' apricots have yellow or whitish skin with pinkish tints, 'Mirlo Rojo' apricots exhibit light orange skin with a red blush. Pérez-Pastor et al. [47] and Pérez-Sarmiento et al. [48] also found higher h° values under RDI at 40–60% ETc during non-critical periods, which aligns with our results, except for the 2010 harvest. There is no firm relationship between RDI and colour changes in apricots; however, reduced vegetative growth increases sunlight exposure to fruits in the inner canopy, affecting their colouration. [47,49].

Firmness is one of the most critical textural properties influencing fruit quality. Consumers generally prefer apricots with firmness ranging from 8–10 N to 25 N [50], a range that includes fruit firmer than what is typically considered "ready-to-eat", around 9–13.5 N [51]. Recent studies suggest that the optimal firmness for eating ranges from 10–25 N [50]. All treatments studied showed maximum force values within the range accepted by consumers. Another study noted that preference increased as firmness decreased from 60 N to around 20 N but dropped significantly below 20 N as fruit softened [52]. The non-linear relationship between flesh firmness and consumer preference may explain the varying results reported in different trials [50]. Several studies have found that fruit firmness was not significantly affected by RDI treatments, regardless of their severity or the apricot variety [46,53,54]. Softer fruits were only observed when irrigation reduction coincided with phase III of fruit growth [3]. Pérez-Sarmiento et al. [48] reported a 30% decrease in firmness during the first harvest of their experimental period, a result not observed in subsequent years. This effect was possibly due to the high accumulated water stress in the initial year, which may have influenced other quality parameters.

Sugar levels are crucial in determining the taste of ripe fleshy fruit. Total soluble solids (TSS) measurement is vital for estimating fruit sugar content and determining its sweetness level, which directly influences consumer acceptance. Additionally, titratable acidity (TA) is important as it affects consumer taste perception, and the maturity index is used to assess fruit ripeness [55]. The findings of this work are consistent with those of other studies that found no significant differences in total acidity levels in the 'Búlida' variety. Pérez-Pastor et al. [47] reported no significant differences in acidity with 25% ETc irrigation. In another study, Pérez-Pastor et al. [46] observed higher acidity values under similar irrigation conditions compared to control treatments. Both studies applied deficit irrigation during fruit growth stages I and II and late post-harvest. Similarly, Pérez-Sarmiento et al. [48] applied deficit irrigation during fruit set, with irrigation ranging from 25% to 60% ETc, and found no significant differences. Kaya et al. (2011) [56] did not find significant differences in total acidity under total irrigation deficit (0% ETc) in the 'Salak' variety, nor did Kumar et al. [57] with 60% ETc irrigation. Other studies have also reported an increase in total soluble solids (TSS) with deficit irrigation strategies. Pérez-Pastor et al. [47] observed this effect when applying 25% ETc irrigation during fruit growth stages I and II and late post-harvest, while Pérez-Sarmiento et al. [48] (2016) reported similar results with 25–60% ETc irrigation during the same stages and fruit set. This trend has also been observed in other stone fruits, such as peaches, under deficit irrigation treatments [58]. However, other authors, such as Kaya et al. [56] and Torrecillas et al. [3], did not find significant differences in TSS under total irrigation restriction (0% ETc). This divergence may be attributed to differences in the varieties studied ('Salak' and 'Búlida' apricots, respectively). Nevertheless, although Torrecillas et al. [3] did not report statistically significant differences in TSS between treatments, a tendency was observed for the soluble solids content to increase in fruits from the T-3 treatment, where irrigation was suppressed from early May to early June, similar to the TD treatment in the present study.

Sugars and organic acids are primary metabolites crucial for fleshy fruits, influencing their flavour profile. The findings about the predominating organic acids (malic, citric and quinic acids) and sugars (sucrose, glucose, and fructose) are consistent with studies on various apricot varieties [59–61]. In contrast to our results, studies on peaches (cv. 'Catherine', a mid-late maturing cultivar) reported significant variations in malic, citric, and tartaric acids and glucose, showed higher values in RDI treatment, but no significant differences in fructose and sucrose between RDI treatment and full irrigation [62]. Similarly, differences in malic and quinic acids were noted in an early-maturing peach cultivar [63], with higher levels observed under deficit irrigation strategies.

Antioxidant activity is a key mechanism through which fruits and vegetables confer health benefits, as they effectively inhibit excessive oxidation caused by free radicals, specifically reactive oxygen species. The antioxidant activity of 'Mirlo Rojo' apricots extracts were conducted by three complementary methods to consider the various mechanisms of antioxidant action. The DPPH· radical is scavenged by antioxidant compounds present in the extracts, which determines its ability to capture radicals, the ABTS·+ method captures the cationic ABTS·+ radical, and finally the FRAP method measures the ability to reduce Fe3+ in the sample. In contrast with the results of this research, in a study carried out on peaches of different Tunisian cultivars ('Flordastar', 'Early May Crest', 'Rubirich', and 'O'Henry') under sustained deficit irrigation (50% ETc in order to apply a water deficit stationary during the total fruit development phase) and controlled deficit irrigation (consisted of re-irrigating at 100% field capacity whenever the soil water content decreased to 50% of field capacity), improvements in antioxidant activity were observed using the DPPH· and ABTS·+ methods. However, these deficit irrigation regimes were applied throughout the entire irrigation season [64]. Another study on raw almonds under deficit irrigation, sustained deficit irrigation, and full irrigation, found no significant differences in antioxidant activity measured by ABTS·+, DPPH·, and FRAP methods [65], which agreed with the results of this work. The trend noticed in total phenols content was similarly observed in early-ripening peach trees (cv. 'Flordastar', grafted on GF677 rootstock), where

peaches irrigated at 25% of ETc during phases I and II of fruit development showed elevated levels of total phenolics [66]. However, in a study on almonds under regulated deficit irrigation (RDI), raw almonds did not exhibit differences in phenolic compounds compared to full irrigation and sustained deficit irrigation treatments [17].

Volatile compounds play a crucial role in shaping the sensory quality of fruits, contributing to their aroma through a diverse array of chemical substances such as alcohols, aldehydes, terpenes, ketones, and esters, among others. The results of the main chemical family (esters) were consistent with findings in other apricot cultivars that associate high ester levels with a fruity aroma [67]. Contrary to our results, in a study on quinces subjected to water stress treatments, volatile compounds were significantly affected by water restriction, resulting in a notable decrease in total volatile concentration, particularly reducing terpenes while increasing alcohols. This effect was attributed to the suppression of irrigation during the middle phase of linear fruit growth [68]. Similarly, in almonds studied under regulated deficit irrigation (RDI), samples subjected to moderate RDI displayed a higher total content of volatile compounds compared to the control [17].

Fatty acids are essential molecules in living organisms, performing various roles such as providing energy, serving structural functions, and modulating physiological processes. They are organic compounds composed of a hydrocarbon chain and a carboxyl group, typically bound to glycerol to form acylglycerides (mono-, di-, or triglycerides). Additionally, fatty acids can be classified as saturated or unsaturated based on the nature of the hydrocarbon chain [69]. The unsaturation ratio indicates the proportion of unsaturated fatty acids relative to saturated ones. Higher values of AI and TI indices indicate a greater risk of atherogenicity and thrombogenicity associated with dietary fat. The AI index measures the content of fatty acids that increase serum lipids (lauric, myristic, and palmitic acids) relative to those with protective actions (MUFAs and PUFAs). Similarly, the TI index assesses the content of myristic, palmitic, and stearic acids, which have thrombogenic effects, in comparison to protective compounds (MUFAs and PUFAs). Myristic acid is the most thrombogenic fatty acid, while n-3 PUFAs are the most antithrombogenic compounds, and n-6 PUFAs are the most antiatherogenic. Thus, AI and TI are valuable indicators of the potential impact of fats on the prevention of atherosclerosis, thrombosis, and overall cardiovascular health [39]. The PUFA/SFA ratio is the most used index to evaluate the effects of diet on cardiovascular health. It is based on the hypothesis that all polyunsaturated fatty acids (PUFA) in the diet can reduce low-density lipoprotein cholesterol (LDL-C) and lower serum cholesterol, while all saturated fatty acids (SFA) contribute to high serum cholesterol. Therefore, a higher PUFA/SFA ratio indicates a more positive effect on cardiovascular health. The H/H ratio may more accurately reflect the impact of the fatty acid profile on cardiovascular disease than the PUFA/SFA ratio since H/H indicates the effects of specific fatty acids on cholesterol metabolism. Nutritionally, higher H/H values are considered more beneficial for human health [40].

The results of the main fatty acids (linolenic, palmitic, and linoleic acids) are consistent with other studies on the fatty acid profiles of different apricot varieties [70]. The AI and TI indices in 'Mirlo Rojo' under the studied irrigation treatments are lower than those found in other plant species, such as all parts of the prickly pear [71] and the yellow, green, and white peach palm fruits [72]. The AI was similar to that of red palm fruit as reported by Santos et al. [72] and cherry tomatoes studied by Fernandes et al. [73], but the TI was lower in 'Mirlo Rojo' apricots compared to these fruits. The H/H ratio was higher in 'Mirlo Rojo' apricots compared to yellow, green, and white palm fruits, and similar to that of red palm fruit [72]. However, the H/H and PUFA/SFA ratios were higher in the cherry tomatoes studied by Fernandes et al. [73]. The U/S ratio was lower in 'Mirlo Rojo' apricots than those studied by Andreu et al. [71] in prickly pear pulp, peel, and old cladodes, and those in white and black mulberry [74], but higher than in the young cladodes of prickly pear [71].

The increase in oleic acid (C18:1c9/C18:1n9) which could be observed in 'Mirlo Rojo' apricots subjected to RDI treatments aligns with the findings of Lipan et al. [17]. In their study on almonds, they observed that mild water stress did not reduce the oleic acid

content; in fact, a slight increase could be observed, although no significant differences were found in this acid among the different irrigation treatments including full irrigation, moderate and severe regulated deficit irrigation, and sustained deficit irrigation. Besides, in their study, Lipan et al. [17] observed a significant reduction in saturated fatty acids such as palmitic acid (C16:0) and arachidic acid (C20:0) when irrigation reduction was applied, but not significant differences among treatments in total MUFA, PUFA, SFA, AI, TI, PUFA/SFA, US ratio, and total fatty acids.

To the best of our knowledge, this study represents the first detailed report on the fatty acid profile of 'Mirlo Rojo' apricots. Interestingly, numerous studies have focused on lipophilic compounds and fatty acids in apricot kernel oil, a by-product of fruit processing. Due to the presence of toxic cyanogenic glycosides, the use of apricot kernel oil in food is limited; however, it holds potential for cosmetic applications or biodiesel. In contrast to the fruits, apricot kernel oil is characterised by a higher content of MUFAs, predominantly oleic acid, which comprises over 50% of the total fatty acids, followed by linolenic and palmitic acids [75,76].

5. Conclusions

The results of this research provide information to understand the impact of different irrigation treatments on the fruit quality of 'Mirlo Rojo' apricots. Four treatments were evaluated: TA (100% ETc irrigation), TB (60% ETc irrigation), TC (33% ETc irrigation), and TD (0% ETc irrigation). The findings indicate that deficit irrigation (TB, TC, and TD) does not negatively influence any of the studied parameters, including physicochemical properties, organic acids, sugars, volatiles, fatty acid profile, and antioxidant activity. In addition, parameters related to higher consumer acceptance, such as total soluble solids, glucose and fructose content, maturity index, and sweetness index, showed higher values in the RDI treatments. This demonstrates the potential benefits of water savings without compromising fruit quality of 'Mirlo Rojo' apricots. Implementing deficit irrigation strategies can thus optimize water usage in agriculture, contributing to sustainable water management while maintaining high-quality produce in 'Mirlo Rojo' apricots. From these results, it can be concluded that the deficit irrigation treatment evaluated has the potential to enhance water use efficiency in 'Mirlo Rojo' apricot without negatively influencing the quality of 'Mirlo Rojo' apricots and without negatively affecting their antioxidant activity, volatile compound profile, and fatty acid profile. However, the success of RDI strategies depends on various factors, including soil conditions, climate, and the accuracy of their implementation. Future research should focus on further evaluating the long-term effects of RDI on apricot yields and quality across different environmental conditions. Additionally, studies could explore optimizing RDI protocols and integrating advanced monitoring technologies to better tailor irrigation practices to specific crop needs and climatic variations. Extrapolating these findings to other stone fruits could provide broader insights into the efficacy of deficit irrigation strategies, potentially guiding water management practices for a range of similar crops.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/horticulturae10121253/s1, Table S1: Fruit quality parameters in 'Mirlo Rojo' apricots under different irrigation treatments; Table S2: Antioxidant activity (mM Trolox DM) and total polyphenol content (TPC) [mg gallic acid equivalent (GAE) 100 g^{-1} DM] in 'Mirlo Rojo' apricots under different irrigation treatments.

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