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Enhancement of sugar content in cantaloupe fruits by hydrogen peroxide treatment

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Abstract
The experiment was accompanied during the two winter seasons of (2019 and 2020) under tunnel conditions at Ismailia Station for Agricultural Researches affiliated to the Agricultural Research Center, Giza, Egypt to evaluated the effect of H_2O_2 at concentrations from 10 to 50 mM on growth and yield parameters as well as fruit sweetness of cantaloupe fruits. The experiment was arranged in a complete randomized design with 3 replicates for each treatment. It found that application 300 ml solution of H_2O_2 to each cantaloupe plant (*Cucumis melo L*. cv. Milagro F1) at different concentrations after one week of fruits set for 3 consecutive weeks increase the plant growth, fruit yield, total soluble sugar content in fruits and improving the fruit quality especially sweetness with increase the concentration. It is propose to treat the plants with hydrogen peroxide solution (50 mM) that could be an agricultural technology applicable to the improvement growth, yield parameters and fruit sweetness.

Keywords: Sugar, cantaloupe, hydrogen peroxide, sweetness, Milagro

Introduction

Cantaloupe plant is a Cucurbitaceae family member and one of Egypt's most significant crops. Cantaloupe is high in antioxidants, phytonutrients, vitamins, and minerals. The sweetness of cantaloupe melons is often recognized as the most essential quality attribute. The implementation of treatments aimed at enhancing photosynthesis, activities of chloroplasts, and cytosolic, as well as the enzymes such as fructose-1, 6-bisphosphatase, sucrose phosphate synthase, and invertases to an augmentation in the levels of fructose, glucose, sucrose, and starch within both leaves and fruits. Moreover, this increase in these sugars contributes to increased sweetness and results in a higher TSS. Certain treatments, including H_2O_2, have been proposed by researchers to potentially improve existing measures, but these treatments are still being investigated. H_2O_2 can have two contrasting effects on plants; it can either worsen damage or indicate the activation of defense responses (Yi *et al*., 2014) [1]. Low quantities of H_2O_2 can operate as signalling molecules, regulating physiological processes such as stomatal opening and shutting and gene activation (Suzuki *et al*., 2012) [2]. H_2O_2 can diffuse quickly through cell membranes (Upadhyaya *et al*., 2007) [3]. A high quantity of H_2O_2 can damage photosynthesis and programmed cell death system (Dat *et al*., 2000) [4]. When the quantity of H_2O_2 is kept normal by a sequence of antioxidant enzymes, it works as a second messenger, coordinating with other essential signal molecules to protect plants from shocks and activate stress tolerance (Li *et al*., 2011). H_2O_2, at levels that are considered beneficial, is involved in controlling plant development, growth, and adaptation to the environment (Quan and others, 2008). It also regulates the expression of various genes related to plant defense, including antioxidant enzymes, defense proteins, and transcription factors (He *et al*., 2009; Abass and Mohamed, 2011) [8]. H2O2 is recognised to be crucial in a variety of physiological activities such as photosynthesis (Noctor and Foyer, 1998) [9], senescence (Peng *et al*., 2005) [10], stomatal movement, and cell growth and development (Deng *et al*., 2012) [11]. Exogenous H_2O_2 treatment at low concentrations induces defence responses in plants against oxidative stressors (Morita *et al*., 1999) [12] and aids in the activation of stress resistance mechanisms (Kumar *et al*., 2010) [13]. Furthermore, (Li *et al*., (2011) [5] reported that exogenous H_2O_2 treatments reduce oxidative stress and endogenous H_2O_2 concentrations in plants and improve plant tolerance to salt stress by increasing the production of enzymatic and nonenzymatic antioxidants that can quench ROS and decrease lipid peroxidation. H_2O_2 treatments increased two cucumber types' osmotic stress tolerance by activating the antioxidant system (Liu *et al*., 2010) [14]. Quan *et al*. (2008) [6] discovered that H_2O_2 has A vital function in the production of salicylic acid. Specifically, they found that H_2O_2 activates an enzyme called benzoic-acid-2 hydroxylase, which converts benzoic acid into salicylic acid. According to López-Delgado *et al*., (2012) [15], the use of H_2O_2 and antioxidants had a beneficial impact on improving potato tubers yield and quality. Ozaki and others, (2009) [16] found that different levels of H_2O_2 (<50 mM) affected photosynthetic activity, sugar metabolizing enzymes, and sugar content in the leaves and fruits of potted plants. They discovered that applying 300 mL of hydrogen peroxide per day to the soil resulted in higher amounts of fructose, glucose, sucrose, and starch in both the leaves and fruits. The use of hydrogen peroxide increased the rate of photosynthesis and the activities of certain enzymes involved in sugar metabolism such as sucrose phosphate synthase, chloroplastic and cytosolic fructose-1, 6-bisphosphatase, and invertases. In a study by Mousa *et al*. (2012) [17], they found that different concentrations of H_2O_2 had a significant impact on the dry matter of potatoes. The results showed that spraying a concentration of 40 mM H_2O_2 resulted in the highest percentage of tuber dry matter compared to other concentrations. This was followed by spraying concentrations of 60 and 20 mM, respectively. According to Khandaker and others, (2012) [18] who applying H_2O_2 externally to tomato plants found an increase on growth, physiological functions, and biochemical characteristics. Orabi *et al*. (2015) [19] discovered that applying H_2O_2 at concentrations of 0.5 mM and 1.0 mM resulted in significant improvements in growth parameters and chlorophyll levels in two varieties of tomatoes. These improvements were attributed to increased levels of growth regulators (GA3, IAA, and ABA) within the plants. Additionally, the treatment led to significantly higher fruit yields and total soluble solids (TSS) in tomato juices. The most effective treatment was found to be at a concentration of 1.0 mM of H_2O_2. According to Orabi *et al*. (2018) [20], the application H_2O_2 enhanced yield and growth parameters, boosted antioxidant enzyme activity in leaves and seeds, and reduced oxidative damage in canola plants grown at various irrigation intervals. Nazir *et al*. (2019) [21] conducted a study on tomato plants and discovered that treating them with hydrogen peroxide improved their growth, photosynthesis, and metabolic state. This treatment also increased the plants' tolerance and ability to cope with copper-induced stress. Mostafa *et al*., (2020) [22] investigated the influence of H_2O_2 on mango growth, development, yield, and fruit quality and discovered that spraying 5 and 20 mM H_2O_2 once a week, two times before anthesis and eight times after anthesis, maximized mango yield, productivity, and fruit quality under field conditions. It is widely recognized that the degree of sweetness is a crucial factor in determining the quality of cantaloupe fruits. Therefore, the purpose of this study was to assess the impact of applying external H_2O_2 to the soil on the sweetness and TSS % content of cantaloupe fruits.

Materials and Methods

1. Experimental procedure

The experiment was conducted at Station of Ismailia for Agricultural Researches, during the 2019 and 2020 winter seasons. The purpose of the experiment was to assess the impact of hydrogen peroxide (H_2O_2) concentrations ranging from 0 to 50 mM on the growth, yield parameters, and fruit sweetness of cantaloupe fruits (Milagro F1). The experiment took place in sandy soil under tunnel conditions. The experiment was set up in a completely randomized block design with three replicates for each treatment. During two subsequent seasons, the seedlings were planted in permanent soil in the first week of January. All of the components essential for plant growth were provided to the plants. After one week of fruit set, 300 ml of H_2O_2 solution was applied to each cantaloupe plant (*Cucumis melo L*. cv. Milagro F1) at (0, 10, 20, 30, 40, and 50 mM) for three weeks. Random plant samples were obtained two weeks after the end treatments to measure various parameters.

1.1 Vegetative growth

Plant height, the number of leaves, leaf area, fresh and dried weights were estimated.

1.1.1 Chlorophyll content

The chlorophyll in the leaf samples was measured using the method developed by Arnon (1949) [23]. Fresh leaves were randomly chosen and crushed in 80% acetone. The resulting mixture was spun in a centrifuge at 5,000 g for 5 minutes. The liquid above the sediment was measured at wavelengths of 663, 645, and 450 nm using a spectrophotometer.

1.2 Crop measurements

The study determined the quantity of fruit/plant, the average weight of the fruit (in grams), the yield of the plant (in grams per plant), the yield of the plot (in kilograms), and the total yield (in tons per fed.).

1.3 Chemical measurements

Total soluble solids (TSS), pH, total acidity (TA), vitamin C, sugars in fruits (sucrose%, glucose%, fructose%, and T. sugar) were assessed, as well as sweetness and color parameters for fruit pulp (L*, a*, b*, Chroma, and Hue angle).

1.3.1Total soluble solids

The Brix degree at 20°C was determined using an Abbe refractometer C10 (USA).

1.3.2 pH

The pH was measured using a Jenway 510 (UK).

1.3.3 Total acidity

The acidity level was measured as the percentage of citric acid using a titration method with 0.1N sodium hydroxide, according to the procedures outlined in the AOAC, (2000) [24] guidelines.

1.3.4 Vitamin C (VC)

The concentration of VC in jam was determined by comparing it to 2,6-Dichlorophenolindophenol and measuring the pink color. The results were reported in milligrams per 100 grams of jam (Ranganna, 2009) [25].

1.3.5 Determination of soluble sugars content

Liquid nitrogen was used to smash fruit samples (200 mg). Soluble sugars content have been separated by boiling in five cm^3 of ethanol 80% for an hour, followed by a 10-minute centrifugation at 10,000 g at 41°C. The procedure was repeated until the extraction was complete. The alcoholic extracts were dried and then dissolved in sterile water so that the levels of fructose, glucose, and sucrose could be measured accurately. The separation of individual sugars in the solution was achieved by utilizing a gradient consisting of two different concentrations of Boric acid–KOH solutions, specifically 0.1 M with a pH of 8.0 and 0.4 M with a pH of 9.0. The Shimadzu HPLC system, including column oven CTO- 10AC VP, column Shim-pack ISA-07/S2504, and fluorescence detector RF-10A XL, was utilized to determine the contents of the separated sugars. The fluorescence detector was set to excite the samples at a wavelength of 350 nm and measure the emitted light at 450 nm.

1.3.6 Total sugar

Total sugars were determined using procedures defined by the AOAC, (2005) [26].

1.3.7 Color assessment

L* (lightness), a* (red to green), and b* (yellow to blue) color characteristics were read using a CR-10 (Konika Minolta reader, Japan). From a* and b* values, the hue angle and chroma were computed.

1.3.8 Sweetness
The sweetness percentage was estimated using the following equation: % sweetness = (% Sucrose*1) + (% Glucose*0.67) + (% Fructose*1.37)

1.4 Statistical analysis
SPSS (version 17) software was used to do an ANOVA analysis at p= 0.05 and the means of treatments were compared.

Results and Discussion
Table 1 displays the influence of varying H_2O_2 concentrations on cantaloupe plant length, leaves number, leaf area, fresh and dry weight. In the second season, there was a noticeable increase plants height when compared to the first season. This remarkable development can influence by H_2O_2, which stimulated the process of cell division, as acknowledged by Hameed *et al*. in 2004 [27]. Another contributing factor to this substantial growth can be attributed to the catalytic properties and the conversion of benzoic acid into salicylic acid by benzoic-acid-2 hydroxylase, as observed by Quan *et al*. in 2008. During both seasons, leaves number was increased at different concentration of H_2O_2 compared to the control group. These leaves contain chloroplasts and chlorophyll pigment, which are essential for the creation of carbohydrates and sugars, which are required for the plant's fast growth and fruit development. Furthermore, increasing the concentration of externally injected H_2O_2 resulted in an increase in leaf area. This suggests that there is a direct relationship between increased leaf area and number of leaves and improved photosynthesis. Furthermore, the rise in H_2O_2 concentration was associated with an increase in both the fresh and dry weight of the plant. The same findings reported by Abass and Mohamed (2011) [8], who discovered that greater external H_2O_2 concentrations boost root development and increase fresh weight. The findings match the findings of Quan *et al*. (2008), who found beneficial effects of H_2O_2 on plant development and growth.

Table 1: The effect of varying H_2O_2 concentrations on plant height, number of leaves, leaf area, fresh and dry of a cantaloupe plant (Milagro F1).

Analysis / Treatments	Plant height (cm)		No. leaves/ plant		leaf area (cm^3)		Fresh weight/ plant (g)		Dry weight/ plant (g)	
	S1	S2	S1	S2	S1	S2	S1	S2	S1	S2
Control	70^f	73^f	122^f	130^f	177.2^f	185.3^f	255^f	265^f	32.9^f	34.7^f
H_2O_2 (10 mM)	89^e	93^e	214^e	233^e	186.8^e	193.4^e	278^e	290^e	36.9^e	39.2^e
H_2O_2 (20 mM)	98^d	101^d	301^d	338^d	191.2^d	197.5^d	298^d	310^d	40.8^d	43.1^d
H_2O_2 (30 mM)	106^c	108^c	343^c	363^c	202.7^c	210.2^c	315^c	333^c	44.4^c	47.5^c
H_2O_2 (40 mM)	110^b	116^b	395^b	413^b	208.4^b	216.9^b	340^b	348^b	49.3^b	51.1^b
H_2O_2 (50 mM)	125^a	133^a	424^a	455^a	214.2^a	221.2^a	360^a	373^a	53.3^a	55.9^a

The different letters inside the same column, show significant changes between the means for different treatments.

According to Orabi *et al*. (2015) [19], the increased growth observed when adding H_2O_2 externally is due to the activation of internal growth regulators such as GA3, IAA, and ABA. Deng *et al*., (2012) [11] have also shown the role of H_2O_2 in cell development and growth. The increase in fresh and dry weight is due to the encouragement of H_2O_2 for photosynthesis and the increase in the formation of starch and various sugars of all kinds, which is reflected in the fresh and dry weight of plants and fruits, and this is consistent with what Ozaki *et al*, 2009 [16] approved. The same outcomes were seen on cucumbers when they were treated with H_2O_2 externally (Goldani *et al*., 2012 [28]; Jiang *et al*., 2012) [29], and the impact was greater when the plants were exposed to light, which stimulated the production of H_2O_2 (Fryer *et al*., 2002) [30].

Table 2: Effect of varying concentrations of H_2O_2 on the levels of chlorophyll a, b, and total chlorophyll in the leaves of a cantaloupe plant (Milagro F1)

Analysis / Treatments	Chl a mg.kg^{-1}		Chl b mg.kg^{-1}		Total Chl mg.kg^{-1}	
	S1	S2	S1	S2	S1	S2
Control	1032^f	1050^f	730^f	755^f	1762^f	1805^f
H_2O_2 (10 mM)	1075^e	1084^e	782^e	791^e	1857^e	1875^e
H_2O_2 (20 mM)	1125^d	1163^d	805^d	835^d	1930^d	1998^d
H_2O_2 (30 mM)	1184^c	1195^c	854^c	873^c	2038^c	2068^c
H_2O_2 (40 mM)	1205^b	1245^b	892^b	899^b	2097^b	2144^b
H_2O_2 (50 mM)	1264^a	1287^a	913^a	933^a	2177^a	2220^a

The different letters inside the same column, show significant changes between the means for different treatments.

Table 2 shows the effects of different H_2O_2 levels on chlorophyll a, b and total chlorophyll in the leaves of cantaloupe plants**.** In the case of chlorophyll a, the addition of hydrogen peroxide led to an increase in chlorophyll levels compared to the control group. In the first season, the treatment with H_2O_2 at a level of 50 mM resulted in the highest chlorophyll a content, measuring 1264 mg/kg. This was higher than the chlorophyll a content of 1032 mg/kg in the control treatment. In the second season, there was an increase in chlorophyll content compared to the first season. The highest concentration of H_2O_2 resulted in the highest amount of chlorophyll a (1287 mg/kg), and this increased as the external H_2O_2 concentration increased. The experiment showed that chlorophyll b behaved similarly in both seasons of agriculture. As the concentration of H_2O_2 increased, so did the concentration of chlorophyll b. Additionally, the second season had higher chlorophyll b content compared to the first season. In terms of the total amount of chlorophyll present, the total content exhibited a noticeable increase as the level of externally added H_2O_2 was raised, reaching its peak at a concentration of 50 mM during both planting seasons. Additionally, the content of chlorophyll was observed to be higher in the second season when compared to the first season. These findings align with the research conducted by Goldani *et al.* (2012) [28], which also demonstrated a higher level of total chlorophyll content of Oregano Plants following treatment with H_2O_2.

Table 3: Effect of varying concentrations of H_2O_2 on different yield parameters in cantaloupe fruits (Milagro F1)

Analysis / Treatments	Number of fruit/plant		Average fruit (g)		Total yield /plant		Total yield /plot		Total yield/fed.(ton)	
	S1	S2	S1	S2	S1	S2	S1	S2	S1	S2
Control	2.6^f	3.2^f	450^f	580^f	1.17^f	1.86^f	23.4^f	37.1^f	9.83^f	15.59^f
H_2O_2 (10 mM)	3.4^e	3.6^e	760^e	820^e	2.58^e	2.95^e	51.7^e	59.0^e	21.71^e	24.80^e
H_2O_2 (20 mM)	4.2^d	4.4^d	1390^d	1470^d	5.84^d	6.47^d	116.8^d	129.4^d	49.04^d	54.33^d
H_2O_2 (30 mM)	4.8^c	5.1^c	1580^c	1650^c	7.58^c	8.42^c	151.7^c	168.3^c	63.71^c	70.69^c
H_2O_2 (40 mM)	5.4^b	5.6^b	1730^b	1850^b	9.34^b	10.36^b	186.8^b	207.2^b	78.47^b	87.02^b
H_2O_2 (50 mM)	6.2^a	6.7^a	1900^a	2000^a	11.78^a	13.40^a	235.6^a	268.0^a	98.95^a	112.56^a

The different letters inside the same column, show significant changes between the means for different treatments.

Table 3 displays the impact of varying concentrations of external H_2O_2 on several crucial factors, including the fruits number for plant, the average weight of the fruits, the total yield of the plants, the yield per plot, and the total yield per fed. The fruits number for one plant increased as the concentration of H_2O_2 increased compared to the control. The treatment with a concentration of 50 mM had the highest fruits number for plant during both planting seasons, with 6.2 and 6.7 fruits per plant respectively. The second season had more fruit numbers than the first season, which will lead to a higher total yield. Additionally, the average weight of the fruits increased significantly when a higher concentration of H_2O_2 was used during both planting seasons. The weight of fruits increased more in the second growing season compared to the first. The highest weight recorded was 2 kg per fruit in the second season when using a level of 50 mM of H_2O_2, while the lowest weight recorded in the first season for the control treatment was 450 g. These findings indicate a significant difference in fruit weight when different concentrations of externally applied H_2O_2 are used on the plant. Increasing the plant fruits number and the average weight for fruit by increasing the concentration of H_2O_2 has resulted in an increase in the total yield per plant. This increase in yield is evident in both the yield of experimental plots and the yield of the fed., as indicated in Table 3. Overall, the rise was proportionate to the rise in H_2O_2 concentration. Finally, it is clear how important H2O2 is for enhancing growth and yield measurements; these findings are consistent with (Vural *et al*., 2000 [31]; Orabi *et al*., 2015) [19], who discovered that H_2O_2 treatment significantly improves growth measurements by increasing internal growth regulators (GA3, IAA, and ABA) as well as increasing plant fruit yield in tomatoes. He *et al*. (2009) [7] discovered that H_2O_2 treatment increases photosynthesis in wheat plants.

Table 4: Effect of varying concentrations of H_2O_2 on moisture, brix, pH, total acidity, Brix/TA, vitamin C and total phenolic of fruits cantaloupe plant (Milagro F1)

Analysis / Treatments	Moisture		Brix		pH		T. acidity (TA)		Brix/TA		Vitamin C (mg/100g)		T. phenolic (mg/100g)	
	S1	S2	S1	S2	S1	S2	S1	S2	S1	S2	S1	S2	S1	S2
Control	85.6^a	85.2^a	13.3^f	13.7^f	6.23^f	6.27^f	0.82^a	0.79^a	16.22^f	17.34^f	16.5^f	18.7^f	52.2^f	57.4^f
H_2O_2 (10 mM)	84.2^b	83.9^b	14.5^e	14.8^e	6.32^e	6.35^e	0.76^b	0.72^b	19.08^e	20.56^e	20.1^e	23.6^e	60.8^e	62.5^e
H_2O_2 (20 mM)	83.2^c	83^c	15.2^d	15.4^d	6.39^d	6.42^d	0.7^c	0.68^c	21.71^d	22.65^d	27.2^d	29.8^d	64.8^d	70.3^d
H_2O_2 (30 mM)	82.6^d	82.4^d	15.6^c	15.8^c	6.47^c	6.51^c	0.66^d	0.62^d	23.64^c	25.48^c	32.9^c	36.5^c	71.6^c	72.4^c
H_2O_2 (40 mM)	82.1^e	82^e	16.0^b	16.1^b	6.55^b	6.58^b	0.59^e	0.56^e	27.12^b	28.75^b	42.8^b	48.9^b	74.1^b	76.3^b
H_2O_2 (50 mM)	81.3^f	81^f	16.5^a	16.8^a	6.63^a	6.69^a	0.53^f	0.51^f	31.13^a	32.94^a	55.7^a	62.1^a	77.1^a	78.6^a

The different letters inside the same column, show significant changes between the means for different treatments.

Table 4 shows the influence of various concentrations of hydrogen peroxide externally applied to the cantaloupe plant on the various qualitative criteria of cantaloupe fruits. In terms of moisture, it is noticed that the level of moisture of fruits treated with H_2O_2 compared to controls reduced during the two growing seasons; moreover, the drop was greater in the second season compared to the first. The drop in moisture content was also accompanied by an increase in the amount of H_2O_2 utilised, with the level of (50 mM) recording the lowest level of moisture for the two planting seasons, with values of (81.3 and 81%) for the first and second seasons, respectively. In terms of total soluble solids (Brix), there is a significant increase in Brix value in fruits extremely treated with H_2O_2 compared to controls, and Brix% increased with increasing the concentration of H_2O_2 used externally, as seen at the level (50 mM) which recorded (16.5%) in the second season compared to (16.8%) in the second season. The similar result was reached by Vural *et al*., (2000) [31] and Orabi *et al*., (2015) [19] on tomatoes as a result of activated endogenous hormones or increased photosynthetic rate as reported by He *et al*. (2009). The control treatment had the greatest acidity over the two seasons of cultivation, with a degree of decline in the second season compared to the first season (0.79 and 0.82%, respectively). The acidity decreased more as the concentration of H_2O_2 grew, while the sweetness of the fruits increased owing to the absence of acidity, which restricts the sugar taste. The Brix/TA scale is an excellent indicator that represents the degree of maturity as well as the degree of sweetness, which increases as the value of this scale increases. The results reveal that raising the concentration of H_2O_2 utilized increases the degree of sweetness, and consequently the quality of the fruits. The results also reveal a rise in the content of vitamin C fruits throughout the two planting seasons by increasing the concentration of H_2O_2 utilized, with values ranging between (55.7 and 62.1 mg 100g) for both the first and second seasons. Also, over the two growing seasons, the same rise in total phenolic content occurred with an increase in H_2O_2 concentration, and the content was greater in the second growing season compared to the first.

Table 5: Effect of varying concentrations of H_2O_2 on different soluble sugar and TSS in cantaloupe fruits (Milagro F1).

Treatments \ Analysis	Sucrose%		Glucose%		Fructose%		T. Sugar		Sweetness%		TSS%	
	S1	S2	S1	S2	S1	S2	S1	S2	S1	S2	S1	S2
Control	43^f	46^f	13^a	15^a	12.60^f	13.2^f	68.6^f	74.2^f	68.7^f	73.8^f	9.3^f	9.9^f
H2O2 (10 mM)	52^e	55^e	12.2^b	13.4^b	16.7^e	18.3^e	80.9^e	86.7^e	82.7^e	88.6^e	10.4^e	10.8^e
H2O2 (20 mM)	58^d	61^d	11.1^c	12.4^c	17.3^d	19.6^d	86.4^d	93.0^d	88.7^d	95.7^d	11.2^d	11.6^d
H2O2 (30 mM)	64^c	66^c	10.4^d	10.8^d	21.3^c	23.1^c	95.7^c	99.9^c	99.7^c	104.4^c	12.3^c	12.8^c
H2O2 (40 mM)	66^b	67^b	8.3^e	8.8^e	23.8^b	24.2^b	98.1^b	100^b	103.6^b	105.5^b	13.2^b	13.7^b
H2O2 (50 mM)	68^a	69^a	4.1^f	4.3^f	25.2^a	26.5^a	97.3^a	99.8^a	104.7^a	107.6^a	13.9^a	14.3^a

The different letters inside the same column, show significant changes between the means for different treatments. Sweetness % = (% Sucrose*1) + (% Glucose*0.67) + (% Fructose*1.37)

The effect of various concentrations of H_2O_2 externally supplied to the cantaloupe plant on the level of different sugars in cantaloupe fruits is shown in Table 5. Sucrose content in fruits increased utilizing H_2O_2 compared to control over the two growing seasons, with the sucrose content increasing higher in the second season compared to the first. The sucrose content increased as the concentration of H_2O_2 utilized increased, with the maximum sucrose content recorded at the highest level of H_2O_2 (50 mM) throughout the planting seasons by (68 and 69%) for the first and second seasons, respectively. Sucrose sugar is a standard sugar (100% sweetness), the other sugars' sweetness is assessed based on it. When it comes to the percentage of glucose in fruits, it has been observed that there is a noteworthy reduction in glucose levels when H_2O_2 is applied compared to the control. The concentration of H_2O_2 used externally has a direct impact on the decrease in glucose percentage, with the most significant decrease occurring at a concentration of 50 mM. In the first season, there was a decrease of 4.1% in glucose percentage, while in the second season, the decrease was slightly higher at 4.3%, indicating a relatively higher glucose content compared to the first season. It is worth noting that glucose is responsible for approximately 67% of the sweetness found in sucrose. As for fructose sugar, which is considered one of the most sugars in the sweet taste, where the sweetness of 137% as much as the sweetness of sucrose. The highest value was recorded during the two planting seasons at the level of H_2O_2 (50 mM) and the sugar content increased with an increase in the concentration of H_2O_2 used compared to the control with an increase in the second season compared to the first season. By monitoring the findings of both sweetness% and TSS%, it is clear that raising the concentration of H_2O_2 has a substantial influence on increasing the degree of sweetness in fruits. This might be due activate sugars metabolic enzymes responsible for the manufacture of sucrose, glucose, and fructose in melon leaves. According to Ozaki *et al*., (2009) [16], exogenously supplied hydrogen peroxide (5-50 mM) increased photosynthetic activity in melon leaves, and they explain this effect as hydrogen peroxide's ability to activate the Calvin cycle and sugar metabolism by encouraging nutrient absorption through roots. They also observed that using H_2O_2 might improve the soluble sugar content of melon fruits. Orabi *et al*. (2015) [19] discovered that higher invertase activity boosted sucrose synthesis by increasing photosynthetic by treated plant leaves with H_2O_2. Furthermore, cytosolic fructose-1,6-bisphosphatase and sucrose phosphate synthase activity increased more than invertase activity. They also stated that increasing invertase activities might elevate not only sucrose levels, but also glucose and fructose levels in melon plant leaves and fruits.

Table 6: Effect of varying concentrations of H_2O_2 on color parameters of cantaloupe fruits (Milagro F1).

Treatments \ Analysis	L*		a*		b*		Chroma		Hue angle	
	S1	S2	S1	S2	S1	S2	S1	S2	S1	S2
Control	78.1^a	77.4^a	-12.3^f	-12.1^f	12.6^f	12.9^f	17.6^f	17.7^f	-45.7^a	-46.8^a
H_2O_2 (10 mM)	77.1^b	76.4^b	-11.7^e	-11.4^e	13.4^e	13.9^e	17.8^e	18.0^e	-48.9^b	-50.6^b
H_2O_2 (20 mM)	74.6^c	73.9^c	-11^d	-10.6^d	14.6^d	15.7^d	18.3^d	18.9^d	-53.0^c	-56.0^c
H_2O_2 (30 mM)	73.2^d	72.1^d	-10.2^c	-9.6^c	16.4^c	17.1^c	19.3^c	19.6^c	-58.1^d	-60.7^d
H_2O_2 (40 mM)	71.5^e	69.3^e	-8.2^b	-7.8^b	17.4^b	17.9^b	19.2^b	19.5^b	-64.8^e	-66.5^e
H_2O_2 (50 mM)	68.4^f	67.6^f	-5.3^a	-4.1^a	18.7^a	19.5^a	19.4^a	19.9^a	-74.2^f	-78.1^f

The different letters inside the same column, show significant changes between the means for different treatments.

The effect of various concentrations of H_2O_2 externally supplied to the cantaloupe plant on several color characteristics of the cantaloupe pulp is shown in. In terms of the L* value, which measures the degree of transparency of the color of the pulp of the fruits, the results show that the fruits treated with H_2O_2 had less transparency than the control. Also, increasing the concentration of H_2O_2 during the two growing seasons resulted in a decrease in transparency, which could be attributed to the acceleration of the degree of settlement with the increase in sugar formation mentioned earlier, as well as enzymatic reactions leading to sweetness increase. The increase in a* value with increasing H_2O_2 concentration is due to the decrease in green pulp color with increasing concentration used to accelerate maturation and increase the formation of yellow color at the expense of green color with increasing maturity, which was accelerated by increasing the concentration of H_2O_2 used. Concerning the values of b*, which reflect the yellow color, it is noticed that as the concentration of H_2O_2 utilized increased the yellow color increased, as the level (50 mM) recorded the maximum yellow color content of the fruit pulp, as evidenced by the Hue angle findings. Regarding the color clarity, which chroma indicates, it is worth noting that the color clarity has improved as the concentration of H_2O_2 applied increased. The results show that a high concentration of H_2O_2 has a positive influence on the color quality of the pulp of the producing cantaloupe fruits.

Conclusion

It found that application 300 ml solution of H_2O_2 (10 mM to 50 mM) to each cantaloupe plant (*Cucumis melo L*. cv. Milagro F1) at different concentrations after one week of fruit set for 3 consecutive weeks increase the plant growth, fruit yield, total soluble sugar content in fruits and improving the fruit quality especially sweetness with increase the concentration. So, it is propose to treat the plants with H_2O_2 solution (50 mM) that could be an agricultural technology applicable to the improvement growth, yield parameters and fruit sweetness.

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