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Effect of eco-friendly fertilizers and edible coatings on fatty acids and phenolics in fresh-cut melon during cold storage

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Abstract: The demand for convenient and ready-to-eat food has increased, including fresh-cut fruit and vegetables. At the same time, people are also becoming more health-conscious and are aware of the positive impact of healthy food choices on their well-being. For this reason, it is important to deliver fruits and vegetables to people's tables using both environmentally and human-friendly practices, from cultivation to postharvest storage. In the current study, in order to support agricultural sustainability, humic acid, liquid vermicompost, and organomineral fertilizers that do not pose a risk to human health or the environment were used in melon. Furthermore, several edible coverings were applied to the fruit derived from the investigation postharvest to examine the impact of changes in phenolic and fatty acids in the fruit throughout storage. The nationally famous Kırkağaç variety of melon was used as the plant material. After harvest, cubed melon slices were dipped into the previously prepared coating materials for 2 min. Following the dipping process, the coated slices were dried using a ventilator for 2 h at 5 °C. Coated fruit and untreated (control) fruit were placed in plastic containers (each package weighing 500 g) and stored at +5 °C and 90%–95% relative humidity for 12 days. Applying humic acid alone led to more accumulation of fatty acids and phenolics in the fruit compared to humic acid in combination with liquid vermicompost and organomineral fertilizer. Furthermore, regardless of preharvest fertilizer treatments, the content of fatty acids and phenolics in the fresh-cut melon were better retained in the samples treated with pectin and sodium alginate rather than in the other edible coating treatments. There were significant differences ($p < 0.05$) among the fertilizer treatments and edible coatings during storage. The tested fertilizers and edible coating treatments show high potential in production and could be particularly useful in agricultural and horticultural applications. These techniques can reduce food waste and improve agricultural sustainability.

Key words: Environmentally friendly applications, melon, edible coating, storage

1. Introduction

Horticultural cultivation produces a range of products of great value to humanity. These include fresh and processed products from fruit and vegetable crops providing essential food, as well as minerals and vitamins critical to human nutrition. These products can counter many of the negative factors affecting human life, such as contamination, stress, and lack of exercise (Boyacı et al., 2023; Lavic et al., 2023). Melon (*Cucumis melo* L.), is a widely consumed fruit belonging to the genus *Cucumis* in the family *Cucurbitaceae*, and it is cultivated in temperate, tropical, and subtropical locations across the globe. Worldwide 28,467,920 t of melons are produced on 1,068,238 acres of land. With 1,724,856 t produced on 76,129 ha, Türkiye is the world's second-largest melon producer, after China.¹ Melons are sweet, delicious, and excellent for human health. Three bioactive substances found in melon are

fatty acids, polyphenols, and carotenoids and they have a variety of positive human health effects. According to some studies (Shofian et al., 2011; Rodríguez-Pérez et al., 2013), melon has historically been considered a natural curative agent that can be used to treat and prevent aging and a variety of chronic diseases, including inflammation and several cancers. Furthermore, it is advised to use melon as a diuretic, stomachic, and vermifuge and for the treatment of cardiovascular problems (Parle and Singh, 2011).

The process of fruit and vegetables from cultivation to harvesting and from postharvest to reaching the consumer has a great effect on product quality. Especially in the postharvest period, it is important to keep them under healthy conditions in order to preserve their shelf life and nutritional value. The expected postharvest loss of fruit and vegetables worldwide is around 40% (Ali et al., 2021; Mushtaq et al., 2023). In order to prevent this very high

¹ FAO (2024). Food and Agriculture Organization of the United Nations [online]. Website <https://www.fao.org/faostat/en/#data> [accessed 08 July 2024].

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level of losses and to reduce waste, increasing the freshness of fruit and vegetables through both storage and packaging practices has become an increasingly important issue (Saleem et al., 2022; Matloob et al., 2023; Ünal et al., 2023; Zaidi et al., 2023).

Factors such as the decline in agricultural areas around the world and the rapid increase in the human population have led to concerns that food and agricultural products, which are essential for human nutrition, cannot be produced in sufficient quantities. Increasing demand for food and agricultural products has accelerated the spread of agricultural production using intensive synthetic inputs called conventional agriculture. However, although high yields can be achieved in a short time with this production method, it has become a common opinion all over the world that it harms the environment and human health in the long term. The problems that arise with this production method have increased the need for environmentally friendly practices day by day. Sustainable agricultural practices are one of the leading production methods needed in this country and around the world. Environmentally friendly practices such as precision agriculture, organic agriculture, and good agriculture are within the scope of sustainable agriculture, and organic agriculture is recognized as the most effective and fastest method to regain the lost natural balance (İşlek, 2022).

Edible coatings are an environmentally friendly method that has shown promising results for preserving the freshness of several fruits (Guimarães et al., 2018; Şaran et al., 2022; El-Araby et al., 2024). The technique slows the ripening process by applying a coating of chemical or biological ingredients to the product's surface, preventing gaseous exchange. Edible films and coatings stand out due to their ability to hold active ingredients like antimicrobial compounds and antibrowning agents, which reduce the risk of infections and preserve food quality, respectively, and extend the postharvest life of products (Cavusoglu et al., 2021). These sustainable ingredients are crucial for a safer and healthier environment. These materials are obtained from proteins, polysaccharides, lipids, plasticizers, emulsifiers, and active substances. In addition, they are eco-friendly since they are made from innocuous materials (El-Araby et al., 2024).

Fresh food, especially entire fruit and vegetables, have a waxy coating of their own; adding an edible coating just makes it more useful. However, because the surface is exposed to the environment and external elements (pathogens), handling fresh-cut food or fruit with minimal processing is more challenging (Fan et al., 2023; R et al., 2024). Fresh cut or minimally processed fruit and vegetables are more susceptible to damage (Dar et al., 2020). Microbial growth that happens when a fruit or vegetable is sliced and peeled off may have an effect

on the fruit or vegetable's stability and shelf life (Kim and Cheigh, 2022). In response to this problem, a variety of techniques have been developed, including polypropylene and microperforated packing sheets (Rodov et al., 2022).

People now consider "fast" living to be necessary because of modern technologies. Additionally, people are growing more conscious of whether their meals are good for their health or not. As a result, while people would like safe and healthful food (Orman, 2023; Özkan, 2023), there is also growing interest in ready-made food because it is convenient and simplifies life. The tendency toward sliced fresh fruit and vegetables has been particularly accelerated by this circumstance. The huge size and high price of melons have led to a rise in the demand for fresh-cut melons (İşlek et al., 2023).

The amounts of phenolic compounds in products can vary significantly depending on a number of factors, including preharvest temperature, light, soil characteristics, irrigation, fertilizer applications, and harvest time. The content of phenolic compounds is regulated by postharvest processing of fruit and vegetables, storage conditions (modified atmosphere storage, controlled atmosphere storage, etc.), and elicitor applications (hormones, edible coating, essential oils, UV-C, etc.) (López-Martínez et al., 2020; Boyacı et al., 2023; İşlek et al., 2023). These actions lead to oxidative stress, which activates antioxidant enzymes (CAT, POD, SOD, and APX) and initiates the production of secondary metabolites that are antioxidants, like phenolic compounds. However, even while it is ideal to boost phenolic compounds in fruit and vegetables after harvest, there are instances when doing so can result in a loss of quality (de la Rosa et al., 2019).

To the best of our knowledge, there have been no published studies on the effects of both different eco-friendly fertilizers and edible coatings on fatty and phenolic acids in fresh-cut melons during cold storage. Therefore, in order to support agricultural sustainability, humic acid, liquid vermicompost, and organomineral fertilizers that do not pose a risk to human health or the environment were used in melon cultivation in the current study. Furthermore, several edible coating materials were applied to examine the change in phenolic and fatty acids in the fruit throughout storage.

2. Materials and methods

The melon variety Kırkağaç was used. In Türkiye, especially in the Aegean and Central Anatolia regions, it is one of the most often planted melon cultivars. The melons are more resilient to postharvest resting and shipping than many other varieties, and their fruit flesh is sweet and tasty. The fruit is 15.5 cm in length, 2.4 kg in average weight, and contains 9% soluble solids in its flesh (Yıldırım et al., 2009).

A commercial company provided the humic acid, liquid vermicompost fertilizer, and organomineral fertilizer required for preharvest fertilizer treatments. A different manufacturer provided the sodium alginate, pectin, and carob gum required for the postharvest edible coating. In 2021, experiments on cultivation were carried out in the village of Atalan located in the Gevaş District of Van Province (at latitude 38.3216 and longitude 43.1519). Daily surface soil wetness series and daily temperature time series at 2 m are shown (Figures 1 and 2).² There were nine plots in the research area. The plots had dimensions of 5 m × 5 m. On May 15, melons were planted in a single row on an elevated bed. Thirty-three plants were planted in each plot, with a row spacing of 1.5 m and plant spacing of 0.5 m.

2.1. Preharvest treatment

All plots received drip irrigation treatment of 20,000 cc/ha humic acid to prepare the soil prior to the seedlings being planted. Only the plots treated with humic acid were therefore regarded as the control group. The remaining plots received treatment via drip irrigation of 20,000 cc/ha organomineral fertilizer and 20,000 cc/ha liquid worm

fertilizer 15 days after planting. Harvesting was done by hand once the melons reached harvest maturity on September 21, when the auricles and leeches on the fruit stalk had dried.

2.2. Postharvest treatment

Ultrapure water was used to make the edible coating solutions, which included carob gum (1% + 1% glycerin), pectin (1% + 1% glycerin), and sodium alginate (1% + 1% glycerin). In order to give the coating materials flexibility and adhesive qualities, glycerin was added.

After all the melons were peeled, the fruit was cut into cubes (3 × 3 × 3 cm) using a sharp knife. Then the cubed slices were dipped into the previously prepared coating materials for 2 min. Following the dipping process, the coated slices were dried using a ventilator for 2 h at 5 °C and 55%–60% relative humidity. The coated fruit and untreated (control) fruit were placed in plastic containers (each package weighing 500 g) and stored in the dark (lights off throughout storage) for 12 days at +5 °C and 90%–95% relative humidity. Every 4 days, measurements and analysis were performed.

²FAO (2021). Food and Agriculture Organization [online]. Website <https://www.fao.org/faostat/en/#data/QCL> [accessed 09 July 2024].

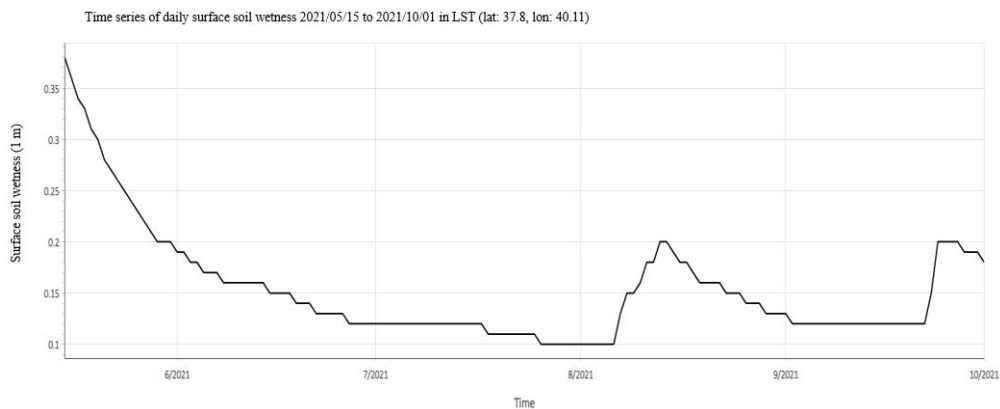


Figure 1. Time series of daily surface soil wetness (1 m).

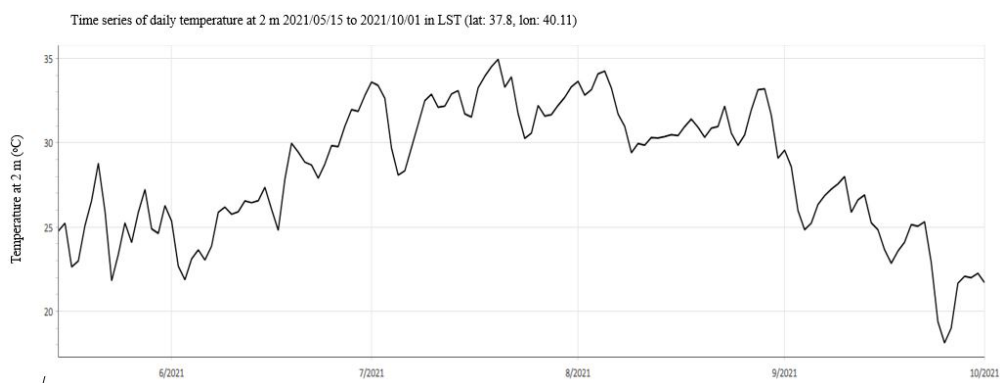


Figure 2. Time series of daily temperature at 2 m (°C).

2.3. Phenolic acids

In order to analyze the fruit for phenolic acid during harvest and the subsequent days, 1-g fruit samples were taken, methanol/water (80:20) was then added, the fruit was homogenized for approximately 1 min, and it was centrifuged at $12,000 \times g$ for 10 min. After that, the samples' supernatant was put through a $0.45\text{-}\mu\text{m}$ membrane filter and utilized to analyze the phenolic acids. A modified version of Rodriguez-Delgado et al.'s (2001) approach was applied for the determination of phenolic acids. Utilizing an Inertsil C18 ODS-3 column with a $5\text{-}\mu\text{m}$ particle size ($4.6\text{ mm} \times 250\text{ mm}$, manufactured in Japan) and an HPLC (Agilent 1100) apparatus with a DAD detector, the readings of the previously extracted samples were examined both during harvest and on the analysis days that followed. The mobile phase composition was methanol, glacial acetic acid, and ultrapure water (28:2:70) and the mobile phase was constant during the whole separation. At a wavelength of 254 nm, vanillic acid, rutin, and quercetin were measured; gallic acid, chlorogenic acid, caffeic acid, syringic acid, p-coumaric acid, ferulic acid, and hydroxycinnamic acid were measured at a wavelength of 280 nm.

2.4. Fatty acids

A modified version of Hara and Radin's (1978) method was employed. A mixer was used for purging 1 g of the fruit, 5 mL of hexane/isopropanol (3:2) was added, and the mixture was centrifuged at $4500 \times g$ for 10 min. Test tubes were filled with the supernatant after it had been filtered and then vortexed with 2.5 mL of 2% methanolic sulfuric acid. For 15 h, the resultant mixture was maintained at $50\text{ }^\circ\text{C}$ in the oven to facilitate methylation. The samples were taken out of the oven, mixed with 2.5 mL of 5% NaCl, and vortexed. The resultant methyl esters were then extracted using 2.5 mL of hexane. Following the extraction of the hexane phase, 2.5 mL of 2% Na_2CO_3 was added, and the mixture was allowed to sit for 1 h to allow the phases to separate. Following the phases' separation, the upper phase was removed by micropipette, put in a test tube, and allowed to evaporate at $45\text{ }^\circ\text{C}$ under nitrogen. The test tube esters were dissolved in 1 mL of hexane and then placed into vials for GC-MS analysis. In the analysis, an FID detector, a 5975C model MS, and a Shimadzu GC-2010 model GC were all used at the same time. The column was configured with the following parameters: temperature: $250\text{ }^\circ\text{C}$; length, and width: $60\text{ m} \times 250\text{ }\mu\text{m} \times 0.15\text{ }\mu\text{m}$; injection volume: $1\text{ }\mu\text{L}$; splitless mode; column flow rate: 1 mL (helium carrier gas); inlet pressure: 20.83 psi; total flow: 34 mL/min . The chromatographic conditions were as follows: it was allowed to wait at $50\text{ }^\circ\text{C}$ for 2 min before increasing to $200\text{ }^\circ\text{C}$ at $20\text{ }^\circ\text{C/min}$ and $230\text{ }^\circ\text{C}$ at $5\text{ }^\circ\text{C/min}$, where it remained for 30 min. There was a 55.5-min analysis time. By comparing with the Wiley and NIST libraries (Belay et al., 2025), the MS results were ascertained. Percentages (%) are used to express the results.

2.5. Statistical analysis

In 2021, both preharvest and postharvest of the study were carried out as a randomized full block with three replications ($n=144$ for phenolic acids and fatty acids; three replicates \times three preharvest fertilizer treatments \times four postharvest edible coatings \times four storage periods). Treatments and fertilizers were taken into consideration as factors. One-way factorial ANOVA was performed on the data, which were represented as mean \pm standard deviation (SD). Comparing results from Duncan's multiple range test was another method used to determine the various levels of various groupings. Using IBM SPSS 20.0 (IBM Corporation, Armonk, NY, USA), a 5% statistical significance level was applied. A heatmap was applied to evaluate the effect of phenolic acids and fatty acids data on preharvest and postharvest treatments and storage period. Heatmap processing and analyses were conducted via a web tool called ClustVis (Metsalu and Vilo, 2015).

3. Results

3.1. Phenolic acids

In the current study, a total of 13 phenolic acids (Tables 1–13) were detected in fresh-cut melons. In general, humic acid, liquid vermicompost, and organomineral treatments resulted in accumulation of the highest concentrations of phenolic acids. However, during storage, the coated fruit's phenolic acid concentration was higher than that of the control (Tables 1–13).

Gallic acid decreased in all samples, regardless of treatment, during the 12-day storage period. It was significantly ($p < 0.05$) higher in the edible coating treated samples, especially with pectin treatment, than in the uncoated samples. Although there was no significant difference between carob and pectin, the highest gallic acid content was found in the humic acid + pectin treatment with $74.99\text{ }\mu\text{g g}^{-1}$ at the end of storage. There were significant differences ($p < 0.05$) in the fertilizer treatments (Table 1).

At the end of the storage period, protocatechuic acid content was found in the humic acid + pectin with $15.16\text{ }\mu\text{g g}^{-1}$, in the organomineral + carob with $13.54\text{ }\mu\text{g g}^{-1}$, and in the liquid vermicompost + pectin with $13.40\text{ }\mu\text{g g}^{-1}$, respectively (Table 2). Both the coating treatments and the fertilizer treatments showed significant differences ($p < 0.05$).

During the fruit's storage period, the combinations that best retained the catechin content were humic acid + sodium alginate, liquid vermicompost + pectin, and organomineral + pectin. After 12 days of storage, the treatment using humic acid and sodium alginate had the greatest catechin level, i.e. $30.31\text{ }\mu\text{g g}^{-1}$. During storage, there were significant differences ($p < 0.05$) between the coated fruit and control fruit, as well as among the fertilizer treatments (Table 3).

Table 1. Changes in gallic acid content ($\mu\text{g g}^{-1}$) during storage. Data are presented as means \pm SD.

		Storage period (day)			
Preharvest treatment	Postharvest treatment	0	4	8	12
Humic acid	Control	87.43 \pm 0.50 a	80.60 \pm 0.33 Ca	73.94 \pm 0.33 Ca	69.54 \pm 0.51 Ca
	Carob	87.43 \pm 0.50 a	84.57 \pm 0.10 Ba	77.13 \pm 0.15 Aa	74.53 \pm 0.13 Aa
	Sodium alginate	87.43 \pm 0.50 a	86.14 \pm 0.19 Aa	75.23 \pm 0.20 Ba	73.00 \pm 0.40 Ba
	Pectin	87.43 \pm 0.50 a	84.99 \pm 0.24 Ba	76.71 \pm 0.25 Aa	74.99 \pm 0.25 Aa
Humic acid + liquid vermicompost	Control	81.80 \pm 0.56 b	73.41 \pm 0.57 Cb	69.54 \pm 0.30 Cb	65.90 \pm 0.29 Db
	Carob	81.80 \pm 0.56 b	76.06 \pm 0.10 Bb	73.41 \pm 0.23 Bb	69.09 \pm 0.21 Cb
	Sodium alginate	81.80 \pm 0.56 b	77.65 \pm 0.29 Ab	74.19 \pm 0.12 Ab	70.31 \pm 0.51 Bb
	Pectin	81.80 \pm 0.56 b	75.49 \pm 0.14 Bb	74.30 \pm 0.13 Ab	71.85 \pm 0.16 Ab
Humic acid + organomineral	Control	80.13 \pm 0.93 b	70.96 \pm 0.37 Cc	64.24 \pm 0.59 Cc	61.07 \pm 0.50 Cc
	Carob	80.13 \pm 0.93 b	74.65 \pm 0.23 Bc	67.78 \pm 0.14 Ac	64.67 \pm 0.26 Ac
	Sodium alginate	80.13 \pm 0.93 b	75.92 \pm 0.12 Ac	66.45 \pm 0.13 Bc	63.03 \pm 0.12 Bc
	Pectin	80.13 \pm 0.93 b	73.95 \pm 0.17 Bc	68.79 \pm 0.19 Ac	65.51 \pm 0.27 Ac

Different capital letters indicate a difference between “coating materials” for the same fertilizer application and storage time. Different lowercase letters indicate a difference between “fertilizer applications” for the same coating material and storage time ($p < 0.05$).

Table 2. Changes in protocatechuic acid content ($\mu\text{g g}^{-1}$) during storage. Data are presented as means \pm SD.

		Storage period (day)			
Preharvest treatment	Postharvest treatment	0	4	8	12
Humic acid	Control	17.83 \pm 0.17 a	15.52 \pm 0.06 Da	15.01 \pm 0.06 Da	12.80 \pm 0.16 Da
	Carob	17.83 \pm 0.17 a	16.10 \pm 0.03 Ca	15.41 \pm 0.05 Ca	14.21 \pm 0.06 Ca
	Sodium alginate	17.83 \pm 0.17 a	16.40 \pm 0.04 Ba	15.94 \pm 0.04 Ba	14.62 \pm 0.04 Ba
	Pectin	17.83 \pm 0.17 a	17.13 \pm 0.04 Aa	16.37 \pm 0.04 Aa	15.16 \pm 0.03 Aa
Humic acid + liquid vermicompost	Control	16.23 \pm 0.12 b	14.25 \pm 0.04 Db	13.18 \pm 0.02 Db	11.36 \pm 0.13 Db
	Carob	16.23 \pm 0.12 b	14.88 \pm 0.05 Cb	13.71 \pm 0.06 Cb	12.78 \pm 0.04 Cb
	Sodium alginate	16.23 \pm 0.12 b	15.12 \pm 0.02 Bb	14.37 \pm 0.02 Ab	13.09 \pm 0.01 Bb
	Pectin	16.23 \pm 0.12 b	15.48 \pm 0.06 Ab	14.11 \pm 0.02 Bb	13.40 \pm 0.03 Ab
Humic acid + organomineral	Control	15.51 \pm 0.12 c	12.99 \pm 0.06 Dc	13.11 \pm 0.02 Cb	10.67 \pm 0.06 Dc
	Carob	15.51 \pm 0.12 c	13.53 \pm 0.05 Cc	14.17 \pm 0.03 Bc	13.54 \pm 0.06 Ac
	Sodium alginate	15.51 \pm 0.12 c	14.32 \pm 0.05 Ac	14.37 \pm 0.05 Ab	13.08 \pm 0.02 Bb
	Pectin	15.51 \pm 0.12 c	13.83 \pm 0.06 Bc	13.12 \pm 0.05 Cc	12.79 \pm 0.05 Cc

Different capital letters indicate a difference between “coating materials” for the same fertilizer application and storage time. Different lowercase letters indicate a difference between “fertilizer applications” for the same coating material and storage time ($p < 0.05$).

Table 3. Changes in catechin content ($\mu\text{g g}^{-1}$) during storage. Data are presented as means \pm SD.

Preharvest treatment	Storage period (day)				
	Postharvest treatment	0	4	8	12
Humic acid	Control	36.15 \pm 0.53 a	30.67 \pm 0.28 Ca	28.44 \pm 0.05 Ca	25.52 \pm 0.06 Ca
	Carob	36.15 \pm 0.53 a	33.42 \pm 0.11 Ba	32.50 \pm 0.07 Ba	29.63 \pm 0.10 Ba
	Sodium alginate	36.15 \pm 0.53 a	32.96 \pm 0.04 Ba	33.70 \pm 0.03 Aa	30.31 \pm 0.07 Aa
	Pectin	36.15 \pm 0.53 a	34.22 \pm 0.12 Aa	32.51 \pm 0.03 Ba	30.09 \pm 0.05 Aa
Humic acid + liquid vermicompost	Control	31.22 \pm 0.54 b	26.88 \pm 0.07 Cb	23.30 \pm 0.03 Db	21.40 \pm 0.16 Cb
	Carob	31.22 \pm 0.54 b	28.50 \pm 0.05 Ab	25.56 \pm 0.06 Cb	24.25 \pm 0.05 Bb
	Sodium alginate	31.22 \pm 0.54 b	28.44 \pm 0.10 Ab	25.94 \pm 0.03 Bb	24.47 \pm 0.03 ABb
	Pectin	31.22 \pm 0.54 b	28.11 \pm 0.06 Bb	26.17 \pm 0.05 Ab	24.65 \pm 0.03 Ab
Humic acid + organomineral	Control	28.00 \pm 0.39 c	24.37 \pm 0.13 Dc	22.24 \pm 0.03 Dc	21.37 \pm 0.05 Db
	Carob	28.00 \pm 0.39 c	26.77 \pm 0.04 Bc	25.20 \pm 0.06 Cc	24.26 \pm 0.03 Cb
	Sodium alginate	28.00 \pm 0.39 c	26.38 \pm 0.03 Cc	25.48 \pm 0.03 Bc	24.59 \pm 0.03 Bb
	Pectin	28.00 \pm 0.39 c	27.05 \pm 0.05 Ac	26.27 \pm 0.03 Ab	24.78 \pm 0.05 Ab

Different capital letters indicate a difference between “coating materials” for the same fertilizer application and storage time. Different lowercase letters indicate a difference between “fertilizer applications” for the same coating material and storage time ($p < 0.05$).

The amount of vanillic acid decreased during storage in all treatments, but it decreased less in the coated fruit than in the control. On day 12 of storage, no significant differences were observed among the coated fruit; however, the humic acid + sodium alginate combination had the highest vanillic acid level, measuring $10.75 \mu\text{g g}^{-1}$. Furthermore, during storage, significant differences ($p < 0.05$) were found among the fertilizers (Table 4).

Vanillic acid and chlorogenic acid showed similar patterns. At the end of the storage period, the humic acid + sodium alginate treatment had the greatest concentration of chlorogenic acid ($12.64 \mu\text{g g}^{-1}$). During storage, there were significant differences ($p < 0.05$) between the coated fruit and control fruit, as well as among the fertilizer treatments (Table 5).

Syringic acid values declined over the storage period, although they did so less in the coated fruit than in the untreated fruit, particularly using sodium alginate. At the end of the storage period, the humic acid + sodium alginate treatment had the greatest concentration of syringic acid, $22.59 \mu\text{g g}^{-1}$. There were significant differences ($p < 0.05$) among the coated fruit and fertilizer treatments (Table 6).

The combination of humic acid + sodium alginate and pectin during storage yielded the highest epicatechin concentration, measuring $1.53 \mu\text{g g}^{-1}$. Conversely, the treatment of liquid vermicompost and organomineral with

pectin at the end of storage yielded the highest epicatechin content. Significant differences ($p < 0.05$) were observed among the coated fruit and fertilizer treatments (Table 7).

The combination of humic acid and pectin yielded the highest p-coumaric acid content, measuring 1.53 with $1.51 \mu\text{g g}^{-1}$. Conversely, the combination of liquid vermicompost and organomineral treatment with sodium alginate at the end of storage produced the highest epicatechin concentration. Significant differences ($p < 0.05$) were observed among the coated fruit and fertilizer treatments (Table 8).

Among all fruit groups, the pectin-treated fruit treatment gave the highest concentration of benzoic acid. Furthermore, at the end of the storage period, the fruit group treated with humic acid + pectin had the highest concentration of oxalic acid ($2.13 \mu\text{g g}^{-1}$) of all the fruit groups. Significant differences ($p < 0.05$) were observed among the coated fruit and fertilizer treatments (Table 9).

The combinations of humic acid + pectin, liquid vermicompost + pectin, and organomineral with both pectin and sodium alginate were the most effective in preserving the fruit's o-coumaric acid content throughout storage. At the end of the storage period, the humic acid + pectin treatment produced the largest amount of o-coumaric acid ($1.21 \mu\text{g g}^{-1}$). Significant differences ($p < 0.05$) were observed among the coated fruit and fertilizer

Table 4. Changes in vanillic acid ($\mu\text{g g}^{-1}$) during storage. Data are presented as means \pm SD.

		Storage period (day)			
Preharvest treatment	Postharvest treatment	0	4	8	12
Humic acid	Control	12.69 \pm 0.03 a	11.44 \pm 0.03 Da	11.03 \pm 0.01 Da	10.27 \pm 0.04 Ba
	Carob	12.69 \pm 0.03 a	11.63 \pm 0.02 Ca	11.35 \pm 0.01 Ca	10.69 \pm 0.01 Aa
	Sodium alginate	12.69 \pm 0.03 a	11.82 \pm 0.02 Ba	11.48 \pm 0.02 Ba	10.75 \pm 0.01 Aa
	Pectin	12.69 \pm 0.03 a	12.07 \pm 0.02 Aa	11.71 \pm 0.01 Aa	10.72 \pm 0.03 Aa
Humic acid + liquid vermicompost	Control	11.30 \pm 0.03 b	10.31 \pm 0.03 Db	9.82 \pm 0.03 Db	9.33 \pm 0.01 Cb
	Carob	11.30 \pm 0.03 b	10.54 \pm 0.02 Bb	10.22 \pm 0.02 Cb	9.99 \pm 0.05 Bb
	Sodium alginate	11.30 \pm 0.03 b	10.45 \pm 0.01 Cb	10.52 \pm 0.02 Ab	10.17 \pm 0.02 Ab
	Pectin	11.30 \pm 0.03 b	10.73 \pm 0.03 Ab	10.38 \pm 0.02 Bb	10.09 \pm 0.01 Ab
Humic acid + organomineral	Control	10.10 \pm 0.03 c	9.37 \pm 0.01 Cc	8.93 \pm 0.01 Cc	8.12 \pm 0.03 Cc
	Carob	10.10 \pm 0.03 c	9.49 \pm 0.01 Bc	9.21 \pm 0.01 ABc	8.89 \pm 0.02 ABc
	Sodium alginate	10.10 \pm 0.03 c	9.58 \pm 0.02 Ac	9.19 \pm 0.03 Bc	8.99 \pm 0.02 Ac
	Pectin	10.10 \pm 0.03 c	9.59 \pm 0.04 Ac	9.28 \pm 0.02 Ac	8.87 \pm 0.06 Bc

Different capital letters indicate a difference between “coating materials” for the same fertilizer application and storage time. Different lowercase letters indicate a difference between “fertilizer applications” for the same coating material and storage time ($p < 0.05$).

Table 5. Changes in chlorogenic acid ($\mu\text{g g}^{-1}$) during storage. Data are presented as means \pm SD.

		Storage period (day)			
Preharvest treatment	Postharvest treatment	0	4	8	12
Humic acid	Control	14.22 \pm 0.06 a	12.48 \pm 0.02 Da	12.03 \pm 0.01 Ca	11.81 \pm 0.01 Da
	Carob	14.22 \pm 0.06 a	13.52 \pm 0.02 Ca	13.11 \pm 0.02 Ba	12.51 \pm 0.02 Ba
	Sodium alginate	14.22 \pm 0.06 a	13.70 \pm 0.04 Aa	13.19 \pm 0.03 Ba	12.64 \pm 0.03 Aa
	Pectin	14.22 \pm 0.06 a	13.62 \pm 0.02 Ba	13.32 \pm 0.05 Aa	12.38 \pm 0.02 Ca
Humic acid + liquid vermicompost	Control	13.50 \pm 0.03 b	11.11 \pm 0.01 Db	10.51 \pm 0.02 Db	10.14 \pm 0.01 Db
	Carob	13.50 \pm 0.03 b	12.73 \pm 0.01 Cb	12.30 \pm 0.03 Cb	11.75 \pm 0.01 Cb
	Sodium alginate	13.50 \pm 0.03 b	12.91 \pm 0.02 Bb	12.49 \pm 0.03 Bb	12.10 \pm 0.03 Ab
	Pectin	13.50 \pm 0.03 b	12.96 \pm 0.01 Ab	12.66 \pm 0.02 Ab	11.95 \pm 0.01 Bb
Humic acid + organomineral	Control	12.18 \pm 0.04 c	10.75 \pm 0.02 Dc	10.18 \pm 0.04 Cc	9.82 \pm 0.04 Dc
	Carob	12.18 \pm 0.04 c	11.46 \pm 0.03 Cc	11.07 \pm 0.03 Bc	10.63 \pm 0.05 Bc
	Sodium alginate	12.18 \pm 0.04 c	11.97 \pm 0.01 Ac	11.20 \pm 0.01 Ac	10.44 \pm 0.05 Cc
	Pectin	12.18 \pm 0.04 c	11.66 \pm 0.02 Bc	11.07 \pm 0.01 Bc	10.81 \pm 0.03 Ac

Different capital letters indicate a difference between “coating materials” for the same fertilizer application and storage time. Different lowercase letters indicate a difference between “fertilizer applications” for the same coating material and storage time ($p < 0.05$).

Table 6. Changes in syringic acid ($\mu\text{g g}^{-1}$) during storage. Data are presented as means \pm SD.

		Storage period (day)			
Preharvest treatment	Postharvest treatment	0	4	8	12
Humic acid	Control	28.25 \pm 0.38 a	25.98 \pm 0.07 Ca	24.95 \pm 0.08 Ca	20.87 \pm 0.33 Ca
	Carob	28.25 \pm 0.38 a	26.64 \pm 0.26 Ba	25.75 \pm 0.04 Ba	21.26 \pm 0.07 Ca
	Sodium alginate	28.25 \pm 0.38 a	27.14 \pm 0.04 Aa	25.92 \pm 0.02 Ba	22.59 \pm 0.03 Aa
	Pectin	28.25 \pm 0.38 a	27.18 \pm 0.04 Aa	26.15 \pm 0.05 Aa	21.83 \pm 0.03 Ba
Humic acid + liquid vermicompost	Control	26.54 \pm 0.58 b	22.04 \pm 0.03 Db	19.80 \pm 0.04 Db	18.32 \pm 0.04 Cb
	Carob	26.54 \pm 0.58 b	22.92 \pm 0.05 Cb	21.41 \pm 0.10 Cb	19.77 \pm 0.06 Bb
	Sodium alginate	26.54 \pm 0.58 b	23.07 \pm 0.04 Bb	22.53 \pm 0.05 Ab	20.66 \pm 0.28 Ab
	Pectin	26.54 \pm 0.58 b	23.47 \pm 0.03 Ab	22.10 \pm 0.04 Bb	20.73 \pm 0.03 Ab
Humic acid + organomineral	Control	24.64 \pm 0.46 c	20.93 \pm 0.06 Cc	18.12 \pm 0.04 Cb	17.89 \pm 0.01 Cc
	Carob	24.64 \pm 0.46 c	22.30 \pm 0.09 Bc	20.08 \pm 0.10 Bc	19.12 \pm 0.07 Bc
	Sodium alginate	24.64 \pm 0.46 c	22.42 \pm 0.03 ABc	20.06 \pm 0.11 Bc	19.47 \pm 0.04 Ac
	Pectin	24.64 \pm 0.46 c	22.54 \pm 0.07 Ac	20.73 \pm 0.06 Ac	19.17 \pm 0.04 Bc

Different capital letters indicate a difference between “coating materials” for the same fertilizer application and storage time. Different lowercase letters indicate a difference between “fertilizer applications” for the same coating material and storage time ($p < 0.05$).

Table 7. Changes in epicatechin content ($\mu\text{g g}^{-1}$) during storage. Data are presented as means \pm SD.

		Storage period (day)			
Preharvest treatment	Postharvest treatment	0	4	8	12
Humic acid	Control	2.21 \pm 0.01 a	1.82 \pm 0.02 Ba	1.57 \pm 0.02 Ba	1.38 \pm 0.02 C
	Carob	2.21 \pm 0.01 a	1.95 \pm 0.01 Aa	1.69 \pm 0.01 Aa	1.47 \pm 0.01 B
	Sodium alginate	2.21 \pm 0.01 a	1.99 \pm 0.01 Aa	1.70 \pm 0.03 Aa	1.53 \pm 0.01 A
	Pectin	2.21 \pm 0.01 a	1.99 \pm 0.03 Aa	1.73 \pm 0.02 A	1.53 \pm 0.01 Ab
Humic acid + liquid vermicompost	Control	2.00 \pm 0.01 b	1.69 \pm 0.02 Cb	1.55 \pm 0.01 Ba	1.37 \pm 0.01 C
	Carob	2.00 \pm 0.01 b	1.84 \pm 0.01 Bb	1.69 \pm 0.02 Aa	1.47 \pm 0.02 B
	Sodium alginate	2.00 \pm 0.01 b	1.89 \pm 0.01 Ab	1.71 \pm 0.01 Aa	1.51 \pm 0.02 B
	Pectin	2.00 \pm 0.01 b	1.84 \pm 0.01 Bb	1.70 \pm 0.03 A	1.57 \pm 0.01 Aa
Humic acid + organomineral	Control	1.88 \pm 0.02 c	1.50 \pm 0.02 Bc	1.39 \pm 0.01 Cb	1.33 \pm 0.01 C
	Carob	1.88 \pm 0.02 c	1.57 \pm 0.02 Bc	1.53 \pm 0.01 Bb	1.43 \pm 0.01 B
	Sodium alginate	1.88 \pm 0.02 c	1.70 \pm 0.01 Ac	1.61 \pm 0.02 Ab	1.48 \pm 0.03 AB
	Pectin	1.88 \pm 0.02 c	1.74 \pm 0.02 Ac	1.65 \pm 0.02 A	1.51 \pm 0.01 Ab

Different capital letters indicate a difference between “coating materials” for the same fertilizer application and storage time. Different lowercase letters indicate a difference between “fertilizer applications” for the same coating material and storage time ($p < 0.05$).

Table 8. Changes in p-coumaric acid ($\mu\text{g g}^{-1}$) during storage. Data are presented as means \pm SD.

		Storage period (day)			
Preharvest treatment	Postharvest treatment	0	4	8	12
Humic acid	Control	1.81 \pm 0.02 a	1.67 \pm 0.01 Da	1.43 \pm 0.01 Ba	1.36 \pm 0.01 C
	Carob	1.81 \pm 0.02 a	1.72 \pm 0.01 Ca	1.54 \pm 0.01 Aa	1.44 \pm 0.01 Ba
	Sodium alginate	1.81 \pm 0.02 a	1.77 \pm 0.01 Ba	1.55 \pm 0.01 Aa	1.48 \pm 0.01 Aa
	Pectin	1.81 \pm 0.02 a	1.84 \pm 0.01 Aa	1.55 \pm 0.02 Aa	1.51 \pm 0.01 Aa
Humic acid + liquid vermicompost	Control	1.74 \pm 0.01 b	1.43 \pm 0.01 Bb	1.39 \pm 0.01 Bb	1.36 \pm 0.01 B
	Carob	1.74 \pm 0.01 b	1.54 \pm 0.01 Ab	1.49 \pm 0.00 Ab	1.41 \pm 0.01 Ab
	Sodium alginate	1.74 \pm 0.01 b	1.54 \pm 0.01 Ab	1.49 \pm 0.01 Ab	1.43 \pm 0.01 Ab
	Pectin	1.74 \pm 0.01 b	1.57 \pm 0.01 Ab	1.51 \pm 0.02 Aab	1.42 \pm 0.01 Ab
Humic acid + organomineral	Control	1.65 \pm 0.01 c	1.41 \pm 0.02 Bb	1.36 \pm 0.01 Bb	1.35 \pm 0.01 B
	Carob	1.65 \pm 0.01 c	1.53 \pm 0.01 Ab	1.47 \pm 0.01 Ab	1.41 \pm 0.01 Ab
	Sodium alginate	1.65 \pm 0.01 c	1.53 \pm 0.02 Ab	1.48 \pm 0.01 Ab	1.43 \pm 0.01 Ab
	Pectin	1.65 \pm 0.01 c	1.49 \pm 0.01 Ac	1.47 \pm 0.00 Ab	1.41 \pm 0.01 Ab

Different capital letters indicate a difference between “coating materials” for the same fertilizer application and storage time. Different lowercase letters indicate a difference between “fertilizer applications” for the same coating material and storage time ($p < 0.05$).

Table 9. Changes in benzoic acid ($\mu\text{g g}^{-1}$) during storage. Data are presented as means \pm SD.

		Storage period (day)			
Preharvest treatment	Postharvest treatment	0	4	8	12
Humic acid	Control	2.63 \pm 0.01 a	2.32 \pm 0.01 Ca	2.10 \pm 0.01 Ca	1.89 \pm 0.01 Da
	Carob	2.63 \pm 0.01 a	2.47 \pm 0.01 Ba	2.26 \pm 0.01 Ba	2.02 \pm 0.01 Ca
	Sodium alginate	2.63 \pm 0.01 a	2.51 \pm 0.01 Aa	2.29 \pm 0.01 Ba	2.06 \pm 0.01 Ba
	Pectin	2.63 \pm 0.01 a	2.53 \pm 0.01 Aa	2.37 \pm 0.02 Aa	2.13 \pm 0.01 Aa
Humic acid + liquid vermicompost	Control	2.29 \pm 0.02 b	2.14 \pm 0.01 Cb	2.01 \pm 0.02 Cb	1.79 \pm 0.03 Cb
	Carob	2.29 \pm 0.02 b	2.25 \pm 0.01 Ab	2.13 \pm 0.01 Bb	1.90 \pm 0.01 Bb
	Sodium alginate	2.29 \pm 0.02 b	2.20 \pm 0.01 Bb	2.15 \pm 0.01 Abb	1.95 \pm 0.01 Abb
	Pectin	2.29 \pm 0.02 b	2.22 \pm 0.01 Ab	2.18 \pm 0.01 Ab	1.99 \pm 0.02 Ab
Humic acid + organomineral	Control	2.17 \pm 0.01 c	2.01 \pm 0.02 Cc	1.94 \pm 0.01 Bc	1.79 \pm 0.01 Bb
	Carob	2.17 \pm 0.01 c	2.11 \pm 0.01 ABc	2.03 \pm 0.01 Ac	1.89 \pm 0.01 Ab
	Sodium alginate	2.17 \pm 0.01 c	2.07 \pm 0.02 Bc	2.04 \pm 0.03 Ac	1.91 \pm 0.02 Ab
	Pectin	2.17 \pm 0.01 c	2.14 \pm 0.00 Ac	2.03 \pm 0.01 Ac	1.92 \pm 0.02 Ac

Different capital letters indicate a difference between “coating materials” for the same fertilizer application and storage time. Different lowercase letters indicate a difference between “fertilizer applications” for the same coating material and storage time ($p < 0.05$).

treatments (Table 10). Similar to o-coumaric acid, trans-cinnamic acid also exhibited changes in concentration during storage. Put another way, the fertilizer treatments containing pectin and sodium alginate showed the highest levels of trans-cinnamic acid at the end of the storage period. Humic acid + pectin and sodium alginate produced the highest trans-cinnamic acid, $1.12 \mu\text{g g}^{-1}$. During storage, there were significant differences ($p < 0.05$) between the coated fruit and control fruit, as well as among the fertilizer treatments (Table 11).

While caffeic acid did diminish throughout the course of storage, coated fruit had smaller declines than the other fruit, particularly when pectin treatment was applied. The combination of humic acid and pectin produced the greatest caffeic acid content, $22.43 \mu\text{g g}^{-1}$. Furthermore, during storage, there were significant differences ($p < 0.05$) among the coated fruit and control fruit as well as among the fertilizer treatments (Table 12).

Ferulic acid showed a trend similar to that of caffeic acid. By the end of the storage period, the combination treatment of humic acid and pectin had the largest amount of ferulic acid ($3.16 \mu\text{g g}^{-1}$). During storage, there were notable variations ($p < 0.05$) among the coated fruit and control fruit, as well as among the fertilizer treatments (Table 13).

3.2. Fatty acids

In the present study, a total of seven fatty acids were detected in fresh-cut melon. Fruit grown with humic acid generally contained higher fatty acids. There were decreases in organic acid values during the storage period. Moreover, coating material applications preserved the organic acids in the fruit better during storage; especially the pectin application came to the fore in terms of all parameters. The myristic acid (C14:1) contents of the fruit varied between 0.58% and 0.28%. The amount of myristic acid decreased during storage in all treatments, but it decreased less in the coated fruit than in the control. On day 12 of storage, there was no significant variation among the coated fruit; however, the humic acid + pectin combination had the highest myristic acid level, measuring 0.43%. Palmitic acid (C16:0) and myristic acid showed similar patterns. At the end of the storage period, the humic acid + pectin treatment had the greatest concentration of palmitic acid (18.34%). Palmitoleic acid (C16:1) content varied between 0.25% and 0.62%. Furthermore, at the end of the storage period, the fruit group treated with liquid vermicompost + pectin had the highest concentration of palmitoleic acid (0.44%) of all the fruit groups. Stearic acid (C18:0) content varied between 8.08% and 10.48%. While stearic acid did diminish throughout the course of storage, the coated

Table 10. Changes in o-coumaric acid ($\mu\text{g g}^{-1}$) during storage. Data are presented as means \pm SD.

Preharvest treatment	Storage period (day)				
	Postharvest treatment	0	4	8	12
Humic acid	Control	1.34 ± 0.10	1.29 ± 0.01 Ba	1.19 ± 0.01 C	1.09 ± 0.01 Ba
	Carob	1.34 ± 0.10	1.33 ± 0.01 Aa	1.25 ± 0.02 B	1.17 ± 0.01 Aa
	Sodium alginate	1.34 ± 0.10	1.33 ± 0.01 Aa	1.32 ± 0.01 Aa	1.20 ± 0.01 A
	Pectin	1.34 ± 0.10	1.35 ± 0.00 Aa	1.26 ± 0.01 B	1.21 ± 0.02 A
Humic acid + liquid vermicompost	Control	1.35 ± 0.01	1.26 ± 0.01 Ca	1.20 ± 0.02 B	1.05 ± 0.02 Bab
	Carob	1.35 ± 0.01	1.29 ± 0.01 Bb	1.25 ± 0.00 A	1.15 ± 0.01 Aab
	Sodium alginate	1.35 ± 0.01	1.32 ± 0.01 Aa	1.27 ± 0.01 Ab	1.17 ± 0.01 A
	Pectin	1.35 ± 0.01	1.33 ± 0.01 Aa	1.27 ± 0.01 A	1.19 ± 0.01 A
Humic acid + organomineral	Control	1.33 ± 0.01	1.19 ± 0.01 Cb	1.15 ± 0.01 C	1.03 ± 0.01 Cc
	Carob	1.33 ± 0.01	1.24 ± 0.01 Bc	1.23 ± 0.01 AB	1.13 ± 0.01 Bc
	Sodium alginate	1.33 ± 0.01	1.27 ± 0.01 ABb	1.22 ± 0.01 Bc	1.17 ± 0.01 A
	Pectin	1.33 ± 0.01	1.29 ± 0.01 Ab	1.25 ± 0.01 A	1.16 ± 0.02 A

Different capital letters indicate a difference between "coating materials" for the same fertilizer application and storage time. Different lowercase letters indicate a difference between "fertilizer applications" for the same coating material and storage time ($p < 0.05$).

Table 11. Changes in trans-cinnamic acid ($\mu\text{g g}^{-1}$) during storage. Data are presented as means \pm SD.

		Storage period (day)			
Preharvest treatment	Postharvest treatment	0	4	8	12
Humic acid	Control	1.24 \pm 0.01 a	1.14 \pm 0.01 Ba	1.10 \pm 0.01 B	1.03 \pm 0.01 B
	Carob	1.24 \pm 0.01 a	1.16 \pm 0.00 A	1.13 \pm 0.01 Aab	1.10 \pm 0.01 Aa
	Sodium alginate	1.24 \pm 0.01 a	1.17 \pm 0.01 A	1.13 \pm 0.01 Aab	1.12 \pm 0.01 Aa
	Pectin	1.24 \pm 0.01 a	1.17 \pm 0.01 A	1.14 \pm 0.01 A	1.12 \pm 0.01 Aa
Humic acid + liquid vermicompost	Control	1.19 \pm 0.01 b	1.13 \pm 0.01 Bb	1.08 \pm 0.01 B	0.97 \pm 0.01 B
	Carob	1.19 \pm 0.01 b	1.16 \pm 0.01 A	1.14 \pm 0.01 Aa	1.06 \pm 0.00 Ab
	Sodium alginate	1.19 \pm 0.01 b	1.17 \pm 0.00 A	1.15 \pm 0.01 Aa	1.08 \pm 0.02 Aab
	Pectin	1.19 \pm 0.01 b	1.16 \pm 0.01 A	1.15 \pm 0.01 A	1.09 \pm 0.01 Aab
Humic acid + organomineral	Control	1.19 \pm 0.01 b	1.12 \pm 0.00 Bc	1.06 \pm 0.01 B	0.94 \pm 0.01 C
	Carob	1.19 \pm 0.01 b	1.15 \pm 0.00 A	1.11 \pm 0.01 Ab	1.03 \pm 0.01 Bc
	Sodium alginate	1.19 \pm 0.01 b	1.15 \pm 0.01 A	1.11 \pm 0.01 Ab	1.06 \pm 0.01 Abb
	Pectin	1.19 \pm 0.01 b	1.16 \pm 0.01 A	1.13 \pm 0.01 A	1.07 \pm 0.01 Ab

Different capital letters indicate a difference between “coating materials” for the same fertilizer application and storage time. Different lowercase letters indicate a difference between “fertilizer applications” for the same coating material and storage time ($p < 0.05$).

Table 12. Changes in caffeic acid ($\mu\text{g g}^{-1}$) during storage. Data are presented as means \pm SD.

		Storage period (day)			
Preharvest treatment	Postharvest treatment	0	4	8	12
Humic acid	Control	25.38 \pm 0.02 a	23.23 \pm 0.01 Ca	22.16 \pm 0.02 Da	21.42 \pm 0.03 Da
	Carob	25.38 \pm 0.02 a	24.30 \pm 0.01 Aa	23.58 \pm 0.02 Ba	22.19 \pm 0.02 Ca
	Sodium alginate	25.38 \pm 0.02 a	24.17 \pm 0.02 Ba	23.68 \pm 0.02 Aa	22.35 \pm 0.01 Ba
	Pectin	25.38 \pm 0.02 a	24.34 \pm 0.02 Aa	23.41 \pm 0.02 Ca	22.43 \pm 0.01 Aa
Humic acid + liquid vermicompost	Control	24.18 \pm 0.02 b	22.11 \pm 0.01 Db	21.46 \pm 0.03 Cb	21.02 \pm 0.02 Db
	Carob	24.18 \pm 0.02 b	23.22 \pm 0.02 Cb	22.39 \pm 0.02 Bb	22.09 \pm 0.01 Cb
	Sodium alginate	24.18 \pm 0.02 b	23.31 \pm 0.02 Bb	22.55 \pm 0.01 Ab	22.28 \pm 0.02 Bb
	Pectin	24.18 \pm 0.02 b	23.39 \pm 0.01 Ab	22.61 \pm 0.01 Ab	22.40 \pm 0.01 Aa
Humic acid + organomineral	Control	23.05 \pm 0.04 c	21.53 \pm 0.03 Cc	21.03 \pm 0.01 Dc	20.44 \pm 0.02 Dc
	Carob	23.05 \pm 0.04 c	22.01 \pm 0.02 Bc	21.49 \pm 0.02 Cc	20.99 \pm 0.02 Cc
	Sodium alginate	23.05 \pm 0.04 c	22.43 \pm 0.01 Ac	21.61 \pm 0.02 Bc	21.09 \pm 0.02 Bc
	Pectin	23.05 \pm 0.04 c	22.50 \pm 0.02 Ac	21.71 \pm 0.01 Ac	21.24 \pm 0.01 Ab

Different capital letters indicate a difference between “coating materials” for the same fertilizer application and storage time. Different lowercase letters indicate a difference between “fertilizer applications” for the same coating material and storage time ($p < 0.05$).

Table 13. Changes in ferulic acid ($\mu\text{g g}^{-1}$) during storage. Data are presented as means \pm SD.

		Storage period (day)			
Preharvest treatment	Postharvest treatment	0	4	8	12
Humic acid	Control	4.47 \pm 0.03 a	3.89 \pm 0.01 Da	3.37 \pm 0.02 Da	2.84 \pm 0.02 Ca
	Carob	4.47 \pm 0.03 a	4.05 \pm 0.02 Ca	3.85 \pm 0.01 Ca	3.06 \pm 0.01 Ba
	Sodium alginate	4.47 \pm 0.03 a	4.11 \pm 0.01 Ba	3.92 \pm 0.01 Ba	3.10 \pm 0.01 Ba
	Pectin	4.47 \pm 0.03 a	4.16 \pm 0.01 Aa	3.97 \pm 0.01 Aa	3.16 \pm 0.01 Aa
Humic acid + liquid vermicompost	Control	4.13 \pm 0.01 b	3.34 \pm 0.02 Cb	3.07 \pm 0.02 Db	2.51 \pm 0.01 Cb
	Carob	4.13 \pm 0.01 b	3.83 \pm 0.02 Bb	3.57 \pm 0.01 Cb	2.95 \pm 0.01 Bb
	Sodium alginate	4.13 \pm 0.01 b	3.92 \pm 0.01 Ab	3.62 \pm 0.01 Bb	3.03 \pm 0.01 Ab
	Pectin	4.13 \pm 0.01 b	3.96 \pm 0.02 Ab	3.69 \pm 0.01 Ab	3.06 \pm 0.02 Ab
Humic acid + organomineral	Control	4.09 \pm 0.01 b	3.21 \pm 0.01 Dc	2.97 \pm 0.01 Dc	2.41 \pm 0.01 Db
	Carob	4.09 \pm 0.01 b	3.61 \pm 0.03 Cc	3.26 \pm 0.01 Cc	2.87 \pm 0.01 Cb
	Sodium alginate	4.09 \pm 0.01 b	3.72 \pm 0.01 Bc	3.33 \pm 0.01 Bc	2.94 \pm 0.01 Bb
	Pectin	4.09 \pm 0.01 b	3.87 \pm 0.01 Ac	3.42 \pm 0.02 Ac	3.03 \pm 0.01 Ab

Different capital letters indicate a difference between “coating materials” for the same fertilizer application and storage time. Different lowercase letters indicate a difference between “fertilizer applications” for the same coating material and storage time ($p < 0.05$).

fruit had smaller declines than the other fruit, particularly when pectin treatment was applied. The combination of humic acid and pectin produced at the end of the storage period the greatest stearic acid content, 9.60%. Oleic acid (C18:1 *n-9 cis*) content varied between 8.86% and 10.25%. On day 12 of storage the humic acid + pectin combination had the highest oleic acid level, measuring 9.55%, and organomineral + control the smallest oleic acid level, measuring 8.86%. Linoleic acid (C18:2 *n-6 cis*) content varied between 1.18% and 2.14%, while linolenic acid (C18:3 *n-3*) content varied between 0.43% and 0.87% at harvest and on the following days of analysis. Linoleic acid and linolenic acid showed similar patterns. At the end of the storage period, the humic acid + sodium alginate treatment gave the greatest concentration of linoleic acid (1.86%), while humic acid + pectin treatment gave the greatest concentration of linolenic acid (0.82%). Significant differences ($p < 0.05$) were observed among the fertilizer treatments as well as between the coated fruit and control fruit in all analyzed fatty acids during storage (Tables 14–20).

3.3. Heatmap

The clustering of heat maps showed that phenolic compounds and fatty acids were generally highly associated with each other. Both fatty acids and phenolic compounds

have a high level of interrelationship among themselves and with each other. This fact shows that there is a positive correlation between fatty acids and phenolic compounds (Figure 3). In addition, a higher level of correlation was observed in humic acid treated samples compared to humic acid + liquid vermicompost and humic acid + organomineral treated samples. Similarly, there was a high level of correlation in the samples treated with coating materials compared to the control group samples (Figure 4).

4. Discussion

Environmental variables and different stress signals influence the synthesis of phenolic compounds since they are secondary metabolites with a range of protective functions (Zahan Akhi et al., 2021). Consequently, phenolic compounds in fruit and vegetables may be enhanced or degraded as a result of pre- and postharvest interventions.

In our study, the accumulations of phenolic compounds and fatty acids were higher in fruits grown with humic acid application on day 0 of storage. There was a steady decrease in fatty acid and phenolic compound content on days 4, 8, and 12 of storage compared to day 0. However, this decrease was relatively less in fruits with edible coating. Fung et al. (1977) reported that this decrease in phenolic

Table 14. Changes in myristic acid (C14:1) (%) during storage.

		Storage period (day)			
Preharvest treatment	Postharvest treatment	0	4	8	12
Humic acid	Control	0.58 ± 0.05 a	0.49 ± 0.02 a	0.45 ± 0.01 Ca	0.35 ± 0.01 Ca
	Carob	0.58 ± 0.05 a	0.52 ± 0.01 a	0.49 ± 0.00 Ba	0.38 ± 0.01 Ba
	Sodium alginate	0.58 ± 0.05 a	0.52 ± 0.02 a	0.51 ± 0.00 Aa	0.41 ± 0.01 Aa
	Pectin	0.58 ± 0.05 a	0.52 ± 0.01 a	0.52 ± 0.01 Aa	0.43 ± 0.01 Aa
Humic acid + liquid vermicompost	Control	0.41 ± 0.01 b	0.38 ± 0.01 Bb	0.35 ± 0.01 Bb	0.32 ± 0.01 Bb
	Carob	0.41 ± 0.01 b	0.41 ± 0.00 Ab	0.38 ± 0.01 Ab	0.35 ± 0.00 ABb
	Sodium alginate	0.41 ± 0.01 b	0.40 ± 0.01 ABb	0.38 ± 0.01 Ab	0.36 ± 0.01 Ab
	Pectin	0.41 ± 0.01 b	0.40 ± 0.01 ABb	0.39 ± 0.01 Ab	0.37 ± 0.01 Ab
Humic acid + organomineral	Control	0.35 ± 0.01 b	0.32 ± 0.00 c	0.30 ± 0.00 Bc	0.28 ± 0.01 Bc
	Carob	0.35 ± 0.01 b	0.34 ± 0.01 c	0.31 ± 0.00 Bc	0.31 ± 0.00 Ac
	Sodium alginate	0.35 ± 0.01 b	0.33 ± 0.01 c	0.33 ± 0.01 Ac	0.31 ± 0.01 Ac
	Pectin	0.35 ± 0.01 b	0.34 ± 0.00 c	0.34 ± 0.00 Ac	0.32 ± 0.01 Ac

Different capital letters indicate a difference between “coating materials” for the same fertilizer application and storage time. Different lowercase letters indicate a difference between “fertilizer applications” for the same coating material and storage time ($p < 0.05$).

Table 15. Changes in palmitic acid (C16:0) (%) during storage. Data are presented as means ± SD.

		Storage period (day)			
Preharvest treatment	Postharvest treatment	0	4	8	12
Humic acid	Control	20.36 ± 0.12 a	18.69 ± 0.09 Ca	18.19 ± 0.02 Da	18.04 ± 0.01 Da
	Carob	20.36 ± 0.12 a	19.27 ± 0.03 Ba	18.48 ± 0.02 Ca	18.26 ± 0.01 Ca
	Sodium alginate	20.36 ± 0.12 a	19.30 ± 0.01 Ba	18.69 ± 0.01 Ba	18.31 ± 0.01 Ba
	Pectin	20.36 ± 0.12 a	19.51 ± 0.04 Aa	19.05 ± 0.00 Aa	18.34 ± 0.01 Aa
Humic acid + liquid vermicompost	Control	19.72 ± 0.10 b	18.24 ± 0.01 Db	17.84 ± 0.04 Cb	17.57 ± 0.01 Cb
	Carob	19.72 ± 0.10 b	18.50 ± 0.02 Cb	17.89 ± 0.02 Cb	17.83 ± 0.01 Bb
	Sodium alginate	19.72 ± 0.10 b	18.58 ± 0.02 Bb	18.08 ± 0.02 Bb	17.91 ± 0.01 Ab
	Pectin	19.72 ± 0.10 b	18.64 ± 0.02 Ab	18.25 ± 0.01 Ab	17.94 ± 0.01 Ab
Humic acid + organomineral	Control	19.19 ± 0.11 c	17.92 ± 0.01 Dc	17.56 ± 0.01 Cc	17.37 ± 0.01 Dc
	Carob	19.19 ± 0.11 c	18.17 ± 0.03 Cc	17.79 ± 0.01 Bc	17.58 ± 0.02 Cc
	Sodium alginate	19.19 ± 0.11 c	18.29 ± 0.01 Bc	17.99 ± 0.04 Ac	17.67 ± 0.01 Bc
	Pectin	19.19 ± 0.11 c	18.38 ± 0.02 Ac	18.03 ± 0.01 Ac	17.77 ± 0.01 Ac

Different capital letters indicate a difference between “coating materials” for the same fertilizer application and storage time. Different lowercase letters indicate a difference between “fertilizer applications” for the same coating material and storage time ($p < 0.05$).

Table 16. Changes in palmitoleic acid (C16:1) (%) during storage. Data are presented as means \pm SD.

		Storage period (day)			
Preharvest treatment	Postharvest treatment	0	4	8	12
Humic acid	Control	0.62 \pm 0.04 a	0.50 \pm 0.02 Ba	0.42 \pm 0.01 Ca	0.33 \pm 0.01 Ca
	Carob	0.62 \pm 0.04 a	0.56 \pm 0.01 Aa	0.46 \pm 0.01 ABa	0.35 \pm 0.00 Bb
	Sodium alginate	0.62 \pm 0.04 a	0.56 \pm 0.01 Aa	0.48 \pm 0.01 Aa	0.42 \pm 0.00 Aa
	Pectin	0.62 \pm 0.04a	0.57 \pm 0.00 Aa	0.45 \pm 0.01 Bb	0.42 \pm 0.00 Aa
Humic acid + liquid vermicompost	Control	0.45 \pm 0.06 b	0.45 \pm 0.01 Cb	0.40 \pm 0.00 Cb	0.34 \pm 0.00 Da
	Carob	0.45 \pm 0.06 b	0.49 \pm 0.01 Bb	0.47 \pm 0.01 Aa	0.42 \pm 0.01 Ba
	Sodium alginate	0.45 \pm 0.06 b	0.52 \pm 0.00 Ab	0.44 \pm 0.01 Bb	0.39 \pm 0.01 Cb
	Pectin	0.45 \pm 0.06 b	0.53 \pm 0.00 Ab	0.49 \pm 0.01 Aa	0.44 \pm 0.01 Aa
Humic acid + organomineral	Control	0.42 \pm 0.03 b	0.33 \pm 0.01 Bc	0.30 \pm 0.00 Bc	0.25 \pm 0.01 Cb
	Carob	0.42 \pm 0.03 b	0.35 \pm 0.00 Ac	0.34 \pm 0.01 Ab	0.32 \pm 0.01 Ac
	Sodium alginate	0.42 \pm 0.03 b	0.37 \pm 0.01 Ac	0.34 \pm 0.01 Ac	0.29 \pm 0.01 Bc
	Pectin	0.42 \pm 0.03 b	0.37 \pm 0.00 Ac	0.33 \pm 0.01 Ac	0.29 \pm 0.01 Bb

Different capital letters indicate a difference between “coating materials” for the same fertilizer application and storage time. Different lowercase letters indicate a difference between “fertilizer applications” for the same coating material and storage time ($p < 0.05$).

Table 17. Changes in stearic acid (C18:0) (%) during storage. Data are presented as means \pm SD.

		Storage period (day)			
Preharvest treatment	Postharvest treatment	0	4	8	12
Humic acid	Control	10.48 \pm 0.03 a	9.54 \pm 0.01 Ba	9.33 \pm 0.01 Ca	9.19 \pm 0.02 Da
	Carob	10.48 \pm 0.03 a	9.72 \pm 0.02 Aa	9.65 \pm 0.04 Ba	9.48 \pm 0.00 Ca
	Sodium alginate	10.48 \pm 0.03 a	9.77 \pm 0.03 Aa	9.72 \pm 0.01 Aa	9.53 \pm 0.01 Ba
	Pectin	10.48 \pm 0.03 a	9.79 \pm 0.01 Aa	9.77 \pm 0.01 Aa	9.60 \pm 0.01 Aa
Humic acid + liquid vermicompost	Control	9.58 \pm 0.05 b	9.07 \pm 0.02 Cb	9.03 \pm 0.01 Db	8.93 \pm 0.01 Db
	Carob	9.58 \pm 0.05 b	9.18 \pm 0.01 Bb	9.13 \pm 0.01 Cb	9.07 \pm 0.01 Cb
	Sodium alginate	9.58 \pm 0.05 b	9.20 \pm 0.02 Bb	9.17 \pm 0.01 Bb	9.11 \pm 0.01 Bb
	Pectin	9.58 \pm 0.05 b	9.28 \pm 0.01 Ab	9.22 \pm 0.01 Ab	9.16 \pm 0.01 Ab
Humic acid + organomineral	Control	8.98 \pm 0.07 c	8.18 \pm 0.02 Cc	8.13 \pm 0.01 Dc	8.08 \pm 0.00 Dc
	Carob	8.98 \pm 0.07 c	8.37 \pm 0.02 Bc	8.30 \pm 0.02 Cc	8.24 \pm 0.01 Cc
	Sodium alginate	8.98 \pm 0.07 c	8.41 \pm 0.01 ABc	8.35 \pm 0.00 Bc	8.30 \pm 0.01 Bc
	Pectin	8.98 \pm 0.07 c	8.45 \pm 0.01 Ac	8.39 \pm 0.01 Ac	8.35 \pm 0.01 Ac

Different capital letters indicate a difference between “coating materials” for the same fertilizer application and storage time. Different lowercase letters indicate a difference between “fertilizer applications” for the same coating material and storage time ($p < 0.05$).

Table 18. Changes in oleic acid (C18:1 n-9 cis) (%) during storage. Data are presented as means ± SD.

		Storage period (day)			
Preharvest treatment	Postharvest treatment	0	4	8	12
Humic acid	Control	10.25 ± 0.62	9.51 ± 0.02 Ca	9.43 ± 0.01 Ca	9.25 ± 0.01 C
	Carob	10.25 ± 0.62	9.67 ± 0.06 Aba	9.63 ± 0.03 Aa	9.53 ± 0.01 Aa
	Sodium alginate	10.25 ± 0.62	9.61 ± 0.01 BCa	9.55 ± 0.01 Ba	9.45 ± 0.01 Ba
	Pectin	10.25 ± 0.62	9.78 ± 0.02 Aa	9.67 ± 0.01 Aa	9.55 ± 0.00 Aa
Humic acid + liquid vermicompost	Control	9.87 ± 0.13	9.40 ± 0.02 Cb	9.33 ± 0.01 Db	9.19 ± 0.01 D
	Carob	9.87 ± 0.13	9.44 ± 0.02 Cb	9.38 ± 0.00 Cb	9.32 ± 0.01 Cb
	Sodium alginate	9.87 ± 0.13	9.55 ± 0.01 Bb	9.44 ± 0.01 Bb	9.37 ± 0.01 Bb
	Pectin	9.87 ± 0.13	9.63 ± 0.01 Ab	9.52 ± 0.01 Ab	9.43 ± 0.01 Ab
Humic acid + organomineral	Control	9.69 ± 0.13	9.13 ± 0.01 Cc	9.05 ± 0.01 Dc	8.86 ± 0.01 D
	Carob	9.69 ± 0.13	9.21 ± 0.01 Bc	9.14 ± 0.01 Cc	9.07 ± 0.01 Cc
	Sodium alginate	9.69 ± 0.13	9.28 ± 0.02 Ac	9.23 ± 0.01 Bc	9.13 ± 0.00 Bc
	Pectin	9.69 ± 0.13	9.31 ± 0.01 Ac	9.28 ± 0.00 Ac	9.22 ± 0.00 Ac

Different capital letters indicate a difference between “coating materials” for the same fertilizer application and storage time. Different lowercase letters indicate a difference between “fertilizer applications” for the same coating material and storage time ($p < 0.05$).

Table 19. Changes in linoleic acid (C18:2 n-6 cis) (%) during storage. Data are presented as means ± SD.

		Storage period (day)			
Preharvest treatment	Postharvest treatment	0	4	8	12
Humic acid	Control	2.14 ± 0.10 a	1.92 ± 0.01 Aa	1.83 ± 0.01 Ba	1.74 ± 0.01 Ca
	Carob	2.14 ± 0.10 a	1.93 ± 0.02 Aa	1.90 ± 0.01 Aa	1.84 ± 0.01 Ba
	Sodium alginate	2.14 ± 0.10 a	1.91 ± 0.01 Aa	1.90 ± 0.02 Aa	1.86 ± 0.01 Aa
	Pectin	2.14 ± 0.10 a	1.92 ± 0.01 Aa	1.83 ± 0.01 Ba	1.74 ± 0.01 Ca
Humic acid + liquid vermicompost	Control	1.82 ± 0.02 b	1.57 ± 0.01 Cb	1.52 ± 0.00 Db	1.37 ± 0.01 Db
	Carob	1.82 ± 0.02 b	1.65 ± 0.01 Bb	1.57 ± 0.00 Cb	1.51 ± 0.00 Cb
	Sodium alginate	1.82 ± 0.02 b	1.66 ± 0.01 ABb	1.59 ± 0.01 Bb	1.56 ± 0.00 Bb
	Pectin	1.82 ± 0.02 b	1.69 ± 0.01 Ab	1.63 ± 0.00 Ab	1.59 ± 0.01 Ab
Humic acid + organomineral	Control	1.70 ± 0.03 b	1.47 ± 0.01 Cc	1.33 ± 0.01 Dc	1.18 ± 0.01 Dc
	Carob	1.70 ± 0.03 b	1.56 ± 0.03 Bc	1.46 ± 0.01 Cc	1.33 ± 0.01 Cc
	Sodium alginate	1.70 ± 0.03 b	1.62 ± 0.02 ABb	1.53 ± 0.01 Bc	1.43 ± 0.01 Bc
	Pectin	1.70 ± 0.03 b	1.67 ± 0.01 Ab	1.57 ± 0.01 Ac	1.51 ± 0.00 Ac

Different capital letters indicate a difference between “coating materials” for the same fertilizer application and storage time. Different lowercase letters indicate a difference between “fertilizer applications” for the same coating material and storage time ($p < 0.05$).

Table 20. Changes in linolenic acid (C18:3 n-3) (%) during storage. Data are presented as means ± SD.

		Storage period (day)			
Preharvest treatment	Postharvest treatment	0	4	8	12
Humic acid	Control	0.87 ± 0.02 a	0.79 ± 0.01 Ca	0.74 ± 0.01 Da	0.57 ± 0.01 Da
	Carob	0.87 ± 0.02 a	0.82 ± 0.01 Ba	0.78 ± 0.01 Ca	0.72 ± 0.00 Ca
	Sodium alginate	0.87 ± 0.02 a	0.84 ± 0.00 Aa	0.81 ± 0.00 Ba	0.76 ± 0.01 Ba
	Pectin	0.87 ± 0.02 a	0.85 ± 0.00 Aa	0.83 ± 0.00 Aa	0.82 ± 0.01 Aa
Humic acid + liquid vermi-compost	Control	0.74 ± 0.01 b	0.63 ± 0.01 Cb	0.56 ± 0.01 Cb	0.52 ± 0.01 Db
	Carob	0.74 ± 0.01 b	0.70 ± 0.00 Ab	0.63 ± 0.00 Bb	0.58 ± 0.01 Bb
	Sodium alginate	0.74 ± 0.01 b	0.67 ± 0.01 Bb	0.62 ± 0.00 Bb	0.56 ± 0.01 Cb
	Pectin	0.74 ± 0.01 b	0.69 ± 0.01 Ab	0.66 ± 0.01 Ab	0.61 ± 0.00 Ab
Humic acid + organomineral	Control	0.67 ± 0.01 c	0.57 ± 0.01 Bc	0.51 ± 0.01 Cc	0.43 ± 0.01 Cc
	Carob	0.67 ± 0.01 c	0.62 ± 0.00 Ac	0.57 ± 0.00 Bc	0.52 ± 0.01 Bc
	Sodium alginate	0.67 ± 0.01 c	0.63 ± 0.01 Ac	0.59 ± 0.01 ABc	0.54 ± 0.01 Bb
	Pectin	0.67 ± 0.01 c	0.63 ± 0.01 Ac	0.61 ± 0.01 Ac	0.57 ± 0.01 Ac

Different capital letters indicate a difference between “coating materials” for the same fertilizer application and storage time. Different lowercase letters indicate a difference between “fertilizer applications” for the same coating material and storage time (p < 0.05).

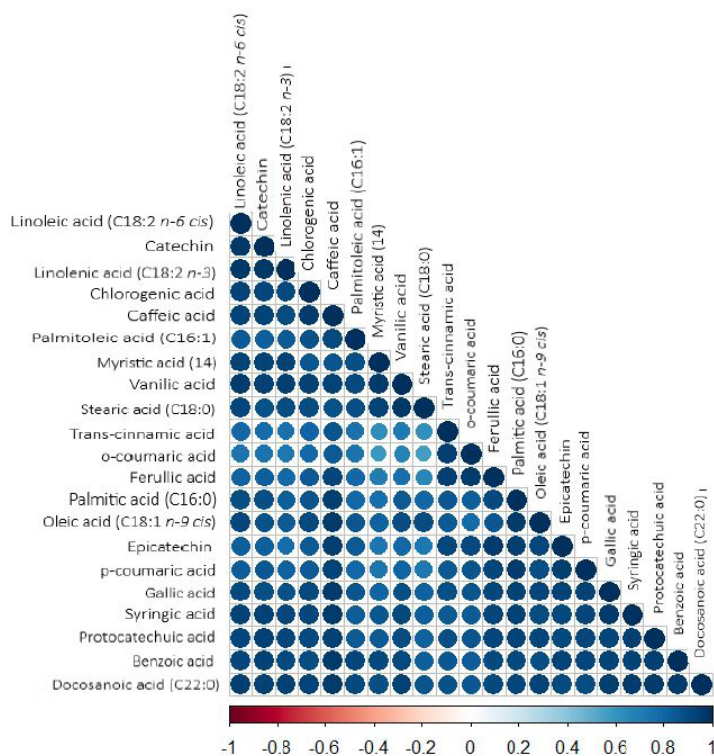


Figure 3. Correlation between fatty acids and phenolic compounds

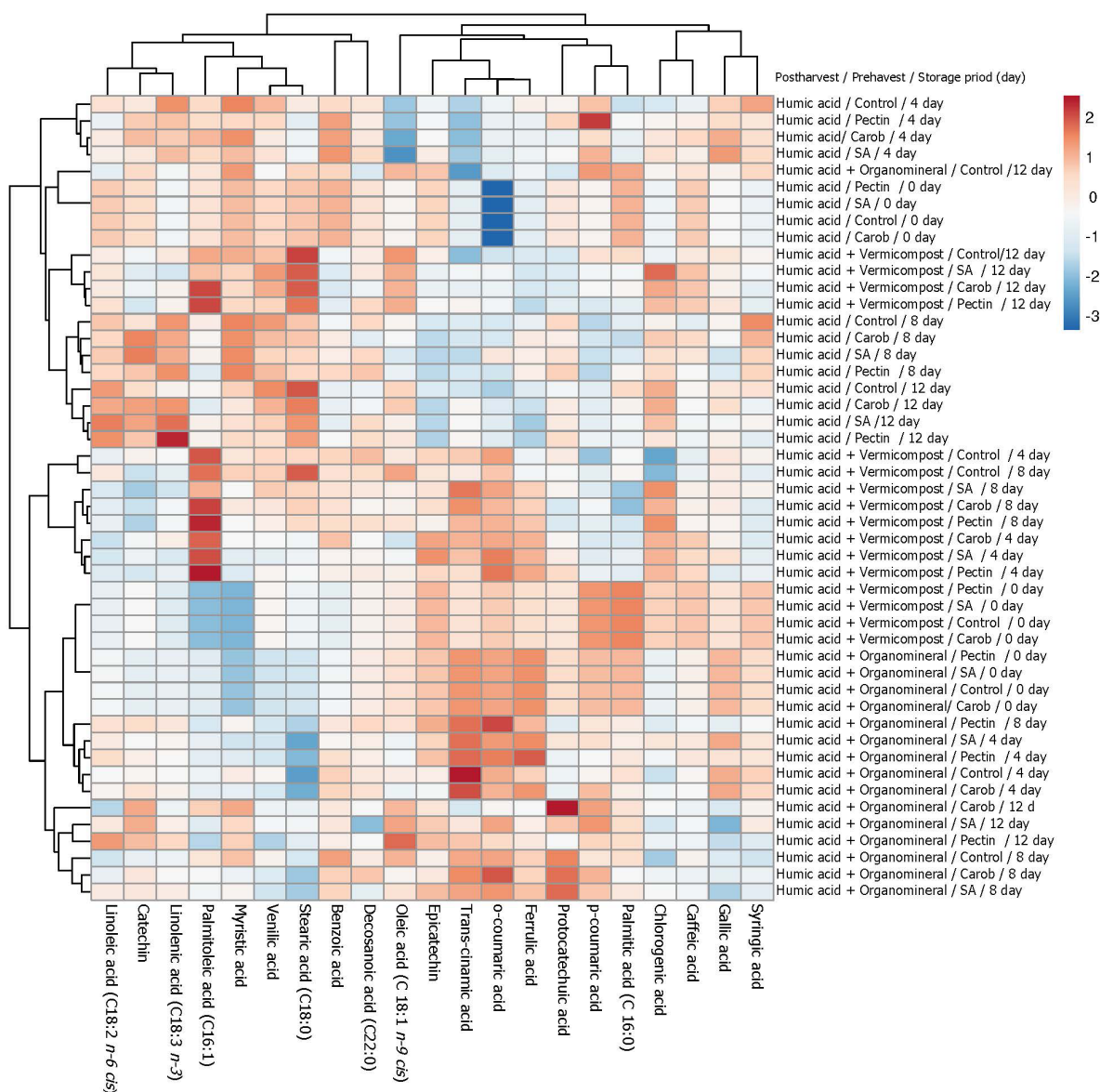


Figure 4. The levels of treatments and analyzed parameters correspond to the color scale. A color gradient from blue to red represents a low level to a high level of the normalized responses.

compounds during storage may be due to deterioration in the cell membrane structure and loss of cell permeability. Similarly, Khodaei and Hamidi-Esfahani (2019) stated that this decreased the phenolic compounds. Temiz (2020) determined that there was a decrease in phenolic compounds in all treatments during the storage period in edible coated strawberries, but a higher value for phenolic compounds was obtained at the end of storage compared to the control group. Karagöz (2018) reported that there was a decrease in phenolic compounds in sliced apples during storage and phenolic compounds were greater in apples coated with sodium alginate at the end of storage than in the control group fruits.

Similar to the current work, postharvest applications of sodium alginate (Chiabrando and Giacalone, 2017), pectin (Panahirad et al., 2020), and carob (Brassesco et al., 2021) were found to impact phenolic content in horticultural crops. Additionally, it was noted that during storage, fruit coated with edible ingredients retained more phenolic content than untreated fruit (Kumar et al., 2020; El-Gioushy et al., 2022; Yilmaz et al., 2023). According to the current study, fruit treated with edible coating materials had better retained phenolic content. This finding supports the theory that coating materials inhibit the activity of enzymes responsible for the breakdown of phenolic compounds like PPO and POD (Shiekh et al., 2021; Guo

et al., 2023). Demir and Demirdöven (2022) treated fresh-cut cv. of Kırkağaç with a 0.5% calcium chloride (CaCl_2) solution. It was then coated with edible film solutions containing 1%, 1.5%, and 2% SA, and packed with polyethylene (30 μm PE) films. They analyzed $\text{O}_2\%$, $\text{CO}_2\%$, total phenolic, antioxidant capacity, pH, water-soluble dry matter, weight loss, texture, and color (L^* , a^* , b^*). As a result, on day 6 of storage, fresh-cut melons coated with sodium alginate had better properties such as antioxidant capacity, water soluble dry matter, weight loss, and O_2 and CO_2 % values. Similarly, in another study, the impact of edible coatings based on alginate, pectin, and gellan on the shelf life of fresh-cut Piel de Sapo melon was examined. It was claimed that wounding stress could be reduced by pectin or alginate. This would prevent the accumulation of total phenolic compounds and other compounds with antioxidant qualities. A pectin-based coating also seems to preserve sensory qualities the best (Oms-Oliu et al., 2008).

In terms of consumer acceptance, fruit aroma is the primary criterion for quality. Different combinations of the fruit's active scent constituents identify different sorts of flavor components. The fruit's physiological characteristics and cultivar are major factors in defining its fragrant nature. An essential component of fruit flavor and taste is metabolites. Sweet and sour sensations are formed in part by primary metabolites, specifically organic acids and sugars (Yilmaz et al., 2023). Because they serve as precursors to volatile chemicals that contribute to fruit scent, fatty acids and amino acids are also associated with fruit quality attributes (Gonda et al., 2010; Pei et al., 2020). Through the regulation of membrane fluidity, unsaturated fatty acids have a significant function in helping plants adapt to many adverse conditions. The primary enzymes in the production of unsaturated fatty acids are fatty acid desaturases (FADs), a class of enzymes that increase membrane unsaturation. Plants' ability to withstand cold will be enhanced when they are exposed to low temperatures because FAD activity will rise (Hernández et al., 2011). Additionally, studies show that FADs can improve plants' ability to withstand cold by controlling unsaturated fatty acids, which increases the fluidity of the cell membrane (Upchurch, 2008).

The most prevalent and significant sources of fruit flavor in climacteric melon are esters generated from fatty and amino acids (Gonda et al., 2016). According to Zhang et al. (2023), chilling damage led to an increase in the quantities of linoleic and linolenic acid in melons following cold storage. In contrast, our study observed a general decrease in fatty acids during storage. According to Baldwin et al. (1999), carnauba wax had no effect on the quantities of aroma volatiles in mango fruit, whereas Natural Seal, a polysaccharide coating based on cellulose, enhanced aroma volatiles in the fruit. Nevertheless, the mango fruit coated with Natural Seal also exhibited considerably greater levels of two off-flavor chemicals, ethanol and

acetaldehyde. Applying several kinds of biopolymers as edible coatings to guava and apricot fruits revealed that dextran and carboxymethylcellulose retained the fruit's water content and scent compound (2-pentanone) better than polyethylene (Quezada Gallo et al., 2003). Likewise, it has been found that coatings based on starch and pectin extend the shelf life and enhance the aroma of Mexican guava (Quezada Gallo et al., 2005). When compared to the untreated fruit, Valencia oranges coated with commercial polysaccharide- or shellac-based coatings showed higher quantities of various aroma volatiles, including ethanol, ethyl butanoate, ethyl acetate, and R-pinene (Baldwin et al., 1999). According to Ma et al. (2021), tannic acid-shellac induces the production of aromatic volatile chemicals. The tannic acid-shellac coating may have a protective effect on aromatic volatile chemicals like fatty acid, as evidenced by the changes in volatile compounds after 12 days of storage.

Unnatural petroleum-based polymers are generally used to protect the postharvest quality and extend the shelf life of fruits and vegetables. These synthetic packages are harmful to the environment and human health. The use of edible film and coating materials is increasing due to their effects such as simple and inexpensive production, being obtained from natural compounds, and preserving the freshness and improving the quality of the product.

5. Conclusion

The present study assessed the effects of postharvest treatments of edible coating materials and fertilizers (humic acid, liquid vermicompost, and organomineral) on fatty and phenolic acids during cold storage. Given that the study was conducted in two parts, the first finding showed that applying humic acid alone led to accumulation of larger concentrations of fatty and phenolic acids in melon fruit than applying humic acid in combination with liquid vermicompost and organomineral fertilizer. Second, regardless of preharvest fertilizer treatments, it was shown that the contents of fatty and phenolic acids in fresh-cut melon were better retained in samples treated with pectin and sodium alginate than with other edible coatings. Considering all these results, it is thought that preharvest humic acid and postharvest pectin or sodium alginate application will be beneficial in terms of meeting the demand for safe and healthy food.

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Data availability statement

The data presented in this study are available on request from the author.

Conflicts of interest

The author declares no conflicts of interest.

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