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Effect of Hot Air-Drying Technique on the Quality and Stability of Blood Orange Slices in Modified Atmosphere Packaging

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Abstract: The choice of time/temperature combination is critical for ensuring microbiological stability and retaining the characteristic taste of dried blood orange slices. The aim of this study was to investigate the capability of hot air-drying technique to maintain the quality characteristic of dried blood orange slices stored in modified atmosphere packaging (MAP). Hot air-drying at 70 °C for 12 h preserved shrinkage without altering the longitudinal diameter, though thickness was significantly reduced, especially in samples with passive MAP. Increased hardness and masticability were noted due to water removal, with active MAP maintaining high hardness and colour integrity up to 100 days of storage (D100). Sensory analysis revealed differences in colour intensity and flavour between active and passive MAP-stored slices. Headspace solid-phase microextraction (HS-SPME) chromatography identified key chemical compounds contributing to aroma and flavour, highlighting the complex interplay between temperature, storage conditions, and volatile organic compounds production. The study demonstrates that drying combined with MAP storage enhances organoleptic qualities and nutritional value, offering a method to produce a healthy, tasty, and visually appealing snack.

Keywords: convective hot-air drying; blood orange slices; sensory; microbial safety; aroma

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1. Introduction

Sweet orange (*Citrus sinensis* (L.) Osbeck) is a subtropical evergreen fruit tree belonging to the Rutacee family. It is likely native to Southeast Asia and has since spread worldwide [1]. The largest producer of oranges globally is Brazil, while Spain, Italy, and Greece are the most important growers in Europe [2]. In Italy, Sicily is the main producer of sweet oranges, especially blood oranges (Moro, Tarocco e Sanguinello varieties) [3,4] due to the climatic conditions that promote the synthesis of anthocyanins [5]. Blood oranges are highly valued for their juiciness, aroma, and are also a natural source of vitamin C, hydroxycinnamic acids, and anthocyanins, which are primarily responsible for their distinctive red colour [6–9]. The cyanidin-3-glycoside (C3G), the main component of blood orange anthocyanins, has high antioxidant capability, opposes the activity of free radicals, and appears to have anticancer properties [10,11]. Oranges are mainly consumed as fresh

fruit or as byproducts, such as juice, but they can also be frozen and processed into jams, canned, or dried fruit [12].

Among orange preservation techniques, particularly drying, numerous studies have been conducted on Navel late [13] and Valencia [14] sweet orange varieties, finger citron [15], kumquat [14], and lemon [16]. However, there is no research on the effects of drying on blood oranges. Various drying techniques exist [17,18], but convective hot-air drying is the most widely used in the food industry [12]. Drying not only extends the shelf life of food but also increases its value [19] by making it available throughout the year [14]. In recent years, researchers have focused on creating healthy foods from waste products along the supply chain [20]. In the drying process, the main objective is to remove moisture up to 14–16% as quickly as possible at a temperature that does not affect the flavour, texture, and colour of foods, while ensuring microbiological stability [13,21]. If the temperature is too low, microorganisms may grow before the food is properly dried; conversely, if the temperature is too high and the moisture is too low, food may harden on the surface and brown, reducing the market value. Studies suggest that temperatures between 37 °C and 71 °C effectively kill bacteria and inactivate enzymes [22–25]. Furthermore, drying reduces the weight of products, as well as their transport and storage costs [17]. In addition, a critical factor in maintaining the shelf life of dried products is the method of storage. In recent years, the preservation of minimally processed and dried fruits has garnered significant attention, particularly concerning modified atmosphere packaging (MAP). MAP is essential for extending shelf life by reducing the respiration rate of fruits, thereby maintaining their quality over time [26]. Modified atmosphere must be considered to maintain optimal conditions due to reducing the respiration rate of the fruit [27,28]. The main used gases in modified atmosphere packaging (MAP) are CO_2, O_2, and N_2, which affect the density of bacterial and viral populations, reduce the possibility of fruit slices sticking [17,29], and prevent the packaging material from collapsing onto the product without altering the food's sensory characteristics [30]. Reducing oxygen and increasing carbon dioxide decreases the respiratory activity of the product, thereby slowing down spoilage [31]. However, the choice of each or their combination depends on the product to be stored. Recent studies on MAP in fruits like strawberries, apples, and other dried citrus fruits have shown its positive impact on preserving color, aroma, and texture, making it a vital aspect of fruit preservation [32]. Furthermore, MAP has been shown to be effective in maintaining the volatile compounds of fruits, which contribute to their aroma and flavor, even after prolonged storage periods [33].

The aim of the present study was to investigate the capability of the hot air-drying technique to maintain the physicochemical, microbiological, and sensory characteristics and volatile compounds, in dried blood orange slices stored in MAP conditions.

2. Materials and Methods

2.1. Vegetal Material

Fifty kilograms of ripe blood oranges (*Citrus sinensis* L. Osbeck) from the Moro, Tarocco, and Sanguinello varieties were randomly hand-picked from 15 trees grown under open-field conditions in the ancient orchard (38°06′ 25″ N–13°21′07″ E) near the Department of Agricultural, Food and Forestry Sciences at the University of Palermo (Sicily, Italy). The fruits were selected for homogeneity and absence of defects (according to the standards of Codex Alimentarius [34]), using peel colour as a ripening index. Then, they were transported to the post-harvest laboratory and stored for 2 days at room temperature (20 ± 5 °C) for 2 h [35]. Afterwards, the fruits were washed under tap water to remove field residues.

2.2. Experimental Design

Fruits were sanitized in a solution of NaClO 2% *v*/*w* at 5 °C for 20 min [36]. Afterwards, the blood oranges were peeled, sliced into pieces with a thickness of 5 ± 0.6 mm, and placed in a convective hot air dryer (Premium Stainless Steel Food Dehydrator, Cosori, Italia). According to the other authors [13,16], to achieve dried products that remain microbiologically stable, a residual moisture content of about 14–16% is necessary. Several preliminary tests were conducted to determine the optimal time/temperature combination. At 70 °C for 8 h [30], the ideal moisture into the sample was not achieved. Therefore, we continued the dehydration process until a constant weight (2 g) was reached, following the Official Methods of Analysis [37]. The final moisture content was measured at 14.6%, in line with previous studies [12]. As a result, blood orange slices were dried at 70 °C for 12 h.

After drying, blood orange slices were stored in polyamide/polyethylene bags (80% PA/20% PE, thickness 90 µm, volume 500 cm^3, oxygen permeability 47.6 $cm^2/(m^2$ day atm), and water vapor transmission rate 3.9 $g/(m^2$ day atm)). The slices were then subjected to Modified Atmosphere Packaging (MAP) technology. They were stored at two different gas concentrations: 100% N_2 (active MAP) and 21% O_2 + 0.04% CO_2 + 78% N_2 (passive MAP).

The dried slices were divided as follows: 50 g of sample per bag × two treatments (active and passive MAP) × 5 days of analysis (D0—immediately after drying, D25, D50, D75, D100) × three replicates. All bags were sealed using a digitally controlled packaging machine (VM 16 Orved S.p.A, Musile di Piave, Venezia, Italy) and then stored at room temperature (20 ± 5 °C) for 100 days.

2.3. Physicochemical Analysis

The following analyses were carried out on a sample of 25 fresh slices before the dehydration process:

- weight (g), using a precision electronic scale (Gibertini EU-C 2002 RS, Novate Milanese, Italy);
- longitudinal diameter (LD-mm) and thickness (mm), using a digital calibre (Turoni TR53307, Forlì, Italy);
- hardness (N) using a TA-XT plus texture analyser (Stable Micro Systems, London, UK) with 50 N load cell. Tests were conducted using a three-point bending method with a span setting of 4 cm, where the dried orange slices were deformed until they broke. The hardness (N) value was calculated from the force/displacement curve using Texture Expert Version software. The pre-test speed was set at 5 mm/s, the test speed at 1 mm/s, and the post-test speed at 5 mm/s. The penetration distance was set at 4 mm for a force of 5 g, using the P/4 cylinder;
- colour was carried out with a digital colorimeter (CR-400, Konica Minolta, Tokyo, Japan) based on the CIE L*a*b* system (CIE L*a*b*: lightness (L*); redness/greenness (a*); yellowness/blueness (b*)). Additionally, the browning index (*BI*) of the dried orange slices was calculated using the following Equation (1) of Ruangchakpet e Sajjaanantakul [38].

$$\boldsymbol{BI} = \frac{(\boldsymbol{x} - \mathbf{0.31})}{\mathbf{0.17}} * \mathbf{100} \quad (1)$$

where $x = (a* + 1.75L*)/(5.645L* + a* - 0.3012b*)$

After the dehydration process, the same analyses were carried out on a sample of 25 dried slices per treatment at D25, D50, D75, and D100.

2.4. Microbiological Analysis

Blood orange slices obtained immediately after dehydration at 70 °C for 12 h, as well as samples taken at specific time points (D25, D50, D75, D100), underwent the decimal serial dilution procedure [39]. Spoilage and pathogenic populations were enumerated using the following media: Plate Count Agar (PCA) for total mesophilic microorganisms and total psychotropic microorganisms, incubated for 2 d at 30 °C and for 7 d at 7 °C, respectively; Pseudomonas Agar Base (PAB) added with CFC supplement for *Pseudomonadaceae*, incubated for 2 d at 25 °C; Violet Red Bile Glucose Agar (VRBGA) for *Enterobacteriaceae*, incubated for 1 d at 37 °C; Baird Parker (BP) agar coagulase-positive *staphylococci*, incubated for 2 d at 37 °C; Hektoen Enteric Agar (HEA) for *Escherichia coli* and *Salmonella* spp. incubated for 1 d at 37 °C; Listeria Selective Agar Base (LSAB) for *Listeria monocytogenes*, incubated for 1 d at 37 °C; Yeast extract Peptone Dextrose (YPD) agar for yeasts and filamentous fungi, incubated for 2 d and 7 d at 25 °C, respectively. Detection of *L. monocytogenes* and *Salmonella* spp. was performed on 25 g of dried blood orange slices samples following the ISO 11290-1 [40] and ISO 6579-1 [41] guidelines, respectively. These analyses were performed in triplicate using media purchased from Oxoid (Basingstoke, UK).

2.5. VOCs Analysis

Headspace solid-phase microextraction (HS-SPME), coupled with gas chromatography-mass spectrometry (GC-MS), was employed for the identification and quantification of volatile organic compounds (VOCs) in blood orange slices treated as above described. Standard organic compounds were injected throughout the experimental sequence using the same extraction and purification procedure to detect and evaluate each compound. The identification of each compound was facilitated using Kovats indices (KI). KI values are based on the retention time normalized to the adjacent eluted n-alkanes. KI values are independent of the method of analysis; therefore, they were useful for the identification of unknown compounds. An Agilent 5890 GC system coupled to an HP 5973 quadrupole mass spectrometer was used for gas chromatographic analyses. An HP5-MS column (5% diphenyl - 5% dimethyl polysiloxane 30 m × 0.2 mm, 0.25 µm film, J & W Scientific, Folsom, CA, USA) was used. Water and oxygen traps (Supelco, Merk Life Science, Milano, Italy) were installed on the carrier gas lines, and ultra-high-purity helium was used as carrier gas at a flow rate of 1 mL min^{-1}. The oven temperature was maintained at 40 °C for 5 min, then was increased at a rate of 5 °C/min to 220 °C and 10 °C/min to 280 °C and held constant for 10 min. Molecular mass spectra were recorded using an ionization voltage of 70 eV and an ion source temperature of 220 °C [42]. The samples were analyzed by the HS-SPME-GC-MS method using a PDMS-CAR-DVB fibre (Supelco, ITA). The extraction and purification process involved exposing the fibre to 3 g of treated blood orange slices in a 40 mL vial with a silica septum, held at 70 °C for 20 min. Following this, the fibre was manually inserted into a GC inlet port equipped with a specialized glass liner designed for SPME injection (0.75 mm i.d.). Fiber was removed from the gas chromatograph inlet port after 3 min at 250 °C using the splitless injection mode. The compounds were confirmed by comparison of mass spectral data with those of authentic reference compounds. When standards were unavailable, the identification of components was conducted via mass spectrum matching utilizing the NIST 11 mass spectral library collection.

2.6. Sensory Evaluation

Ten semi-trained judges with extensive experience in sensory evaluation of food performed a liking test on previously prepared dried blood orange slices. During the preliminary session, 15 qualitative descriptors were chosen for sensory profiling [43,44], generated based on the frequency of citation (>60%) and rated on a hedonic scale from

1-"absence of the descriptor" to 9-"highest descriptor intensity". Dried blood orange slices stored in active and passive MAP were evaluated at the end of the storage period (D100) by 99 consumers aged 18–60 years (37% women and 63% men) [45]. Consumers were given two slices from each MAP sample (passive and active) in coded and randomly distributed cups. They were trained to taste and score (1 to 9) the following descriptors: colour intensity, orange odour, honey odour, unpleasant odour, taste acceptance, orange taste, caramel taste, sweet, acid, bitter, unpleasant taste, gummy, masticability, fibrousness, overall acceptance. The test was carried out in individual booths under white light at room temperature in the Sensory Analysis Laboratory at the University of Palermo (Italy). The presentation order and the identification codes were randomized using Smart Sensory Box 2.11.4 software (Smart Sensory Solutions S.r.l., Sassari, Italy). Water was provided to cleanse the palate between the samples.

After completing their tasting evaluations, consumers were asked how often they consume dried fruit by selecting one option from the following list: "almost every day", "several times a month", "very sporadically", or "never". They were then asked, using a dichotomous scale (yes/no) [46], if they "would buy this product if it were available in your usual supermarket".

2.7. Statistical Analysis

Using Minitab 2020 software [47], repeated measures ANOVAs and Tukey's Honestly Significant Difference (HSD) tests ($p \leq 0.05$) were performed for all parameters studied in order to assess significant differences between the treatments and days of storage, except for the microbiological analysis, where $p \leq 0.001$ was considered significant. Data were presented as mean ± standard deviation (SD) of the replicates ($n = 3$).

3. Results and Discussion

3.1. Physicochemical Analysis

Fruits and vegetables have a highly porous and hygroscopic structure. One of the most important physical changes that food undergoes during drying is the reduction of its volume, typically defined as a shrinkage of the food product [48]. This phenomenon causes physicochemical changes and also results in an increase in flesh texture and consumer preferences [49–52]. As shown in Table 1, there are no significant differences ($p \leq 0.05$) between fresh and dried orange slices in terms of LD and BI. While, after the drying process, the thickness decreases of 0.70 mm and the hardness increases of 8.51 N, due to the normal shrivelling of the flesh and also the associated depolymerization of cell wall constituents, including pectin [53]. Similar results on hardness were obtained by Roppolo et al. [54], who observed an increase of 10 N on pescabivona fruits after the drying process.

Table 1. Longitudinal diameter (LD—mm), thickness (mm), hardness (N), browning index (BI), and soluble solids content (SSC—°Brix) of fresh and dried orange slices. Results indicate the mean values ± standard deviation (S.D.) of the replicates ($n = 3$). Asterisks indicate significant differences between fresh and dried orange slices with * for $p \leq 0.05$, ** for $p \leq 0.01$; ns indicates no significant differences between the same.

Sample	Longitudinal Diameter (LD—mm)	Thickness (mm)	Hardness (N)	Browning Index (BI)
Fresh	47.70 ± 2.02	5.48 ± 0.68	5.67 ± 1.72	30.22 ± 2.58
Dried	47.67 ± 2.49	4.78 ± 0.71	14.18 ± 1.25	31.21 ± 2.85
T-Test	ns	*	**	ns

Therefore, the chosen time/temperature combination was effective in maintaining the same LD parameter after drying, according to Mayor e Sereno [55], who observed, under conditions of high temperature and reduced hot air exposure, different rates of water diffusion from the inside to the outside of the flesh. In this way, strong moisture gradients are formed in the material, which inhibit shrinkage during drying [55]. Instead, after the drying process LD decreased steadily ($p \geq 0.05$) up to D100 for both MAP treatments (Figure 1). On the last day of analysis (D100), the dried orange slices lost 7.80% in passive MAP and 8.32% in active MAP. However, although storage in active MAP showed no significant differences ($p \geq 0.05$) compared with passive MAP treatment during 100 days of storage, the presence of N_2 seems to have maintained the initial characteristics of the bags, according to Passafiume et al. [56].

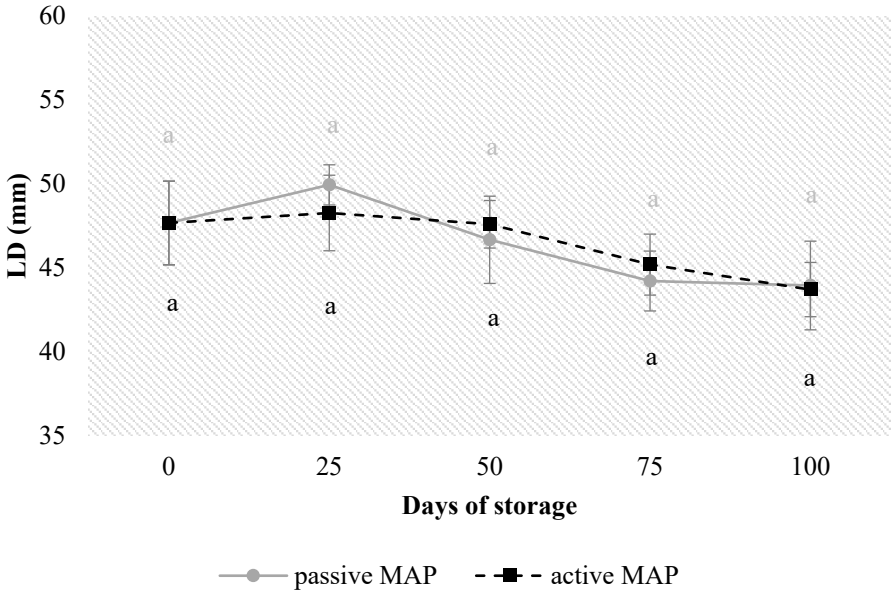


Figure 1. Longitudinal diameter expressed in mm for dried blood orange slices during 100 days of storage in active and passive MAP. Results indicate the mean values ± standard deviation (S.D.). Different letters and different colours of the letters represent significant differences ($p \leq 0.05$) on individual treatments for each day of storage; no asterisk indicates no significant differences between treatments.

Regarding the thickness of blood orange slices, Figure 2 shows the variation in slice thickness during the storage period. Statistically different behaviors were observed between passive MAP and active MAP at D25 ($p \leq 0.05$) and at D50 ($p \leq 0.01$). For passive MAP at D25, a higher value than the initial one is shown, probably due to some little difference in the cut of slices. The presence of N_2 in active MAP seems to have slowed down the thickness loss, showing an almost linear trend throughout the storage period and reaching (D100) a value of 3.46 ± 0.88 mm. While in passive MAP, the thickness decreased much more rapidly, reaching a value of 2.87 ± 1.06 at the last day of storage.

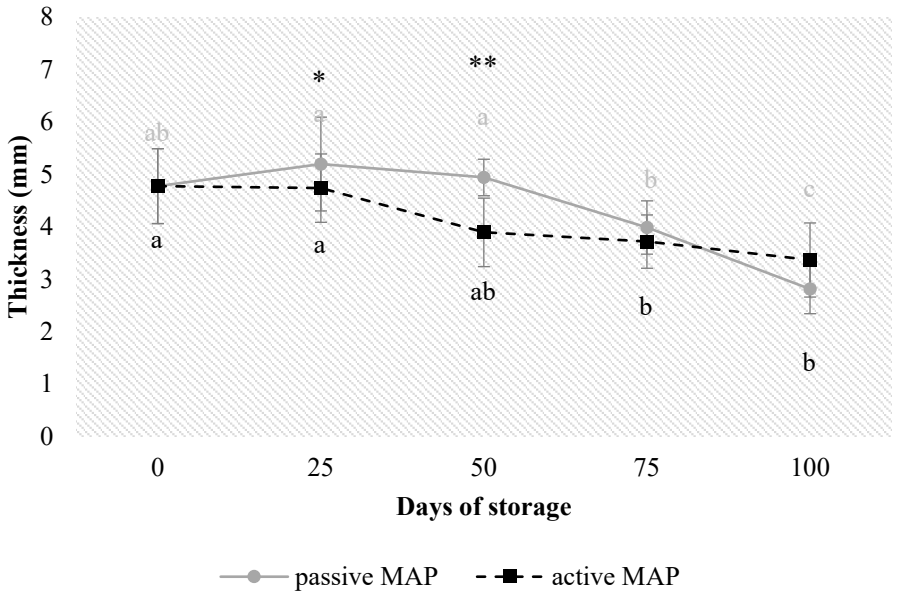


Figure 2. Thickness expressed in mm for dried blood orange slices during 100 days of storage in active and passive MAP. Results indicate the mean values ± standard deviation (S.D.). Different letters and different colours of the letters represent significant differences ($p \leq 0.05$) on individual treatments for each day of storage; asterisks indicate significant differences between MAP treatments with * for $p \leq 0.05$, ** for $p \leq 0.01$; no asterisk indicates no significant differences between treatments.

To obtain a moisture content of 14–16%, a loss of thickness occurred; however, our primary focus was microbiological stability. The decrease of thickness during storage may be due to the moisture loss that causing the pores of the slices to collapse [57]. Nevertheless, this change did not influence consumers' liking during the sensory evaluation, as confirmed by the scores obtained on the texture descriptor. Therefore, the shrinkage of blood orange slices, as recorded through analytical tools, remains a negligible factor for positive consumer perception. Similar results were obtained by Llorca et al. [45] on the acceptability of dried persimmon slices.

Zotarelli et al. [58] observed thickness losses of 17% and 23% on banana and mango slices dried at temperatures of 60 °C, respectively, to a residual moisture content of 12%. The short drying times likely preserved the cellular structure of the flesh, reducing the loss of thickness. This is because such processes could result in sample thickness reduction due to the moisture gradient passing outward in the form of water vapor. This can cause the collapse of capillaries responsible for transporting fluids inside, leading to irreversible structural changes [49]. Furthermore, during storage, the loss in thickness can be attributed to the characteristics of the packaging used. In fact, the 80% PA/20% PE blend maintained some water vapor permeability, leading to a reduction in thickness. In fact, the water vapor permeability of packaging plays a key role in food preservation, especially in maintaining the physical characteristics of food [50,51].

Regarding hardness, the data set (Figure 3) indicates that in both MAP treatments there was a significant loss of hardness from D0 to D25 (about 2.60 N). During the 100-day storage period, active MAP was more effective as it lost only 9.98% of hardness (at D100) compared to the passive MAP treatment, which decreases by 45.39%. Statistically significant differences were observed between the two treatments starting at D75. The loss of hardness represents a decline of quality for dried products. Varying hardness often affects the preservation of flavour [52], which may contribute to consumer non-acceptance, especially when consumed at the end of its shelf life.

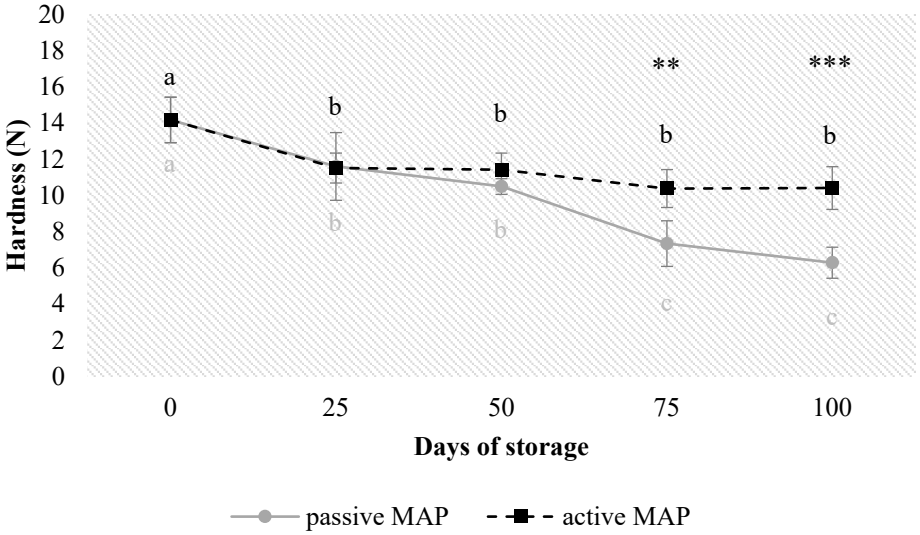


Figure 3. Hardness expressed in N for dried blood orange slices during 100 days of storage in active and passive MAP. Results indicate the mean values ± standard deviation (S.D.). Different letters and different colours of the letters represent significant differences ($p \leq 0.05$) on individual treatments for each day of storage; asterisks indicate significant differences between MAP treatments with ** for $p \leq 0.01$, *** for $p \leq 0.001$; no asterisk indicates no significant differences between treatments.

This behavior could be associated with the presence of N_2 in the bags, which seems to maintain the hardness characteristics of the stored samples. Several researchers have shown that N_2 delays the senescence process in dried tomato [59], avocado [60], and loquat fruits [29], thereby keeping the cell structure intact for longer. Additionally, the removal of water from plant tissues causes the movement of water-soluble compounds within the cells, thereby increasing the hardness of the cell walls [61]. This phenomenon not only results in shrinkage of the product but also causes changes in mechanical properties, including texture, which define the quality of fruit products [12,62]. This property is mainly related to the microstructure and intracellular spaces of the dried product and the breaking of cellular bonds during the drying process [63,64]. In fact, dried products are characterized by a "glass-like" state that gives them a solid and crisp texture [65].

Color is another critical parameter in the consumers' choice of product [66]. It is an important indicator of perceived quality because variations in it are often associated with non-enzymatic browning [67].

Figure 4 shows the browning index (BI) variation in dried blood orange slices during storage. Starting from a value of 33.31 (D0), BI increased for both treatments throughout the storage period. However, it was found that passive MAP remained significantly lower on the last day of analysis (BI = 41.97 ± 2.53) than active MAP treatment (50.11 ± 2.97).

In general, if fruit tissue cells are damaged, oxygen in the air reacts with enzymes on the fruit surface, generating melanin, which is mainly responsible for fruit browning, resulting in loss of economic value [68]. In addition, no flesh decay phenomena were detected, which was also confirmed by sensory analysis. According to a study conducted by Polat [12], the change in sample thickness and cell structure from fresh to dried affects light reflection on orange slices, altering the color values of the samples. The tissues of dried products have been shown to undergo some degree of shrinkage, resulting in changes in chemical components. Consequently, there may have been a change in the chemical composition of the outer cell wall of the dried product. A similar study [69] explained that the reasons for the colour change are likely attributed to the decomposition of carotenoids and other pigments in the orange slices and the triggering of the Maillard reaction [70].

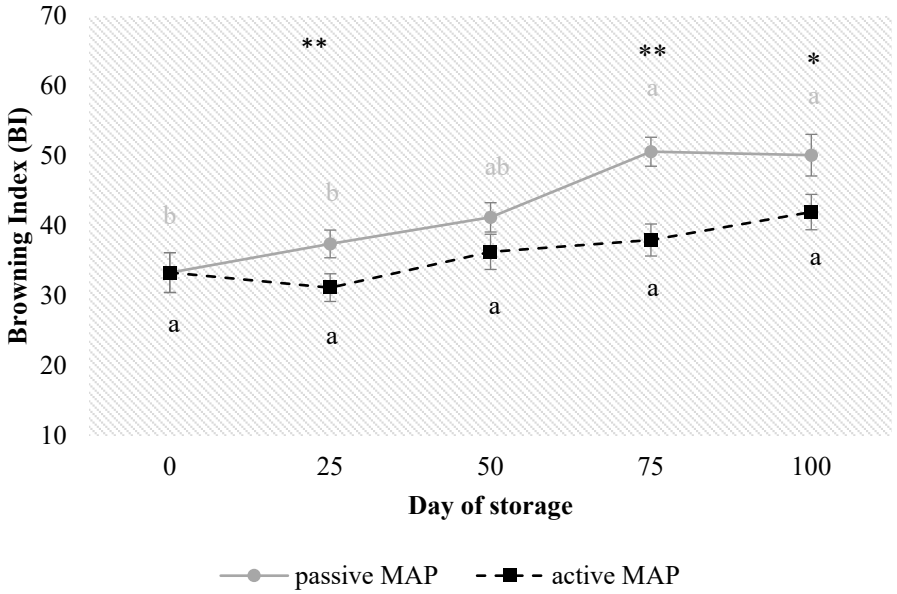


Figure 4. Browning index for dried blood orange slices during 100 days of storage in active and passive MAP. Results indicate the mean values ± standard deviation (S.D.). Different letters and different colours of the letters represent significant differences ($p \leq 0.05$) on individual treatments for each day of storage; asterisks indicate significant differences between MAP treatments with * for $p \leq 0.05$, ** for $p \leq 0.01$; no asterisk indicates no significant differences between treatments.

3.2. Microbiological Analysis

According to the report of the World Health Organization (WHO), despite having low water activity (a_w), dried fruits and vegetables can still serve as carriers for foodborne pathogens [71,72]. Many of these microorganisms can endure on dried fruits and vegetables for extended periods, potentially leading to foodborne illnesses due to their low infectious dose [73]. Therefore, it is crucial to evaluate the microbiological aspects of dried blood orange slices before their introduction to the market. In this study, the presence of the main spoilage and pathogenic microorganisms commonly associated with food of plant origin [74] was investigated by a culture-dependent approach. In all analysed samples, the levels of *Pseudomonas* spp., yeasts, and moulds, known to cause physicochemical alterations in plant-based food products [75], were below the detection limit of <2 Log CFU/g. Throughout the storage period (D0, D25, D50, D75, and D100), regardless of the MAP treatment used, no coagulase-positive *staphylococci*, *E. coli*, *L. monocytogenes*, and *Salmonella* spp. were detected. These findings comply with the microbiological criteria for foodstuff outlined in Commission Regulation 2073/2005 (EC, 2005). However, the absence of all investigated microbial groups on the dried blood orange slices can be attributed to both the drying process [76] and the strict hygiene standards of fruit sanitation and handling applied in this study [57].

3.3. VOCs Analysis

Dried orange slices treated with two different gas concentrations (active MAP and passive MAP) were analyzed using the HS–SPME–GC–MS analytical method. The composition and relative amounts of volatile organic compounds (VOCs) are shown in Figure 5.

A total of 120 VOCs were identified and quantified: 83 compounds in passive MAP-treated samples and 75 in active MAP-treated samples. Identification was based on chromatographic peak Linear Retention Index (LRI), Kovats' retention index (KI), similarity index over 80%, and reference standards [76]. Terpenes were the most abundant, constituting 68.2% and 64.7% of the total composition in passive and active MAP treatments, respectively. Hydrocarbons were 3.5% and 9%, and esters were 5.2% and 3%, respec-

tively. Aromatic compounds were 2.5% in passive MAP and 3.4% in active MAP. Other compounds, including ketones (0.9% for both active and passive MAP), aldehydes (0.3% and 0.2%, respectively), and alkanes (0.1% and 0.5%, respectively), appeared in smaller proportions, representing 2.9% and 10% of total composition in passive and active MAP. D-Limonene had the highest relative peak area values, followed by (-)-α-Panasinsen and Cedrene-V6 in both treatments. Several studies have reported higher concentrations of terpenes in extracts from fresh orange, orange juice, and orange peel [77]. Terpenes are a large category of organic compounds commonly present in essential oils and resins and contributes to distinctive aroma and taste of various plants and fruits. In passive MAP treatment, D-Limonene made up 35.3%, (-)-α-Panasinsen accounted for 6.9%, and Cedrene-V6 was 6.5%. In active MAP treatment, D-Limonene constituted 22.7%, (-)-α-Panasinsen 9.5%, and Cedrene-V6 7%.

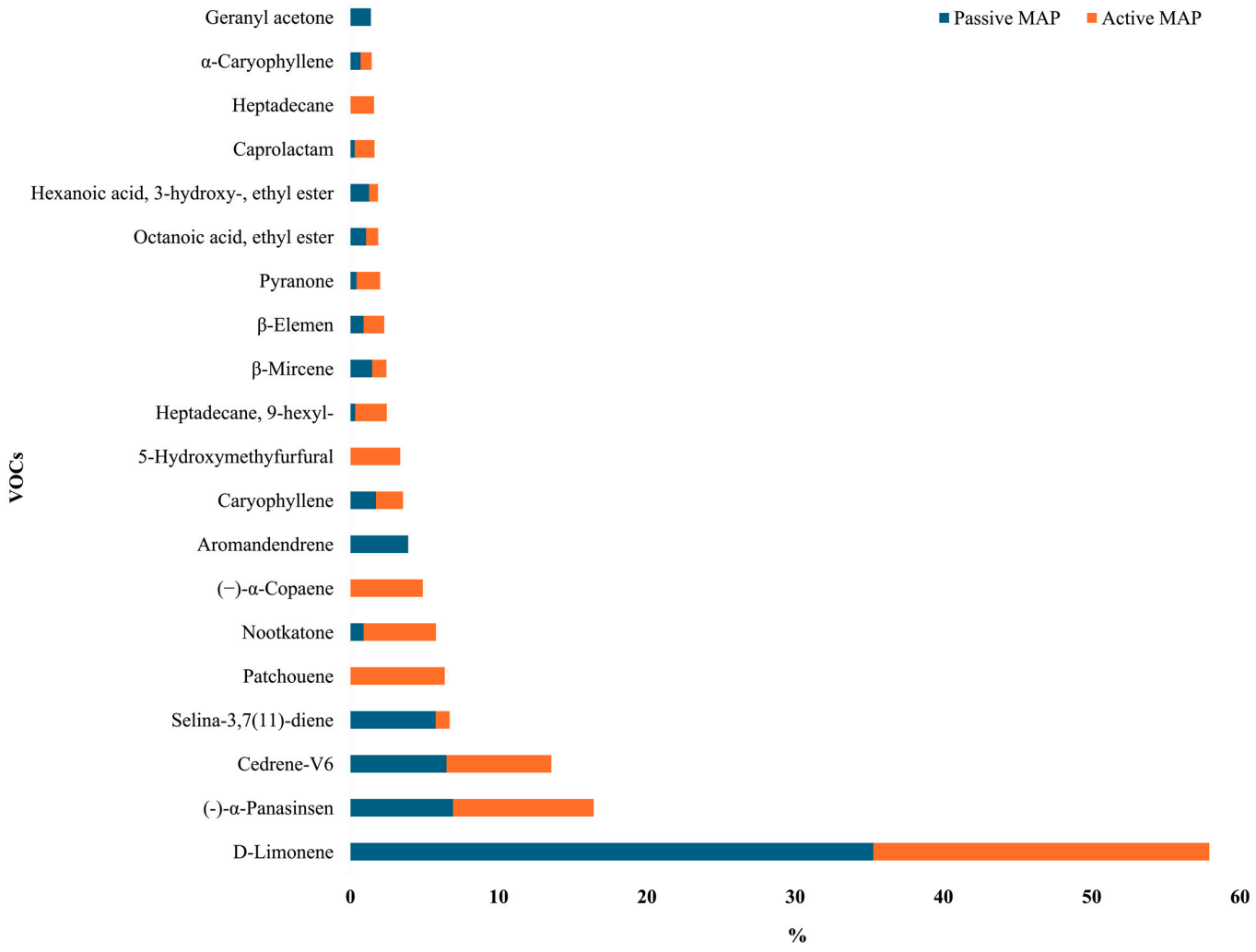
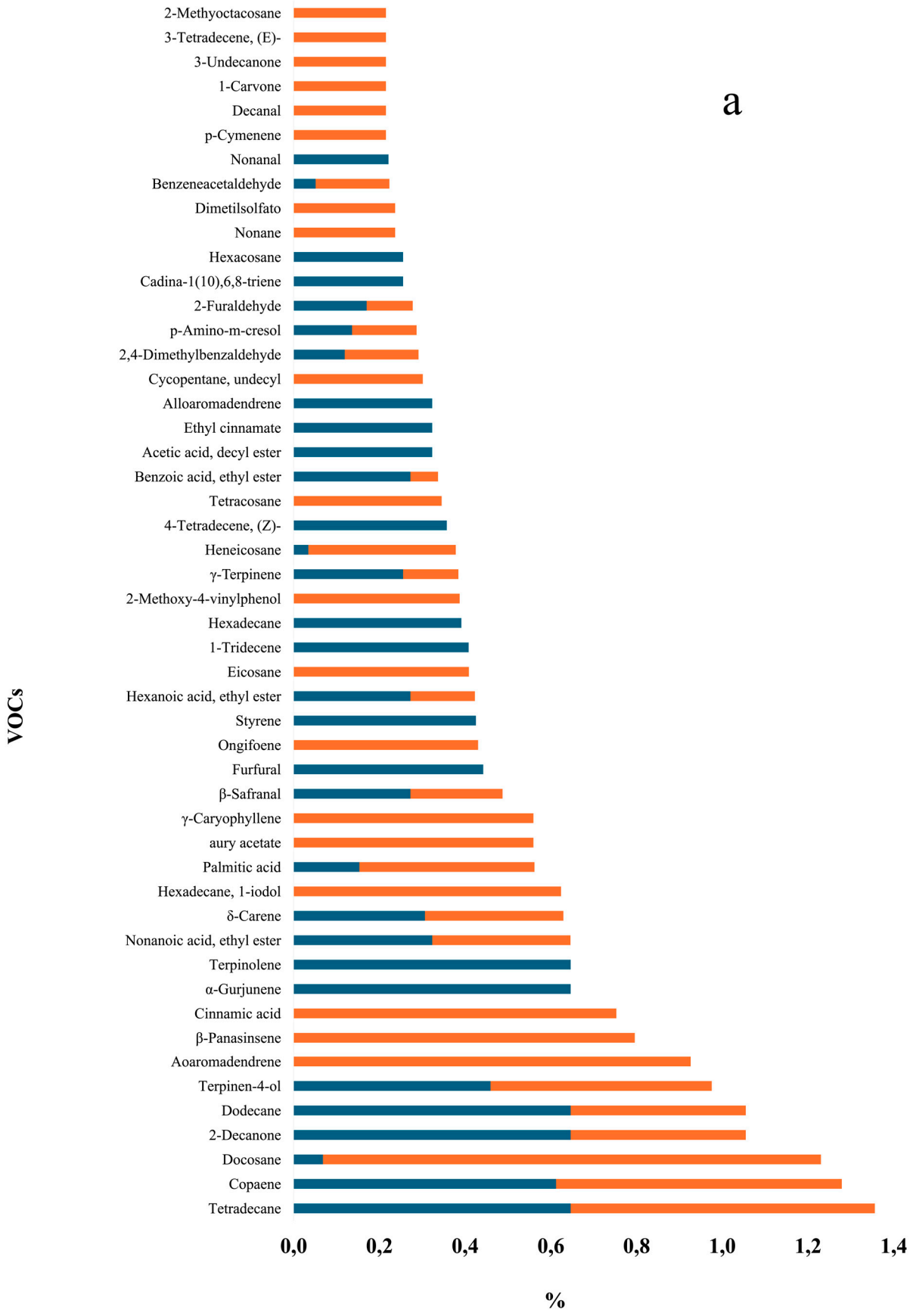


Figure 5. *Cont.*



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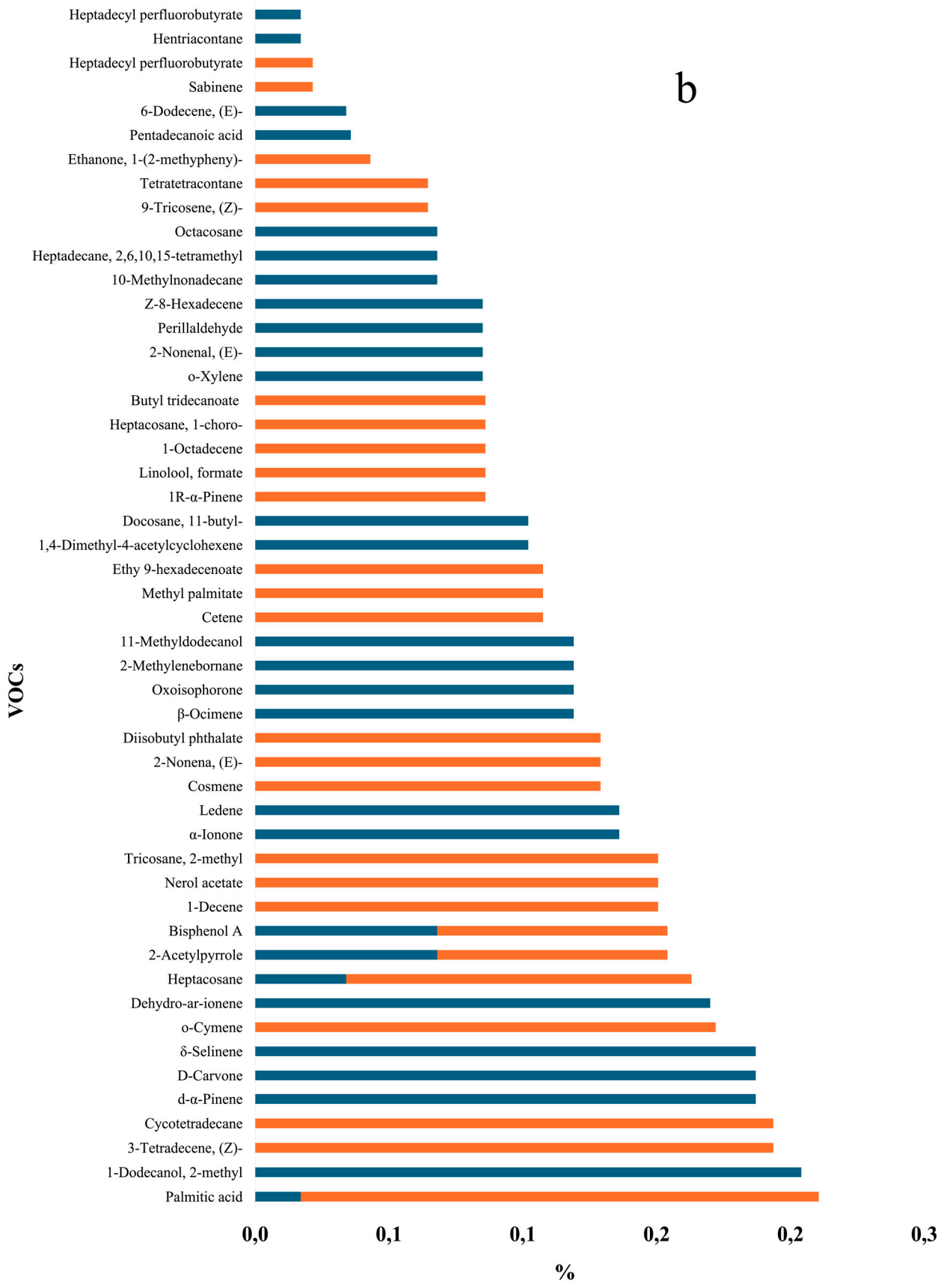

Figure 5. VOCs (%) detected in dried orange slices with Passive MAP and Active MAP treatments. (Panel (**a**) highlights VOC concentrations ranging from 0% to 1.4% while Panel (**b**) highlights those from 0% to 0.3%).

Significant differences in VOC concentrations were observed between the two treatments. For instance, Aromandendrene, Geranyl acetone, α-Gurjunene, and Terpinolene were exclusive to passive MAP-treated samples (3.9%, 1.4%, 4.6%, and 4.6%, respectively), while Patchouene (6.4%), (-)-α-Copaene (4.9%), 5-Hydroxymethylfurfural (3.3%), and Heptadecane (1.6%) were uniquely found in active MAP-treated samples. Other compounds with lower concentration values, such as β-Myrcene (1.5% and 1%), Octanoic acid ethyl ester (1% and 0.8%), Terpinen-4-ol (0.4% and 0.5%), Hexanoic acid, 3-hydroxy-, ethyl ester (1.2% and 0.6%), and Caryophyllene (1.7% and 1.8%), were identified in both active and passive MAP treatments with different concentration values. The above-mentioned differences highlighted the potential presence of additional sources of VOCs by using active MAP atmosphere that increases the nutraceutical values of process production. Among the alkanes identified, the most abundant were Heptadecane 9-hexyl- with 0.3% and 2.1%, and Tetradecane with 0.6% and 0.7%, in passive and active MAP-treated samples, respectively. In dried blood orange slices, alkanes are originated from the waxy outer layer of the fruit's peel or from lipid-rich components within the orange fruit, and they were present primarily when the fruit reaches maturity [78]. Their presence can contribute to aroma, flavor, and other sensory attributes of dried fruit. Sixteen unsaturated and saturated fatty acid esters were additionally detected in dried blood orange slices. Among these, the most abundant were Octanoic acid-ethyl ester, with concentrations of 1% and 0.9%, Hexanoic acid, 3-hydroxy-, ethyl ester, with 1.2% and 0.6%, and Nonanoic acid-ethyl ester, which measured 0.3% in both passive and active MAP treatments. However, blood orange slices treated with passive MAP treatment exhibited a higher concentration value of esters compared to active MAP treatment, likely attributable to different compositions and types of gases within packaging. Different gas compositions within the passive MAP atmosphere influences esters formation compared to the active MAP atmosphere. Gas composition in passive MAP treatment promotes ester formation, whereas active MAP treatment determines the opposite effect, leading to a decrease in ester formation as described above and shown in Figure 5. Passive MAP treatment determined a higher production of ethylene, which influenced ripening and the formation of volatile compounds such as esters. Oxygen in passive MAP contributes to ester formation reducing the rate of fatty acid oxidation, which is a key step in ester synthesis. Furthermore, carbon dioxide concentration in passive MAP promotes ester formation, while in active MAP treatment, where carbon dioxide is absent, this process is not observed. Indeed, carbon dioxide influences acidity in food products, promoting the reaction between present acids and alcohols to form esters. This finding is supported by a study conducted on bitter oranges, which highlights that the presence of carbon dioxide in modified atmospheres, compared to untreated ones, improves quality and shelf life of food products. Finally, passive MAP atmosphere decreases humidity conditions inside the package, which contributes to ester formation through esterification reactions [79].

3.4. Sensory Evaluation

The sensory analysis results are presented in Figure 6, highlighting significant differences in three attributes: color intensity, orange aroma, and honey aroma. The active MAP sample exhibited significantly higher color intensity ($p < 0.001$) compared to the passive MAP sample. Additionally, the orange and honey aromas were rated higher in the active MAP samples, indicating noteworthy differences ($p < 0.05$), as noted by the tasting panel. The two samples were perceived as similar in other attributes considered by the panel. Overall, attributes such as taste acceptance, sweetness, acidity, gumminess, masticability, and overall acceptance received higher scores for the active MAP sample, although these differences were not statistically significant. The panel reported lower ratings for any

unpleasant tastes or odors, indicating that none were specifically identified. Based on responses from the affective test following the descriptive test, only 3% of participants reported consuming dried fruit almost daily, 14% consumed it several times a month, 50% consumed occasionally, and 33% did not consume dried fruit at all.

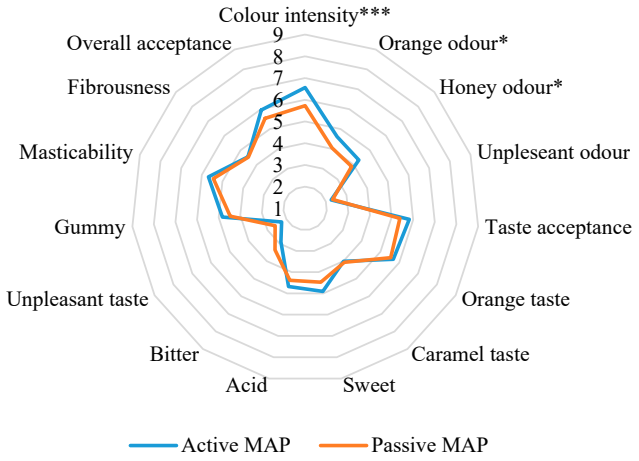

Figure 6. Sensory evaluation of dried blood orange slices at 100 days of storage in active and passive MAP. Symbols: * $p < 0.05$, *** $p < 0.001$.

Furthermore, 56% of participants expressed their willingness to purchase the active MAP sample if it were available in supermarkets (Figure 7).

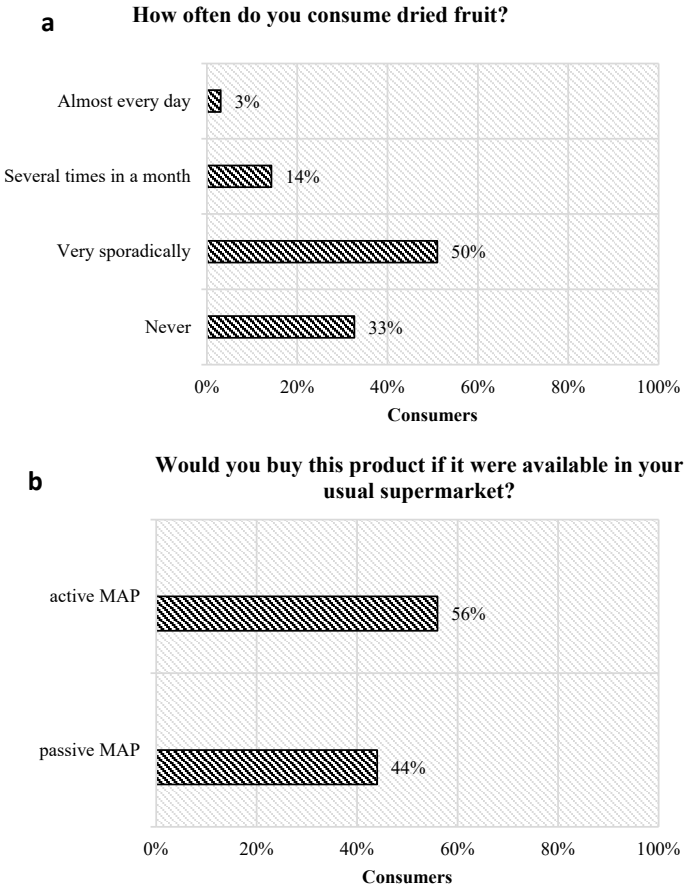

Figure 7. (**a**) percentage of consumers who have selected different dehydrated fruit consumption habits, (**b**) intention to purchase dried blood orange slices depending on the conservation treatment (active e passive MAP).

4. Conclusions

The appropriate choice of time and temperature for the drying process is essential to ensure microbiological stability and retain the characteristic taste of dried blood orange slices. Data confirms that hot air-drying at 70 °C for 12 h maintained shrinkage without altering the longitudinal-diameter slices. However, significant thickness loss was observed, especially in samples treated with passive MAP, even during storage. Additionally, an increase in hardness was noted due to water removal, enhancing masticability. Active MAP maintained high hardness values up to D100 and preserved the typical colour of blood oranges, as confirmed by sensory analysis. Sensory analysis showed that blood oranges dried and stored in active and passive MAP mainly differed in colour intensity and characteristic flavour. The use of HS-SPME chromatography facilitated the identification of chemical compounds responsible for aroma, flavour, and other sensory attributes. Costa et al. [80] also revealed the complex relationship between temperature, storage conditions, and VOCs production. This study highlighted significant enhancement in the food product's value. Enhancing organoleptic characteristics and nutritional integrity in blood orange slices can improve consumer satisfaction and health outcomes by potentially enriching the nutraceutical profile through modified atmosphere processing.

In conclusion, combining the drying technique with MAP storage is a valid method for maintaining the initial quality of dried slices, making it an excellent approach to produce a healthy, tasty, and visually attractive snack.

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References

1. Nicolosi, E.; Deng, Z.; Gentile, A.; La Malfa, S.; Continella, G.; Tribulato, E. Citrus Phylogeny and Genetic Origin of Important Species as Investigated by Molecular Markers. *Theor. Appl. Genet.* **2000**, *100*, 1155–1166. [CrossRef]
2. FAOSTAT. Food and Agriculture Data. 2019. Available online: http://www.fao.org/faostat/en/#data/EP/visualize (accessed on 24 January 2020).
3. Pannitteri, C.; Continella, A.; Cicero, L.L.; Gentile, A.; La Malfa, S.; Sperlinga, E.; Napoli, E.; Strano, T.; Ruberto, G.; Siracusa, L. Influence of Postharvest Treatments on Qualitative and Chemical Parameters of Tarocco Blood Orange Fruits to Be Used for Fresh Chilled Juice. *Food Chem.* **2017**, *230*, 441–447. [CrossRef]
4. Rapisarda, P.; Bellomo, S.E.; Intelisano, S. Storage Temperature Effects on Blood Orange Fruit Quality. *J. Agric. Food Chem.* **2001**, *49*, 3230–3235. [CrossRef]
5. Zarbà, A.S.; Pulvirenti, G. The Consumption of Sicilian Red Oranges: Implications for Firms Involved in Commercialization. *J. Bus. Chem.* **2006**, *3*, 22–41.

6. Barbagallo, R.; Palmeri, R.; Fabiano, S.; Rapisarda, P.; Spagna, G. Characteristic of β-Glucosidase from Sicilian Blood Oranges in Relation to Anthocyanin Degradation. *Enzym. Microb. Technol.* **2007**, *41*, 570–575. [CrossRef]
7. Dugo, P.; Mondello, L.; Morabito, D.; Dugo, G. Characterization of the Anthocyanin Fraction of Sicilian Blood Orange Juice by Micro-HPLC-ESI/MS. *J. Agric. Food Chem.* **2003**, *51*, 1173–1176. [CrossRef]
8. Rapisarda, P.; Bianco, M.L.; Pannuzzo, P.; Timpanaro, N. Effect of Cold Storage on Vitamin C, Phenolics and Antioxidant Activity of Five Orange Genotypes [*Citrus sinensis* (L.) Osbeck]. *Postharvest Biol. Technol.* **2008**, *49*, 348–354. [CrossRef]
9. Rapisarda, P.; Carollo, G.; Fallico, B.; Tomaselli, F.; Maccarone, E. Hydroxycinnamic Acids as Markers of Italian Blood Orange Juices. *J. Agric. Food Chem.* **1998**, *46*, 464–470. [CrossRef]
10. Habibi, F.; Ramezanian, A.; Guillén, F.; Serrano, M.; Valero, D. Blood Oranges Maintain Bioactive Compounds and Nutritional Quality by Postharvest Treatments with γ-Aminobutyric Acid, Methyl Jasmonate or Methyl Salicylate during Cold Storage. *Food Chem.* **2020**, *306*, 125634. [CrossRef]
11. Butelli, E.; Licciardello, C.; Zhang, Y.; Liu, J.; Mackay, S.; Bailey, P.; Reforgiato-Recupero, G.; Martin, C. Retrotransposons Control Fruit-Specific, Cold-Dependent Accumulation of Anthocyanins in Blood Oranges. *Plant Cell* **2012**, *24*, 1242–1255. [CrossRef] [PubMed]
12. Polat, S. Color Quality, Ascorbic Acid, Total Carotenoid, and Volatile Compounds of Dried Orange Slices as Influenced by Packaging Methods and Storage Conditions. *J. Food Process. Preserv.* **2022**, *46*, e15898. [CrossRef]
13. Dıaz, G.R.; Martınez-Monzo, J.; Fito, P.; Chiralt, A. Modelling of Dehydration-Rehydration of Orange Slices in Combined Microwave/Air Drying. *Innov. Food Sci. Emerg. Technol.* **2003**, *4*, 203–209. [CrossRef]
14. Ozcan-Sinir, G.; Ozkan-Karabacak, A.; Tamer, C.E.; Copur, O.U. The Effect of Hot Air, Vacuum and Microwave Drying on Drying Characteristics, Rehydration Capacity, Color, Total Phenolic Content and Antioxidant Capacity of Kumquat (*Citrus japonica*). *Food Sci. Technol.* **2018**, *39*, 475–484. [CrossRef]
15. Xu, W.; Pei, Y.; Tian, J.; Cao, X.; Li, G.; Jiang, Y.; Zhu, G. Effects of Different Drying Methods on Sensory Qualities and Aroma Compounds of Finger Citron (*Citrus medica* L. Var. Sarcodactylis Swingle) Slices. *J. Food Meas. Charact.* **2021**, *15*, 4465–4474. [CrossRef]
16. Kesbi, O.M.; Sadeghi, M.; Mireei, S.A. Quality Assessment and Modeling of Microwave-Convective Drying of Lemon Slices. *Eng. Agric. Environ. Food* **2016**, *9*, 216–223.
17. Bourdoux, S.; Li, D.; Rajkovic, A.; Devlieghere, F.; Uyttendaele, M. Performance of Drying Technologies to Ensure Microbial Safety of Dried Fruits and Vegetables. *Compr. Rev. Food Sci. Food Saf.* **2016**, *15*, 1056–1066. [CrossRef]
18. Omolola, A.O.; Jideani, A.I.; Kapila, P.F. Quality Properties of Fruits as Affected by Drying Operation. *Crit. Rev. Food Sci. Nutr.* **2017**, *57*, 95–108. [CrossRef]
19. Ramos, I.; Brandão, T.R.; Silva, C. Structural Changes during Air Drying of Fruits and Vegetables. *Food Sci. Technol. Int.* **2003**, *9*, 201–206. [CrossRef]
20. Bala, S.; Garg, D.; Sridhar, K.; Inbaraj, B.S.; Singh, R.; Kamma, S.; Tripathi, M.; Sharma, M. Transformation of Agro-Waste into Value-Added Bioproducts and Bioactive Compounds: Micro/Nano Formulations and Application in the Agri-Food-Pharma Sector. *Bioengineering* **2023**, *10*, 152. [CrossRef] [PubMed]
21. Sellami, I.H.; Wannes, W.A.; Bettaieb, I.; Berrima, S.; Chahed, T.; Marzouk, B.; Limam, F. Qualitative and Quantitative Changes in the Essential Oil of Laurus Nobilis L. Leaves as Affected by Different Drying Methods. *Food Chem.* **2011**, *126*, 691–697. [CrossRef]
22. Dalgleish, J.; Andy, N. Dehydration and Dried Products. In *Food Industries Manual*; Ranken, M.D., Ed.; Blackie: Glasgow, UK, 1988.
23. McMinn, W.; Magee, T. Physical Characteristics of Dehydrated Potatoes—Part I. *J. Food Eng.* **1997**, *33*, 37–48. [CrossRef]
24. Singh, U.; Jain, S.K.; Doshi, A.; Jain, H.K.; Chahar, V.K. Effects of Pretreatments on Drying Characteristics of Button Mushroom. *Int. J. Food Eng.* **2008**, *4*, 4. [CrossRef]
25. Kendall, P.; DiPersio, P.; Sofos, J.; Allen, L. Drying Vegetables. In *Service in Action*; Colorado State University Cooperative Extension: Fort Collins, CO, USA, 2004; No. 9.308.
26. Caleb, O.J.; Mahajan, P.V.; Al-Said, F.A.-J.; Opara, U.L. Modified Atmosphere Packaging Technology of Fresh and Fresh-Cut Produce and the Microbial Consequences—A Review. *Food Bioprocess Technol.* **2013**, *6*, 303–329. [CrossRef] [PubMed]
27. Falagán, N.; Terry, L.A. Recent Advances in Controlled and Modified Atmosphere of Fresh Produce. *Johns. Matthey Technol. Rev.* **2018**, *62*, 107–117. [CrossRef]
28. Del Carmen Villalobos, M.; Serradilla, M.J.; Martín, A.; Hernández-León, A.; Ruíz-Moyano, S.; de Guía Córdoba, M. Characterization of Microbial Population of Breba and Main Crops (*Ficus carica*) during Cold Storage: Influence of Passive Modified Atmospheres (MAP) and Antimicrobial Extract Application. *Food Microbiol.* **2017**, *63*, 35–46. [CrossRef] [PubMed]
29. Tinebra, I.; Passafiume, R.; Scuderi, D.; Pirrone, A.; Gaglio, R.; Palazzolo, E.; Farina, V. Effects of Tray-Drying on the Physicochemical, Microbiological, Proximate, and Sensory Properties of White-and Red-Fleshed Loquat (Eriobotrya Japonica Lindl.) Fruit. *Agronomy* **2022**, *12*, 540. [CrossRef]

30. Phillips, C.A. Modified Atmosphere Packaging and Its Effects on the Microbiological Quality and Safety of Produce. *Int. J. Food Sci. Technol.* **1996**, *31*, 463–479. [CrossRef]
31. Kumar, N.; Devgan, K.; Kumar, A.; Kaur, P.; Mahajan, P. Active and Passive Modified Atmosphere Packaging. In *Nonthermal Food Engineering Operations*; John Wiley & Sons, Ltd.: Hoboken, NJ, USA, 2024; pp. 225–259, ISBN 978-1-119-77646-8.
32. Wilson, M.D.; Stanley, R.A.; Eyles, A.; Ross, T. Innovative Processes and Technologies for Modified Atmosphere Packaging of Fresh and Fresh-Cut Fruits and Vegetables. *Crit. Rev. Food Sci. Nutr.* **2019**, *59*, 411–422. [CrossRef]
33. Fu, M.; Xiao, G.; Wu, J.; Chen, Y.; Yu, Y.; Chen, W.; Xu, Y. Effects of Modified Atmosphere Packaging on the Quality of Dried Lemon Slices. *J. Food Process. Preserv.* **2017**, *41*, e13043. [CrossRef]
34. Joint FAO/WHO Codex Alimentarius Commission. In *Codex Alimentarius*; Food & Agriculture Organization: Rome, Italy, 1992; ISBN 92-5-103629-2.
35. Zielinska, M.; Markowski, M. The Influence of Microwave-Assisted Drying Techniques on the Rehydration Behavior of Blueberries (*Vaccinium corymbosum* L.). *Food Chem.* **2016**, *196*, 1188–1196. [CrossRef] [PubMed]
36. Passafiume, R.; Gugliuzza, G.; Gaglio, R.; Busetta, G.; Tinebra, I.; Sortino, G.; Farina, V. Aloe-Based Edible Coating to Maintain Quality of Fresh-Cut Italian Pears (*Pyrus communis* L.) during Cold Storage. *Horticulturae* **2021**, *7*, 581. [CrossRef]
37. Association of Official Analytical Chemists. *Official Methods of Analysis*; AOAC: Rockville, MD, USA, 1990; Volume 12.
38. Ruangchakpet, A.; Sajjaanantakul, T. Effect of Browning on Total Phenolic, Flavonoid Content and Antioxidant Activity in Indian Gooseberry (*Phyllanthus emblica* Linn.). *Agric. Nat. Resour.* **2007**, *41*, 331–337.
39. Passafiume, R.; Tinebra, I.; Gaglio, R.; Settanni, L.; Sortino, G.; Allegra, A.; Farina, V. Fresh-Cut Mangoes: How to Increase Shelf Life by Using Neem Oil Edible Coating. *Coatings* **2022**, *12*, 664. [CrossRef]
40. *ISO 21872-1:2017*; Microbiology of the Food Chain–Horizontal Method for the Determination of Vibrio Spp.–Part 1, Detection of Potentially Enteropathogenic Vibrio Parahaemolyticus, Vibrio Cholerae and Vibrio Vulnificus. International Organization for Standardization: Geneva, Switzerland, 2017.
41. *ISO 6579-1: 2017-04*; A Method for the Detection, Enumeration and Serotyping of Salmonella. Polish Committee for Standardization: Warsaw, Poland, 2017.
42. Cotter, R.J. Mass Spectrometry of Nonvolatile Compounds by Desorption from Extended Probes. *Anal. Chem.* **1980**, *52*, 1589–1606. [CrossRef]
43. Marzec, A.; Kowalska, H.; Kowalska, J.; Domian, E.; Lenart, A. Influence of Pear Variety and Drying Methods on the Quality of Dried Fruit. *Molecules* **2020**, *25*, 5146. [CrossRef] [PubMed]
44. Baxter, I.A.; Easton, K.; Schneebeli, K.; Whitfield, F.B. High Pressure Processing of Australian Navel Orange Juices: Sensory Analysis and Volatile Flavor Profiling. *Innov. Food Sci. Emerg. Technol.* **2005**, *6*, 372–387. [CrossRef]
45. Llorca, E.; Pons-Gómez, A.; Besada, C. Physico-Chemical and Microstructural Changes during the Drying of Persimmons with Different Disorders. Consumer Acceptance of Dried Slices as a Criterion to Valorise Discards. *LWT* **2023**, *182*, 114882. [CrossRef]
46. Heim, S.; Stang, J.; Ireland, M. A Garden Pilot Project Enhances Fruit and Vegetable Consumption among Children. *J. Am. Diet. Assoc.* **2009**, *109*, 1220–1226. [CrossRef]
47. Minitab, Inc. MINITAB. 2020. Available online: http://www.minitab.com/en-US/products/minitab/ (accessed on 12 May 2023).
48. Mahiuddin, M.; Khan, M.I.H.; Kumar, C.; Rahman, M.M.; Karim, M. Shrinkage of Food Materials during Drying: Current Status and Challenges. *Compr. Rev. Food Sci. Food Saf.* **2018**, *17*, 1113–1126. [CrossRef]
49. Panyawong, S.; Devahastin, S. Determination of Deformation of a Food Product Undergoing Different Drying Methods and Conditions via Evolution of a Shape Factor. *J. Food Eng.* **2007**, *78*, 151–161. [CrossRef]
50. Siracusa, V. Food Packaging Permeability Behaviour: A Report. *Int. J. Polym. Sci.* **2012**, *2012*, 302029. [CrossRef]
51. Kamal, M.; Jinnah, I.; Utracki, L. Permeability of Oxygen and Water Vapor through Polyethylene/Polyamide Films. *Polym. Eng. Sci.* **1984**, *24*, 1337–1347. [CrossRef]
52. Link, J.V.; Tribuzi, G.; Laurindo, J.B. Improving Quality of Dried Fruits: A Comparison between Conductive Multi-Flash and Traditional Drying Methods. *LWT* **2017**, *84*, 717–725. [CrossRef]
53. Jiang, H.; Zhang, M.; Mujumdar, A.S.; Lim, R. Comparison of the Effect of Microwave Freeze Drying and Microwave Vacuum Drying upon the Process and Quality Characteristics of Potato/Banana Re-structured Chips. *Int. J. Food Sci. Technol.* **2011**, *46*, 570–576. [CrossRef]
54. Roppolo, P.; Tinebra, I.; Passafiume, R.; Allegra, A.; Sortino, G.; Inglese, P.; Farina, V. Tray-Drying Is a New Way to Valorise White-Fleshed Peach Fruit. *AIMS Agric. Food* **2023**, *8*, 944–961. [CrossRef]
55. Mayor, L.; Sereno, A. Modelling Shrinkage during Convective Drying of Food Materials: A Review. *J. Food Eng.* **2004**, *61*, 373–386. [CrossRef]
56. Passafiume, R.; Roppolo, P.; Tinebra, I.; Pirrone, A.; Gaglio, R.; Palazzolo, E.; Farina, V. Reduction of Pericarp Browning and Microbial Spoilage on Litchi Fruits in Modified Atmosphere Packaging. *Horticulturae* **2023**, *9*, 651. [CrossRef]
57. Yan, Z.; Sousa-Gallagher, M.J.; Oliveira, F.A. Shrinkage and Porosity of Banana, Pineapple and Mango Slices during Air-Drying. *J. Food Eng.* **2008**, *84*, 430–440. [CrossRef]

58. Zotarelli, M.F.; Porciuncula, B.D.A.; Laurindo, J.B. A Convective Multi-Flash Drying Process for Producing Dehydrated Crispy Fruits. *J. Food Eng.* **2012**, *108*, 523–531. [CrossRef]
59. Kelly, M.O.; Saltveit, M.E., Jr. Effect of Endogenously Synthesized and Exogenously Applied Ethanol on Tomato Fruit Ripening. *Plant Physiol.* **1988**, *88*, 143–147. [CrossRef] [PubMed]
60. Pesis, E.; Marinansky, R.; Zauberman, G.; Fuchs, Y. Reduction of Chilling Injury Symptoms of Stored Avocado Fruit by Prestorage Treatment with High Nitrogen Atmosphere. *Physiol. Basis Postharvest Technol.* **1992**, *343*, 251–256. [CrossRef]
61. Lewicki, P.P. Effect of Pre-drying Treatment, Drying and Rehydration on Plant Tissue Properties: A Review. *Int. J. Food Prop.* **1998**, *1*, 1–22. [CrossRef]
62. Bianchi, T.; Guerrero, L.; Gratacós-Cubarsí, M.; Claret, A.; Argyris, J.; Garcia-Mas, J.; Hortós, M. Textural Properties of Different Melon (*Cucumis melo* L.) Fruit Types: Sensory and Physical-Chemical Evaluation. *Sci. Hortic.* **2016**, *201*, 46–56. [CrossRef]
63. Contreras, C.; Martín, M.E.; Martínez-Navarrete, N.; Chiralt, A. Effect of Vacuum Impregnation and Microwave Application on Structural Changes Which Occurred during Air-Drying of Apple. *LWT-Food Sci. Technol.* **2005**, *38*, 471–477. [CrossRef]
64. Deng, Y.; Zhao, Y. Effect of Pulsed Vacuum and Ultrasound Osmopretreatments on Glass Transition Temperature, Texture, Microstructure and Calcium Penetration of Dried Apples (Fuji). *LWT-Food Sci. Technol.* **2008**, *41*, 1575–1585. [CrossRef]
65. Karel, M.; Anglea, S.; Buera, P.; Karmas, R.; Levi, G.; Roos, Y. Stability-Related Transitions of Amorphous Foods. *Thermochim. Acta* **1994**, *246*, 249–269. [CrossRef]
66. Pathare, P.B.; Opara, U.L.; Al-Said, F.A.-J. Colour Measurement and Analysis in Fresh and Processed Foods: A Review. *Food Bioprocess Technol.* **2013**, *6*, 36–60. [CrossRef]
67. Ceballos, A.M.; Giraldo, G.I.; Orrego, C.E. Effect of Freezing Rate on Quality Parameters of Freeze Dried Soursop Fruit Pulp. *J. Food Eng.* **2012**, *111*, 360–365. [CrossRef]
68. Singh, B.; Suri, K.; Shevkani, K.; Kaur, A.; Kaur, A.; Singh, N. Enzymatic Browning of Fruit and Vegetables: A Review. In *Enzymes in Food Technology: Improvements and Innovations*; Springer: Singapore, 2018; pp. 63–78.
69. Özkan-Karabacak, A.; Acoğlu, B.; Yolci Ömeroğlu, P.; Çopur, Ö.U. Microwave Pre-treatment for Vacuum Drying of Orange Slices: Drying Characteristics, Rehydration Capacity and Quality Properties. *J. Food Process Eng.* **2020**, *43*, e13511. [CrossRef]
70. Amaya-Farfan, J.; Rodriguez-Amaya, D.B. The Maillard Reactions. In *Chemical Changes During Processing and Storage of Foods*; Elsevier: Amsterdam, The Netherlands, 2021; pp. 215–263.
71. Food and Agriculture Organization of the United Nations; World Health Organization. *Ranking of Low-Moisture Foods in Support of Microbiological Risk Management: Meeting Report and Systematic Review*; Food & Agriculture Organization: Rome, Italy, 2022; ISBN 978-92-5-136559-5.
72. Beuchat, L.R.; Komitopoulou, E.; Beckers, H.; Betts, R.P.; Bourdichon, F.; Fanning, S.; Joosten, H.M.; Ter Kuile, B.H. Low-Water Activity Foods: Increased Concern as Vehicles of Foodborne Pathogens. *J. Food Prot.* **2013**, *76*, 150–172. [CrossRef] [PubMed]
73. Victor, N.; Peter, C.; Raphael, K.; Tendekayi, G.H.; Jephris, G.; Taole, M.; Portia, P.R. Microbiological Quality of Selected Dried Fruits and Vegetables in Maseru, Lesotho. *Afr. J. Microbiol. Res.* **2017**, *11*, 185–193.
74. Kaczmarek, M.; Avery, S.V.; Singleton, I. Microbes Associated with Fresh Produce: Sources, Types and Methods to Reduce Spoilage and Contamination. In *Advances in Applied Microbiology*; Elsevier: Amsterdam, The Netherlands, 2019; Volume 107, pp. 29–82, ISBN 0065-2164.
75. Miceli, A.; Gaglio, R.; Francesca, N.; Ciminata, A.; Moschetti, G.; Settanni, L. Evolution of Shelf Life Parameters of Ready-to-Eat Escarole (Cichorium Endivia Var. Latifolium) Subjected to Different Cutting Operations. *Sci. Hortic.* **2019**, *247*, 175–183. [CrossRef]
76. Mishra, A.; Upadhyay, A.; Jaiswal, P.; Sharma, N. Effect of Different Drying Method on the Chemical and Microstructural Properties of Loquat Slices. *J. Food Process. Preserv.* **2021**, *45*, e15105. [CrossRef]
77. Perez-Cacho, P.R.; Rouseff, R. Processing and Storage Effects on Orange Juice Aroma: A Review. *J. Agric. Food Chem.* **2008**, *56*, 9785–9796. [CrossRef] [PubMed]
78. El-Otmani, M.; Arpaia, M.L.; Coggins, C.W., Jr. Developmental and Topophysical Effects on the N-Alkanes of Valencia Orange Fruit Epicuticular Wax. *J. Agric. Food Chem.* **1987**, *35*, 42–46. [CrossRef]
79. Khazaei, N.; Jouki, M.; Jouki, A. Effects of Modified Atmosphere Packaging on Physicochemical Characteristics and Sensory Evaluation of Bitter Orange (*Citrus aurantium*). *Indian J. Agric. Sci.* **2011**, *81*, 1014.
80. Costa, C.; Lucera, A.; Conte, A.; Mastromatteo, M.; Speranza, B.; Antonacci, A.; Del Nobile, M.A. Effects of Passive and Active Modified Atmosphere Packaging Conditions on Ready-to-Eat Table Grape. *J. Food Eng.* **2011**, *102*, 115–121. [CrossRef]