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Quality Properties and Reduction of Microbial Infection of Various Watermelon Fresh-Cut Shapes in Response to: 1-Methyl Cyclopropene and Calcium Chloride.

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ABSTRACT

This study was conducted on watermelon in El-Mansoura Research Station during the summer seasons of 2014 and 2015. Two potential compounds of 1-methylcyclopropene (1-MCP) at 0.5% (full fruits), calcium chloride ($CaCl_2$) at 1.5% (fresh cut) and dual application as well as untreated control in combination with three cutting shapes (slices, triangle with rind and cubes without rind) were evaluated to increase quality, reduce weight loss and microbial count efficiency under cold storage period**.**The combined application of 1-MCP and $CaCl_2$ with slices (9 days after storage, DAS) exhibited significant positive effect on total (TSS, lycopene, sugars and aldehydes). Also, this treatment enhanced color, taste and texture and reduced weight loss, juice leakage, total alcohols and the bacterial counts followed by triangle with rind (6 DAS) and cubes without rind (3 DAS) compared to the control and separate treatments under cold storage at 4°C and 98% RH. This is turns reflecting on quality, storability and visual characters. Conclusively, treated fruits with 1- MCP at 0.5% and dipped slides with rind in solution of $CaCl_2$ at 1.5% for keeping, storing and reduce microbial infection of watermelon fresh-cut for 9 days at 4°C/98% RH in retail markets.
Keywords: Watermelon; fresh-cut; MCP; calcium chloride; cold storage

INTRODUCTION

Watermelon (*Citrullus lanatus* Thunb. Mansfeld) is one of the important horticultural crops belonging to the family Cucurbitaceae. Today, watermelon fruits are mainly enjoyed fresh cut due to their sweet and refreshing taste (Abker *et al*., 2016). Red flesh watermelon fruits are rich in lycopene (40 % higher than tomato), volatile compound, ascorbic acid, flavonoids, and phenolic antioxidants and seeds contain iron and zinc with large quantities (Perkins-Veazie *et al*., 2001). Recently, watermelon fresh cut estimates about 10% of total sales of watermelon (National Watermelon Promotion Board, 2002). Now day, the available information of aroma compounds (alcohols, aldehydes, phenols, ethers and other heterocyclic) and flavor has been increased because they are concerning to quality properties. The aroma compounds are considered advantageous preferred by consumers, yet they are sensitive to any variation in their chemical composition. Fresh-cut products are known as vegetables or fruits that have been related to biochemical changes while maintaining the fresh cut properties as well as the nutritional quality and microbial infection safety (Kim *et al*., 1999). Light processing stages include selection, sanitation, peeling, and slicing. All stages are aimed to the final products with good quality. The cutting operation caused injury not only increases the respiration rate and ethylene production, but also causes increases in other biochemical reactions that responsible for changes in color, flavor, aroma compounds, texture and nutritional quality (Brech, 1995). Fresh cut products with high quality include fresh regular appearance, acceptable texture, flavor and aroma (Moretti, 2004).

Watermelon Fresh cut is sold as halves and quarters slices with rind, or as cubes without rind. Quality degradation of watermelon fresh cut included weight and texture losses, color retention and total sugar content. Adverse characteristics particular to fresh-cut watermelon are the pronounced juice leakage incurred with storage and the pronounced vulnerability of the product to mechanical damage. Both factors render the product aesthetically unattractive; encourage microbial growth and limit of its shelf-life (Rushing *et al*., 2001). Petrou *et al.* (2013) found that the presence of rind improved the storage stability of watermelon slices and presents an advantageous way of marketing fresh-cut watermelon slices stored at 4°C for 9 days.

Using some chemicals that prevent biochemical reactions responsible for color changes, volatile compounds of aroma, texture and nutritional quality may be preferred in this subject. Treatments of packaged fresh cut products with 1-MCP at low dosage prevent ethylene production of watermelons and aroma volatile compounds linked with flavor but not the off odors and off flavor that might develop during the cold storage at 5°C. Prolongation the time from harvest to application of 1-MCP significant decrease in total aromatic volatile compounds and alcohol concentrations in tissue extracts from watermelon fresh cut (Saftnera *et al*., 2007). Application of 1-Methyl cyclopropene at low dosage, an effective inhibitor of ethylene action, maintains the quality characteristics and prolongs shelf life of many vegetables and fruits, especially climacteric fruits, but can also inhibit aromatic volatile production that give a share in the flavor (and aroma) of the fruits (Blankenship and Dole, 2003). Recently, 1-MCP maintains the firmness of whole watermelon fruits stored in the presence or absence of ethylene (Mao *et al*., 2004; Bernardino *et al*., 2016), but is not able to keep the firmness or prolong the shelf life of fresh cut pieces stored at 10°C (Mao *et al*., 2006). While whole melons and watermelons that stored below 10°C may develop rind and flesh damage, and more sensitive to chilling injury than the products of fresh cut (Beaulieu and Gorny, 2001). Storing fruits on temperature degree near zero provide shelf life by controlling the growth of bacteria. Watermelon fresh cut was stored with quality stability for 10 days at 1–3°C under modified atmosphere (MA) conditions (Fonseca *et al*., 2004). Application of 1-MCP can inhibit the growth of microbes (bacteria) of watermelon full fruit and slices (Mao *et al*., 2004). Among postharvest applications, dipping fruits in $CaCl_2$ caused shelf life increasing especially in fresh-cut products by preventing firmness loss and maintaining physical quality (Gupta *et al*., 2011). Dual application of 1-MCP and $CaCl_2$ reduced softening, respiration rates, tissue degradation and bacterial growth as compared to the control, which had a 6-day shelf life. In strawberries fresh cut related to the combination treatment, the shelf life was extended to 9^{th} day from storage at 5°C (Aguayo *et al*., 2006). In fresh-cut of carrot calcium application enhanced tissue resistance to microbial attack by stabilizing or strengthening cell walls thereby making them more resistant to pectin hydrolysis enzymes produced by microbes (Izumi and Watada, 1994).

The objective of this research is to evaluate the potential effect of 1-methyl cyclopropene, calcium chloride alone or together, cutting shapes and their interaction on quality properties, physical appearance and reduction of microbial infection of watermelon fresh-cut during cold storage in 4^oC and 98% RH for 9 days.

MATERIALS AND METHODS

Plant materials and storage conditions

Watermelon fruits (*Citrullus lanatus* Thunb. Mansfeld, cv. Giza 1) were harvested at the maturity stage in the field of Gamasa district on 15^{th} of July of 2014 and 2015 seasons, and immediately transported to the laboratory of El-Mansoura Horticulture Research Station, Dakahlia Governorate, Egypt. Undamaged watermelon fruits were chosen with uniformity size and were stored at room temperature (35^oC) until used.

1-Methyl cyclopropene (1-MCP)

At 7^{th} day after harvest, eighteen uniformly watermelon fruits were set, each weighed about 8 kg were treated with 0.5% 1-MCP according to the method described in details by Mao *et al*. (2004) using a 0.14% fine powder formula of Smart Fresh® (Agro Fresh Inc., PA, USA). The only adjustment of this technique that 1-MCP was used by fogging machine (model C20 ULV, Korea) under plastic cover (50 micron thickness) for 24 hours at 35^oC or left untreated.

Calcium chloride ($CaCl_2$)

Calcium chloride dehydrated ($CaCl_2.2H_2O$, 98.0%; M.W. =147.02) was obtained from SDDCL (SD Fine-Chem. Limited), Mumbai, India. Treatment group was rinsed with autoclaved 1.5% $CaCl_2$ for 2 seconds, and fresh-cut dipped in the solution for 2 minutes.

Light processing of watermelons

Watermelons were washed by tap water and dipped in 0.01% Na-hypochlorite with pH 6.0 for 1-minute. With the sharp sterilize custom melor slicer rustproof stainless steel blade with centre cutout for easy (Fig. 1), the slicer cut 12 uniform slices suitable for all types of watermelons. The slices were placed (2 per container) in 20×15×3 cm foam trays (Diamond, Egypt). Slices with rind cut into six uniform triangle and slices without rind cut into 16 equal-shaped cubes. All fresh-cut treatments wrapped with stretch. The packaged slices, triangle and cubes were stored at 4^oC and 98% RH for subsequent evaluation. A completely randomized design was used. The experiments consist of 12 treatments, which in a combination with three cutting shapes and four treatments (control, $CaCl_2$, MCP and $CaCl_2$+MCP). Six fruits without treatments cut into slices, triangle and cubes of watermelon as the control treatments. $CaCl_2$, 1-MCP and $CaCl_2$+1-MCP-treated watermelons were used as subsets. Each experimental unit consists of 3 trays, each tray contains 2 slides about (1.333kg) or 6 triangle with rind about (1.333 kg) or 16 cubes without rind about (550 g).

Fig.1. melor slicer cutting of watermelon fruits

Data and measurements

Watermelon fresh cut from each treatment (T) were weighed separately before and each storage intervals (3 days) and the percentage of weight loss was calculated using the following formula:

Total weight loss (%) = [(initial weight of T - final weight of T per time) / initial weight of T ×100 (1)

Juice leakage percentage was estimated by weight after each storage period, using the equation by:

Percent juice leakage(%) = [((container + Juice wt.) - container wt.)/(container +fruit wt.)-container wt.)]×100 (2)

Total soluble solid (TSS) from fruit juice was measured by a digital refractometer (PAL-1, Atago, Tokyo, Japan). The units of TSS were expressed as a percentage.

Total lycopene, total sugars and total alcohols and aldehydes in flesh weight homogenate samples were determined as described by Fish and Davis (2003), AOAC (2000) and Dima *et al*. (2014), respectively.

At the end of storing period, all quality evaluation procedures were performed at ≈35 °C. A panel of ten judges scores the visual quality (taste and texture). The scores of fresh cut were based on a 9-point hedonic scale, where 9 excellent; 7 very good; 5 good (limit of marketability); 3 fair (limit of usability); and 1 poor (unusable). The color scores were, 9-darken red, 7-red, 5- rose, 3-light, and 1-very light (Wright and Kader1997; Agar *et al*., 1999).

Bacterial Enumeration:

The number of bacterial cells in the control and treated samples were determined using the pour plate technique; 1 g from the fresh-cut samples were transferred to a tube containing 9 ml sterile water and macerated gently then left five minutes to settle, double fold serial dilution was done to the specimen in test tubes containing in each 9 ml sterile water, 0.5 ml from dilutions 10^{-2} , 10^{-4} and 10^{-6} were transferred to labeled empty sterile petri dishes, then melted nutrient agar (NA) at 45˚C was poured in the petri dishes, the dishes were gently swirled to mix the specimen with NA which then allowed to gel before incubation at 28˚C for 48 h, after incubation the grown colonies in the dishes were counted (Marshall, 1992). To determine number of bacterial cells which referred as colony forming units (CFU) in the specimen the following equation was applied:

CFU / g = 2 x CFU/ plate x dilution factor (Lorenz *et al*., 1982)

Nutrient agar (NA) medium (pH=7.2-7.4) consists of beef extract (Lab-Lemco, 1.0 g), yeast extract (2.0 g), peptone (5.0 g), NaCl (5.0 g), Agar (oxoid No. 3, 20.0 g) and finally, distilled water (1000 ml).

Statistical Analysis:

Data were analyzed using analysis of variance technique (type: 2 way completely randomized) and the differences of treatment means were compared using Duncan multiple range test at 5% by Costat Ink program (Version 6.400, CA, 93940, USA).

RESULTS AND DISCUSSION

Effect of interaction on weight loss

The interaction effect between potential compounds ($CaCl_2$, 1-MCP and $CaCl_2$+1-MCP) and cutting methods (slices, triangle with rind and cubes without rind) of watermelon fresh cut, had significant differences on weight loss%, during different storage periods at 4°C (Table 1). Slices with rind and $CaCl_2$+1-MCP treatment exhibited significant reduction on weight loss at different storage periods compared with controls and other treatments (Fig. 2), followed by slices with rind + $CaCl_2$, slices with rind + 1-MCP, triangle with rind + 1-MCP and triangle with rind + $CaCl_2$+1-MCP (Fig. 3), cubes with treated of $CaCl_2$+1-MCP (Fig. 4) in both seasons, respectively. Higher weight loss was observed in control treatments than $CaCl_2$/1-MCP combined treatments of watermelon fresh cut. This may be related to higher water evaporation as a result of cutting and increase juice leakage.

Fig.2. Slices with rind and $CaCl_2$+1-MCP

Fig.3. Triangle with rind + $CaCl_2$ + 1-MCP

Fig.4 $CaCl_2$+1-MCP with cubes no rind

Effect of cutting shapes on weight loss

Slices with rind of watermelon fresh cut had significant reduction in weight loss followed by triangle with rind and cubes without rind after 3, 6 and 9 days storage at 4°C in both seasons, respectively (Table 1). This could be due to evaporation and concentration of water during storage.

Effect of $CaCl_2$ and 1-MCP on weight loss

$CaCl_2$, 1-MCP and $CaCl_2$+1-MCP treatments greatly suppressed the incidence of weight loss compared to the control (Table 1). Fresh cut of watermelon treated with $CaCl_2$+1-MCP had significant decrease on weight loss, followed by $CaCl_2$ after 3, 6 and 9 days storage at 4°C in both seasons. The higher loss of water quantity may effects on tissue destructive, loss of visual quality, and in change of texture.

Effect of interaction on juice leakage

Untreated cubes without rind of watermelon fresh cut had higher significant of juice leakage values at 3, 6 and 9 days as compared with untreated slices and triangle with rind in both seasons (Table 2). 1-MCP-treated fruit at 0.5% provided with $CaCl_2$ (1.5%) dip fresh-cut tissue ($CaCl_2$+1-MCP) slightly decreased the percent of juice leakage percentage at 3 days as compared with zero time and other interaction treatments and decreased through 6 and 9 days in the two seasons (Table 2). The treatments in Table 2 illustrate that the tissue structure of fresh cut controls in the initial and the end of the storage period. In the initial time of the storage period, a high concentration of liquid was observed among the cells in the tissue structure, as indicated by the turgid and tender appearance of the fresh cut products. At the end of the storage period, the changes in the tissue structure may be due to mass loss and release of liquid caused by cell decompartmentalization (Beaulieu and Gorny, 2001).

Lower juice leakage in Ca treated could be due to the increased in Ca^{2+} concentration which resulted from the application of $CaCl_2$. This was also true between the combinations of $CaCl_2$ with 1-MCP. Results proved that $CaCl_2$ provided firming effect, retarding tissue softening (Mao *et al*., 2004).

Table 1. Weight loss (%) in fresh cut watermelon as affected by 1-methyl cyclopropene and calcium chloride at zero time*during different storage periods at 4°C in 2014 and 2015 seasons.

Treatments/	Days of storage	3		6		9	
	Seasons	2014	2015	2014	2015	2014	2015
Slices with rind	Control	8.00 a	6.00 a	7.44 c	8.64 c	10.53 c	11.37 b
	$CaCl_2$	0.00 f	0.00 f	0.51 h	0.55 gh	0.92 gh	0.87 fg
	1-MCP	0.00 f	0.00 f	0.39 h	0.39 h	0.75 hi	0.69 gh
	$CaCl_2$+ 1-MCP	0.00 f	0.00 f	0.00 h	0.00 h	0.12 i	0.11 h
Triangle with rind	Control	7.00 b	7.33 b	9.82 b	10.33 b	11.40 b	11.90 b
	$CaCl_2$	0.00 f	0.00 f	1.19 g	1.17 g	1.62 g	1.60 f
	1-MCP	0.00 f	0.00 f	1.23 g	1.24 g	1.42 gh	1.38 fg
	$CaCl_2$+ 1-MCP	0.00 f	0.00 f	0.00 h	0.00 h	0.94 gh	1.25 fg
cubbies without rind	Control	5.00 c	9.33 a	12.26 a	12.99 a	16.52 a	16.96 a
	$CaCl_2$	1.28 e	0.00 f	3.53 e	3.38 e	4.59 e	4.57 d
	1-MCP	2.45 d	2.24 d	5.14 d	5.22 d	6.08 d	5.87 c
	$CaCl_2$ + 1-MCP	0.00 f	1.20 e	2.61 f	2.61 f	3.48 f	3.47 e
Slices		1.25 c	1.50 c	2.08 c	2.39 c	3.08 c	3.26 c
Triangle		1.75 b	1.83 b	3.06 b	3.19 b	3.85 b	4.03 b
Cubbies		2.93 a	3.19 a	5.87 a	6.05 a	7.67 a	7.72 a
	Control	6.67 a	7.56 a	9.84 a	10.66 a	12.82 a	13.41 a
	$CaCl_2$	0.43 b	0.00 c	2.25 b	2.28 b	2.75 b	2.35 b
	1-MCP	0.82 b	0.78 b	1.74 b	1.70 c	2.38 b	2.69 b
	$CaCl_2$ + 1-MCP	0.00 b	0.40 bc	0.87 c	0.87 d	1.52 c	1.61 c

Means of each column for every separate factor and interaction followed with the same letters are not significantly different according to Duncan multiple range test at the probability of 0.05 levels *Zero time (2014 season) = 0.00 % *Zero time (2015 season) = 0.00 %

Table 2. Juice Leakage (%) in fresh cut watermelon as affected by 1-methyl cyclopropene and calcium chloride at zero time*during different storage periods at 4°C in 2014 and 2015 seasons.

Treatments/	Days of storage	3		6		9	
	Seasons	2014	2015	2014	2015	2014	2015
Slices with rind	Control	2.56 c	2.71 b	3.23 ab	3.27 a	3.30 ab	3.32 ab
	$CaCl_2$	0.64 g	0.62 e	0.63 e	0.64 d	0.497 d	0.48 d
	1-MCP	0.27 h	0.24 ef	0.26 f	0.25 de	0.247 d	0.23 d
	$Cacl_2$+ 1-MCP	0.11 h	0.11 f	0.07 f	0.146 e	0.096 d	0.126 d
Triangle with rind	Control	2.96 b	2.98 b	2.89 b	2.95 b	2.96 b	2.99 b
	$CaCl_2$	1.27 ef	1.24 cd	1.23 cd	1.24 c	1.13 c	1.18 c
	1-MCP	1.74 d	1.66 c	1.61 c	1.58 c	1.47 c	1.39 c
	$CaCl_2$+ 1-MCP	1.18 f	1.12 d	1.15 d	1.13 c	1.13 c	1.12 c
cubbies without rind	Control	3.55 a	3.58 a	3.44 a	3.79 b	3.50 a	3.66 a
	$CaCl_2$	1.28 ef	1.23 cd	1.38 cd	1.36 c	1.45 c	1.41 c
	1-MCP	1.49 de	1.41 cd	1.31 cd	1.30 c	1.35 c	1.30 c
	$CaCl_2$ + 1-MCP	1.42 ef	1.35 cd	1.45 cd	1.33 c	1.54 c	1.47 c
slices		0.90 c	0.92 c	1.05 b	1.08 b	1.04 c	1.05 c
triangle		1.79 b	1.75 b	1.72 a	1.72 a	1.68 b	1.67 b
Cubbies		1.94 a	1.89 a	1.90 a	1.95 a	1.96 a	1.96 a
	Control	3.02 a	3.09 a	3.19 a	3.33 a	3.25 a	3.33 a
	$CaCl_2$	1.17 b	1.03 b	1.08 b	1.07 b	1.03 b	1.02 b
	1-MCP	1.07 b	1.10 b	1.06 b	1.04 b	1.02 b	0.97 b
	$CaCl_2$ + 1-MCP	0.90 b	0.86 b	0.89 b	0.87 b	0.92 b	0.91 b

Means of each column for every separate factor and interaction followed with the same letters are not significantly different according to Duncan multiple range test at the probability of 0.05 levels *Zero time (2014 season) = 0.00 % *Zero time (2015 season) = 0.00 %

Effect of cutting shapes on juice leakage

Watermelon fresh cut of slices with rind had a significant effect on juice leakage. Juice leakage was recorded a minimum values for slices with rind than for triangle with rind and cubes without rind (Table 2). The higher leakage noticed in cubes without rind. This may be due to the greater cut surface injury happened with processing (Rushing *et al*., 2001).

Juice leakage tended to stabilize after the first 3 days of storage. At the end of storage, juice leakage from slices with rind and cubes without rind reached 1.04% and 1.96%, respectively. These results were confused considerably from previous reports (Petrou *et al*., 2013). In another study, Perkins-Veazie and Collins (2004) found that juice leakage of watermelon cubes ranged from 11% to 13% when stored at 2°C for 2 days. Such high levels of juice leakage may cause a physiological disorder due to cutting of fruit flesh, especially, in cold storage conditions (Sargent, 1998).

Effect of $CaCl_2$ and 1-MCP on juice leakage

Juice leakage were higher in watermelon fresh cut in case of control treatment which stored at 3 days compared with zero time and increased slightly through 9 days from beginning of storage. Leakage of treatment 1-MCP-treated fruit plus $CaCl_2$ dip fresh-cut existed slightly lower than values of the control. Moreover, separate treatments had the same trends, in the two seasons (Table 2).

Juices leakage is major factor determining the shelf life and quality of fresh-cut fruits. Application of calcium ($CaCl_2$) reduced the loss of juices due to membrane destroyed. The tissue treated with calcium chloride had a higher tissue firmness compared with the control that have a lower firmness of tissues where the calcium transported across cellular membranes and enclosed the tissue in fruits and support it.

Mao *et al*., (2004) reported that treated whole and fresh cut watermelons with 1-MCP (10 ppm) for 18 hours completely inhibited ethylene production that caused softening and juice leakage. Our results indicated that application of 1-MCP at low dosage is enough to control watermelon tissue damage and microbial growth associated with ethylene production and enhancement of quality and storability.

Effect of interaction on Total soluble solids

All interaction treatments gave the highest TSS% compared with control treatments (Table 3). Slices with rind and treated with $CaCl_2$+1-MCP or slices with rind and dipped in $CaCl_2$, resulted in the highest values of TSS (%) at different storage periods, followed by slices with rind + 1-MCP, triangle with rind + 1-MCP and triangle with rind + $CaCl_2$+1-MCP (with no considerable significant differences between them) in both seasons, respectively. Results suggest that $CaCl_2$ concentration at 1.5% may be too high in aspect of phospholipids metabolism. Further investigations on measuring kinetic concentrations of Ca^{2+} in relation to applied concentrations of $CaCl_2$ and metabolic activities associated with quality could be of paramount importance to extend shelf life of fresh-cut watermelon with $CaCl_2$ application (Wills *et al*., 2002). Application of $CaCl_2$ with or without 1-MCP maintained the high firmness, which changed little throughout the entire storage period. When $CaCl_2$ was absent, a rapid loss of firmness occurred after 4 days of storage. On the other hand, the difference between the control and 1-MCP treatment was very low. This was also true between $CaCl_2$ and the combination of $CaCl_2$ with 1-MCP. Results proved that $CaCl_2$ provided firming effect, retarding tissue softening (Mao *et al*., 2004).

In this study, 1-MCP is applied before cutting in expectations to inhibit wound-induced ethylene biosynthesis and action. This attempt seems partially to be realized because Ca-retention of phospholipase C, phospholipase D and lipoxygenase are reduced or inhibited by 1-MCP, although ethylene was not detected in fresh-cut. This firming effect has been attributed to the cross linking between the carboxyl groups of adjacent polyuronide chains and divalent Ca ions in cell wall (King and Bolin, 1989) imparting improvement of structural integrity and cell adhesion (Wills *et al*., 2002).

Effect of cutting shapes on Total soluble solids

Slices with rind retained higher TSS% than triangle with rind and cubes without rind (Table 3). Decrease in TSS has also been reported for watermelon cubes stored at 2°C and in full fruits of watermelon stored at 7–27°C (Perkins-Veazie and Collins, 2004). The presence of rind gave the highest total soluble solids; especially total sugars content (Petrou *et al*., 2013).

Table 3. TSS (%) content in fresh cut watermelon as affected by 1-methyl cyclopropene and calcium chloride at zero time*during different storage periods at 4°C in 2014 and 2015 seasons.

Treatments/Days of storage		3		6		9	
	Seasons	2014	2015	2014	2015	2014	2015
Slices with rind	Control	7.92 g	8.02 d	8.90 cd	6.71 d	8.80 b	5.56 d
	$CaCl_2$	10.16 a	10.70 a	9.97 ab	10.56 a	9.72 a	10.38 a
	1-MCP	9.72 c	9.87 b	9.41 bc	9.41 b	9.13 b	9.13 b
	$CaCl_2$+ 1-MCP	10.12 a	10.56 a	10.14 a	10.54 a	9.89 a	10.42 a
Triangle with rind	Control	8.22 f	8.18 d	7.17 f	6.50 d	7.01 a	5.30 d
	$CaCl_2$	9.84 b	10.84 a	9.61 ab	10.55 a	9.15 b	10.08 a
	1-MCP	8.60 e	9.27 bc	8.65 de	9.23 b	8.70 b	9.16 b
	$CaCl_2$+ 1-MCP	8.63 e	9.29 bc	8.64 de	9.29 b	8.55 bc	9.20 b
cubbies without rind	Control	8.64 e	7.55 d	6.78 f	6.45 d	6.27 e	3.61 e
	$CaCl_2$	7.58 h	9.53 bc	8.21 e	8.19 c	8.08 c	8.08 c
	1-MCP	7.58 h	9.54 bc	8.67 de	8.74 bc	8.60 bc	8.51 bc
	$CaCl_2$ + 1-MCP	8.94 d	9.07 c	8.75 de	8.75 bc	8.66 bc	8.66 bc
Slices		9.48 a	9.78 a	9.61 a	9.31 a	9.61 a	8.87 a
triangle		8.82 b	9.39 b	8.52 b	8.89 b	8.52 b	7.21 b
Cubbies		8.19 c	8.91 c	8.09 c	8.03 c	8.09 c	7.21 b
	Control	8.26 c	7.91 c	7.62 b	6.55 c	7.62 b	4.82 c
	$CaCl_2$	9.19 a	10.36 a	9.26 a	9.77 a	9.26 a	9.51 a
	1-MCP	8.63 b	9.54 b	8.91 a	9.13 b	8.91 a	8.93 b
	$CaCl_2$ + 1-MCP	9.23 a	9.64 b	9.18 a	9.53 ab	9.18 a	9.42 a

Means of each column for every separate factor and interaction followed with the same letters are not significantly different according to Duncan multiple range test at the probability of 0.05 levels *Zero time (2014 season) = 10% *Zero time (2015 season) = 11 %

Effect of $CaCl_2$ and 1-MCP on Total soluble solids

Total soluble solids of watermelon fresh cut was 10 and 11% in fresh fruit at zero time and decreased to about 9.23 and 9.64% at 3th day in both seasons, respectively, irrespective of $CaCl_2$+1-MCP treatment (Table 3). Thereafter, TSS% remained slightly decreasing to reach 9.18 and 9.53% in day-6 from storage, in both seasons, respectively. The control treatment tissue showed significantly decreased TSS than the other treatments. The influence of $CaCl_2$/1-MCP treatment or $CaCl_2$ alone on TSS has been shown to be increase in fresh cut of watermelon flesh and decrease respiration rate and evaporation (Perkins Veazie and Collins, 2004).

Effect of interaction on total lycopene

Treated of watermelon slices with $CaCl_2$+1-MCP had a significant effect on lycopene, in both seasons of study (Table 4). Lycopene concentration reduced after 3 days from storage and not had significant change up to the end of storage. The control treatments had high significant of lycopene loss at first 3 days (5.82 mg/gm F.W.) compared with 0 time (11.30 mg/gm F.W.; average two seasons). Lycopene loss in control treatment may be happened during cutting, juice leakage or high respiration rate (Lichanporn *et al*., 2014).

Table 4. Lycopene (mg/100 g F.W.) in fresh cut watermelon as affected by 1-methyl cyclopropene and calcium chloride at zero time* during different storage periods at 4°C in 2014 and 2015 seasons.

Treatments / Days of storage		3		6		9	
	Seasons	2014	2015	2014	2015	2014	2015
Slices with rind	Control	5.57 d	6.87 e	4.81 e	6.18 e	4.96 d	5.82 d
	$CaCl_2$	11.21 b	12.01 bc	11.19 b	11.99 b	11.14 b	11.94 b
	1-MCP	11.20 b	12.00 bc	11.18 b	11.98 b	11.16 b	11.96 b
	$CaCl_2$+ 1-MCP	12.49 a	13.29 a	12.62 a	13.42 a	12.10 a	12.90 a
Triangle with rind	Control	4.47 e	5.27 f	4.23 ef	5.36 e	4.13 d	4.88 e
	$CaCl_2$	11.24 b	12.04 bc	11.25 b	12.05 b	11.23 b	12.03 b
	1-MCP	11.18 b	11.98 bc	11.15 b	11.95 b	11.13 b	11.93 b
	$CaCl_2$+ 1-MCP	11.32 b	12.12 b	11.27 b	1.07 b	11.22 b	12.02 b
cubbies without rind	Control	3.60 f	4.49 g	3.42 f	4.25 f	3.23 e	4.03 f
	$CaCl_2$	10.98 b	11.78 c	7.49 d	8.9 d	7.53 c	8.33 c
	1-MCP	10.99 c	11.79 c	8.45 cd	9.25 cd	8.01 c	8.81 c
	$CaCl_2$ + 1-MCP	10.11 b	10.91 d	8.78 c	9.58 c	8.20 c	9.00 c
Slices		10.22 a	11.04 a	9.95 a	10.89 a	9.77 a	10.65 a
Triangle		9.55 b	10.35 b	9.47 a	10.36 a	9.43 a	10.22 a
Cubbies		8.92 c	9.74 c	7.03 b	7.84 b	6.75 b	7.55 b
	Control	4.55 c	5.54 c	4.15 c	5.26 c	4.02 c	4.91 c
	$CaCl_2$	11.14 b	11.94 b	9.98 b	10.78 b	9.97 b	10.77 b
	1-MCP	11.13 b	11.92 b	10.26 ab	11.06 ab	10.10 ab	10.90 ab
	$CaCl_2$ + 1-MCP	11.31 a	12.11 a	10.89 a	11.69 a	10.51 a	11.31 a

Means of each column for every separate factor and interaction followed with the same letters are not significantly different according to Duncan multiple range test at the probability of 0.05 levels *Zero time (2014 season) = 11.25 *Zero time (2015 season) = 11.35

In watermelon fresh cut, there is an increase in enzyme-catalyzed color reactions and prevent oxidation of exposed tissues to $CaCl_2$+1-MCP, also grated carrots fresh cut lost 20–40% of initial carotene levels after storage for 8 days at 5°C without any treatment (Perkins-Veazie and Collins, 2004). $CaCl_2$+1-MCP had an intensive red color especially on the initial time of storage. This may be caused by slight degradation of lycopene and increased the level of enzyme-catalyzed color reactions (Kyriacou and Soteriou, 2012).

Effect of cutting shapes on total lycopene

Slices with rind retained higher on lycopene for 9 days after storage at 4°C than triangle with rind and cubes without rind (Table 4) in the two seasons of study. In this regards, Perkins-Veazie and Collins (2004) reported that fresh cut of watermelon slices showed a different storage behavior at cold storage that mentioned for full fruits of watermelon and stored at ambient temperature, wherein lycopene content remained at high levels after 7 days of storage (Kyriacou and Soteriou, 2012).

Effect of $CaCl_2$ and 1-MCP on total lycopene

All treatments of calcium chloride and methylcyclopropane and their combination gave the higher content of total lycopene compare to the control (Table 4). Treatment of $CaCl_2$/1-MCP combination had a significant effect of total lycopene at different times of storage at 4°C in comparison with the other treatments. In this regard, Jiang and Joyce (2002) found that exposure of intact or fresh-cut apple fruit to 1-MCP resulted in reduced respiration and ethylene production rates and delayed softening and color changes.

Effect of interaction on total sugars

Slices treated with $CaCl_2$+1-MCP of watermelon fresh cut had a significant effect on total sugars in comparison with other treatments (Table 5). This is true in both seasons of study. 1-MCP can inhibited ethylene action by decelerating ethylene synthesis, respiration rate and decrease sugar transformation (Bernardino *et al*., 2016). The rind maintained the total soluble solids during cold storage periods (Petrou *et al*., 2013).

Effect of cutting shapes on total sugars

The cutting shapes of watermelon fresh cut had significant effects on total sugars in both seasons of study (Table 5). The results show the rind gave the highest total sugars, in slices that stored at 4°C, followed by triangle. On the other hand, the cubes without rind have a higher respiration rate from cutting surface that suffered from additional injury in the peeling process (Petrou *et al*., 2013).

Effect of $CaCl_2$ and 1-MCP on total sugars

Treatment of $CaCl_2$+1-MCP of watermelon fresh cut shows the highest total sugars with significant differences compared to the control and the other treatments at different times of storage in both season of study (Table 5). Our data demonstrate that 1-MCP/$CaCl_2$ combination retards ripening stage in watermelon fresh cut, as illustrated by lower activities of hydrolysis and lipolytic enzymes in relative to the control. $CaCl_2$ alone may not be sufficient to maintain quality of fresh cut products and even would exert negative effects such as stimulating lipolytic enzymes (Mao *et al*., 2004).

Table 5. Total sugars (mg/100 g F.W.) in fresh cut watermelon as affected by 1-methyl cyclopropene and calcium chloride at zero time* during different storage periods at 4°C in 2014 and 2015 seasons.

Treatments/Days of storage		3		6		9	
	Seasons	2014	2015	2014	2015	2014	2015
Slices with rind	Control	13.82 d	13.22 d	12.79 e	12.13 g	12.27 ef	12.27 fg
	$CaCl_2$	15.92 b	15.92 b	15.95 b	15.95 bc	16.07 b	16.06 b
	1-MCP	15.89 b	15.89 b	15.98 b	15.98 bc	16.14 ab	16.14 ab
	$CaCl_2$+ 1-MCP	16.73 a	16.73 a	16.89 a	16.88 a	16.94 a	16.93 a
Triangle with rind	Control	14.0 d	13.35 d	13.22 e	13.22 f	12.96 de	12.96 ef
	$CaCl_2$	14.64 c	14.64 c	14.06 cd	14.05 e	13.29 cd	13.29 de
	1-MCP	15.73 b	15.73 b	15.69 b	15.69 cd	16.50 ab	16.50 ab
	$CaCl_2$+ 1-MCP	16.13 b	16.13 ab	16.57 a	16.57 ab	16.26 ab	16.26 ab
cubbies without rind	Control	13.27 e	13.11 d	12.33 f	12.47 g	11.93 f	11.93 g
	$CaCl_2$	14.46 c	14.46 c	13.89 d	14.22 e	13.92 c	13.91 d
	1-MCP	14.80 c	14.80 c	14.38 c	14.38 e	13.62 cd	13.62 de
	$CaCl_2$ + 1-MCP	15.91 b	15.91 b	15.86 b	15.21 d	15.97 b	15.26 c
Slices		15.19 a	15.44 a	15.40 a	15.23 a	15.35 a	15.35 a
Triangle		15.17 a	14.96 b	14.89 b	14.88 a	14.76 b	14.75 a
Cubbies		14.97 a	14.57 c	14.12 c	13.99 b	13.86 c	13.68 b
	Control	13.91 d	13.23 d	13.06 d	12.61 d	12.39 d	12.39 d
	$CaCl_2$	14.79 c	15.01 c	14.35 c	14.63 c	14.43 c	14.42 c
	1-MCP	15.47 b	15.47 b	15.35 b	15.35 b	15.42 b	15.42 b
	$CaCl_2$ + 1-MCP	16.26 a	16.26 a	16.43 a	16.22 a	16.39 a	16.15 a

Means of each column for every separate factor and interaction followed with the same letters are not significantly different according to Duncan multiple range test at the probability of 0.05 levels *Zero time (2014 season) = 15.90 *Zero time (2015 season) = 16.94

Effect of interaction on volatile compound of aroma

The aromatic volatiles resulted in extracts of watermelon heart tissue were mostly aldehydes and alcohols. However, esters and ketone were lower concentrations of watermelon (Fig. 5).

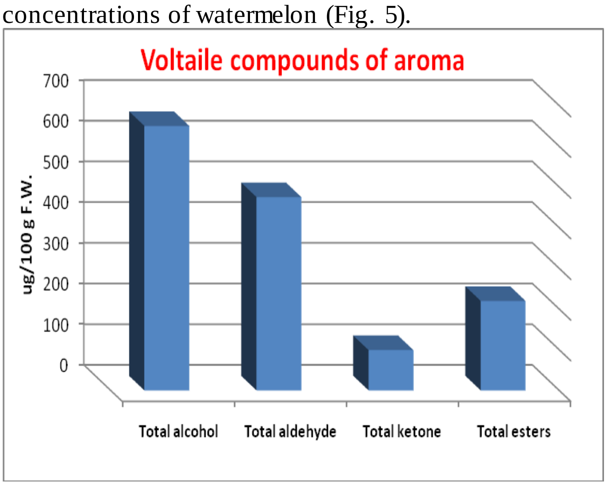

Fig. 5. Components of watermelon fresh cut aroma

All interaction treatments had significant effects on volatile compounds (Figs. 6 and 7). Slices with rind and treated with $CaCl_2$+1-MCP or 1-MCP alone resulted in the lowest total alcohols and highest values of total aldehydes at different storage period, followed by slices with rind + 1-MCP, triangle with rind + 1-MCP and triangle with rind + $CaCl_2$/1-MCP, respectively (average two seasons). Generally, slightly decreased in total aldehydes and alcohols were found due to application of $CaCl_2$ plus1-MCP with slices-shaped compared to zero time (Figs. 6 and 7). Aldehydes and alcohols are responsible for the flavor and aroma compounds of watermelon fresh cut stored at 5 °C and 95% RH for ten days and that the aroma minimized in density as storage progressed, even though it did not affect the final quality of product (Xisto *et al*., 2012). Alcohols come the second rank of volatile compounds during cold storage. $CaCl_2$ plus1-MCP with slices-shaped treatment can also suppress aromatic volatile production that share in the aroma (and flavor) of the watermelon fruits (Blankenship and Dole, 2003).

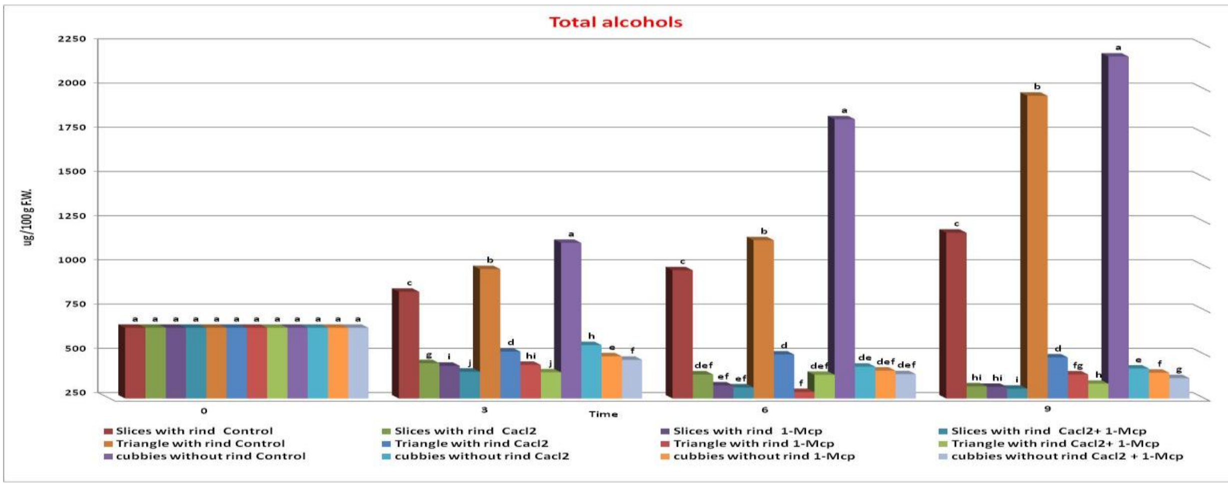

Fig. 6. Total alcohols of watermelon fresh cut as affected interaction at different storage periods.

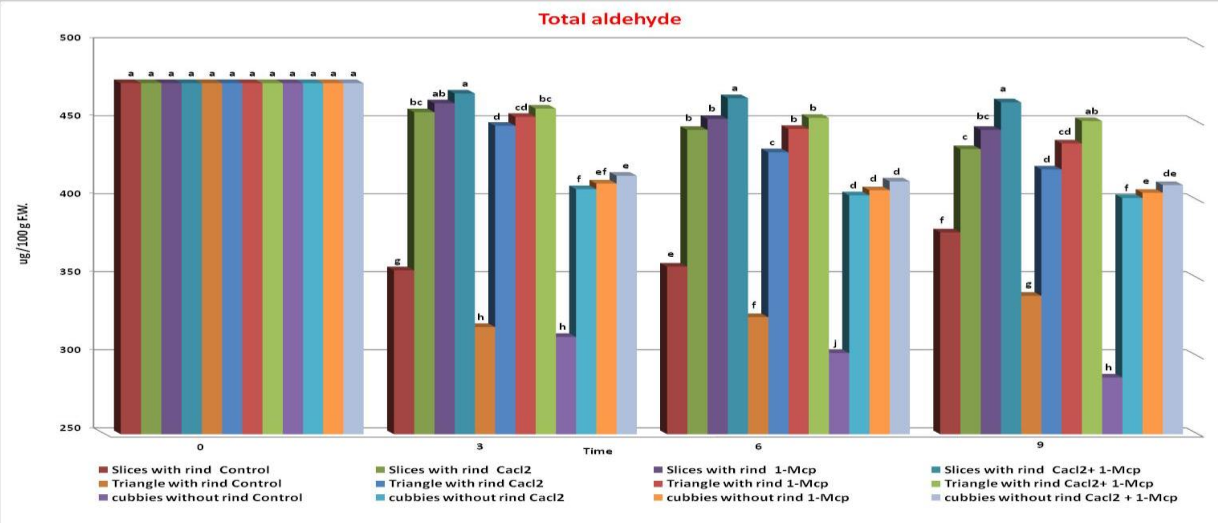

Fig. 7. Total aldehyde of watermelon fresh cut as affected interaction at different storage periods.

Effect of cutting shapes on volatile compounds of aroma

Slices with rind had significant effects on total aldehydes and total alcohols of the watermelon fresh cut (average two seasons; Figs. 8 and 9). The slices with rind show significant decreases in total alcohols and increased significantly total aldehydes compared to other two shapes. On the other hand, the changes in total aldehydes were not significant during different storage period, in case of slices, compared to zero time and show significant effect in comparison with triangle and cubbies. The cutting of fruits may be increase the damage by (i) increases respiration rate and (ii) ethylene production and (iii) increases other biochemical reactions that responsible for changes in color, flavor, aroma, texture and nutritional quality (Brech, 1995).

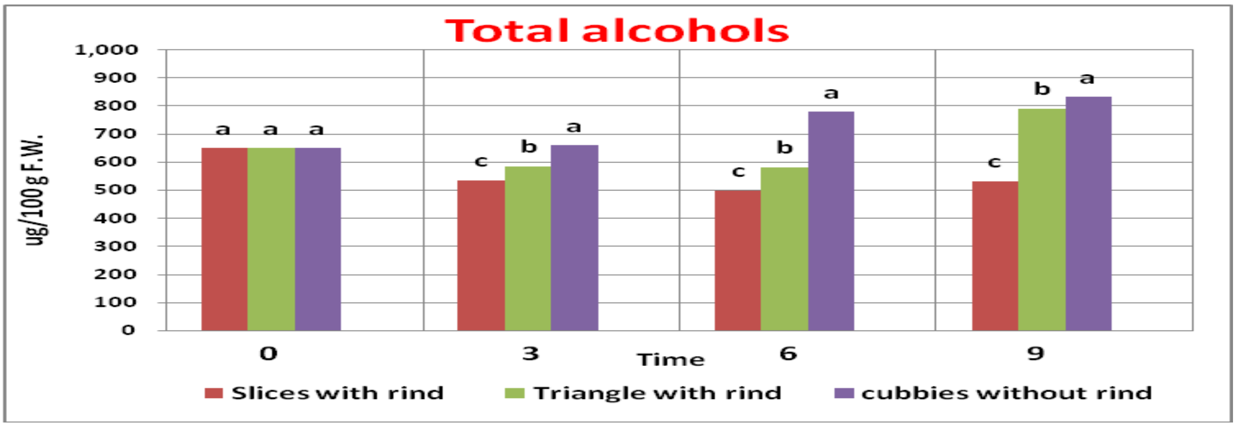

Fig. 8.Total alcohols of watermelon fresh cut as affected shape methods at different storage periods.

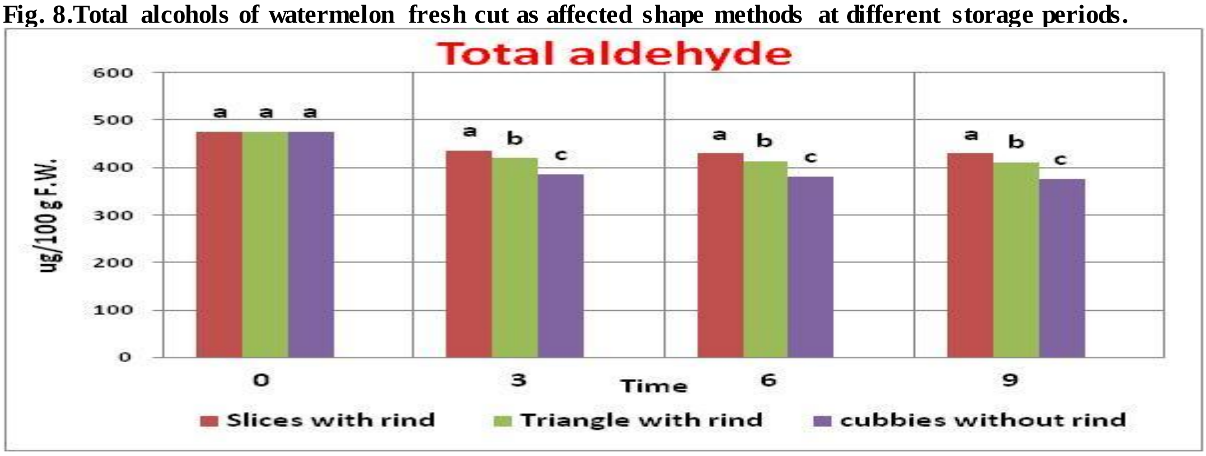

Fig. 9. Total aldehyde of watermelon fresh cut as affected shape methods at different storage periods.

Effect of $CaCl_2$ and 1-MCP on volatile compound of aroma

Watermelon fresh cut with treated with $CaCl_2$+1-MCP had significant reduced in total alcohols at the end of storage period and reached about 334.44 (Fig. 10) compared to zero time (650 µg/100 g F.W.) and the value increased to 1766.00 µg/100 g F.W. in control treatment at 9th days of storage, respectively.

Total aldehydes in watermelon fresh cut was 475 µg/100 g F.W. in zero time and slightly decreased till the end of storage without any significant changes during the different storage periods (Fig. 11). The control treatment tissue showed significantly decreased aldehydes levels than the other treatments. Our results was confirmed by those obtained of Saftnera *et al*. (2007), they found that applied of 1-MCP consistently led to decrease of total aromatic volatile and hexanal concentrations in tissue extracts from watermelon fresh cut.

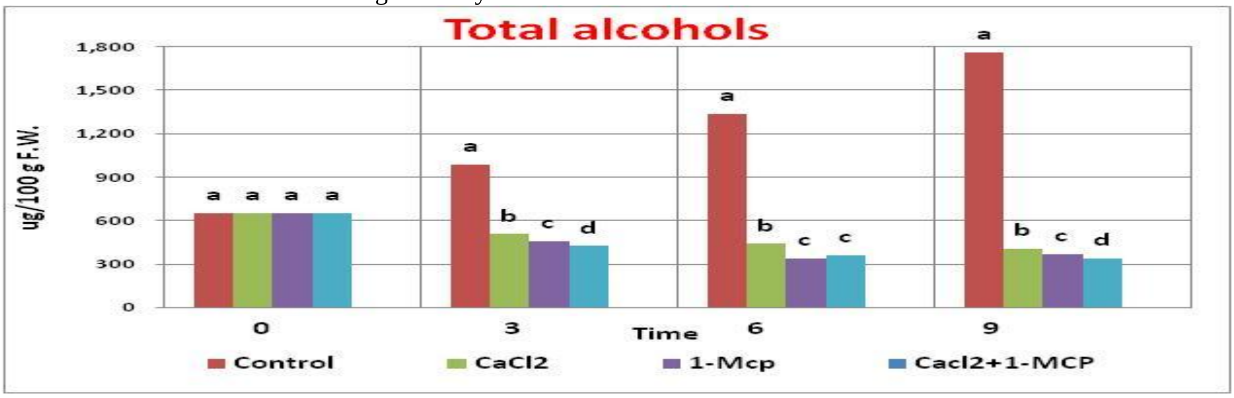

Fig. 10. Total aldehyde of watermelon fresh cut as affected by treatments at different storage periods.

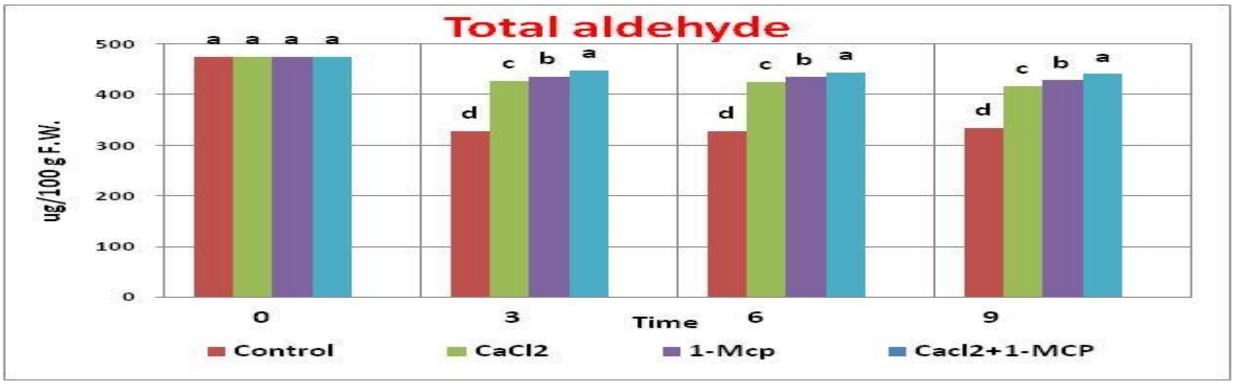

Fig. 11. Total aldehyde of watermelon fresh cut as affected by treatments at different storage periods.

Effect of interaction on physical characters

The interaction treatments had significant differences on visual quality parameters (Table 6). Visual quality (color, taste and texture) was favorable until 9th day, when the border of sale-ability was attained due to application of $CaCl_2$+1-MCP (Fig. 12). In the end of storage period, control treatment had dark in color, glossy texture, softening of tissues and decrease of firmness (Fig. 13). These results were accordance by Artes *et al*. (2007). Mechanical wounding of watermelon fresh cut may induce increases in ethylene that can promote physiological disorders like softening related to cell wall catalytic enzymes (Vilas-Boas and Kader, 2006). 1-MCP can inhibited ethylene production, delayed tissue looseness and cell wall degrading (Bernardino *et al*., 2016).

The effect of calcium chloride on texture has been attributed to the cross linking between the carboxyl groups of adjacent polyuronide chains and divalent Ca ions in cell wall, imparting improvement of structural integrity and cell adhesion. Relations between greater turgor pressure and firmness in Ca treated tissues were also found (Bernardino *et al*., 2016). Treatment with Ca results in lower juice leakage, which could be indicated as good membrane integrity since tissue firmness and texture were much higher for this treatment throughout storage.

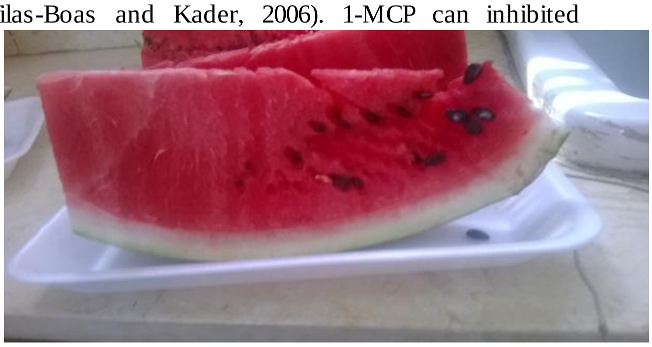

Fig. 12. Slides treated with $CaCl_2$+MCP at 9th day after storing at 4°C

Fig. 13. Slides control at 9th day after storing at 4°C

Effect of cutting shapes physical characters

Slices with rind retained high significant on physical characters for 9 days after storage at 4°C followed by triangle with rind and cubes without rind (with no considerable differences between them) (Table 6) in the two seasons. Slices with rind had significant effects on the weight loss and juice leakage of the watermelon fresh cut during storage at 4°C and 98% RH. The higher leakage observed in rind-free slices was related most probably to the greater cut surface injury incurred with processing. Juice leakage tended to stabilize after the first 2 days of storage (Petrou *et al*., 2013).

Table 6. Physical characters in fresh cut watermelon as affected by 1-methyl cyclopropene and calcium chloride in the end of storage at 4°C in 2014 and 2015 seasons.

Treatments / Characters		Color		Taste		Texture	
	Seasons	2014	2015	2014	2015	2014	2015
Slices with rind	Control	3.00 c	3.66 c	3 .00 d	3.66 e	3.00 e	3.00 d
	$CaCl_2$	7.00 b	6.33 b	9.00 a	8.33 ab	7.00 c	6.33 bc
	1-MCP	9.00 a	9.00 a	9 .00 a	9.00 a	9.00 a	9.00 a
	$CaCl_2$+ 1-MCP	9 .00 a	9.00 a	9 .00 a	9.00 a	9 .00 a	9.00 a
Triangle with rind	Control	3.00 c	3.00 c	3.00 d	3.00 e	3.00 e	3.00 d
	$CaCl_2$	9 .00 a	9.00 a	7 .00 b	6.33 cd	7 .00 c	6.33 bc
	1-MCP	7.00 b	7.00 b	7 .00 b	7.66 abc	7.67 bc	7.66 ab
	$Cacl_2$+ 1-MCP	7.00 b	6.33 b	9.00 a	9.00 a	5.67 d	5.66 bc
cubbies without rind	Control	3.00 c	3.00 c	3.00 d	3.00 e	3.00 e	3.00 d
	$CaCl_2$	9 .00 a	9.00 a	7.00 b	7.66 abc	8.33 a	8.33 a
	1-MCP	7.00 b	7.66 ab	5.67 b	5.66 d	5.67 d	5.66 bc
	$CaCl_2$ + 1-MCP	7.00 b	6.33 b	6.33 bc	7.00 bcd	5 .00 d	5.00 c
Slices		7.00 a	7.00 a	7 .00 a	7.50 a	7.50 a	6.83 a
Triangle		6.50 b	6.50 ab	6.50 b	6.50 b	6.50 b	5.66 b
Cubbies		6.50 b	6.33 b	6.50 b	5.83 c	5.50 c	5.50 b
	Control	3.00 d	3.22 c	3.00 d	3.22 b	3.00 b	3.00 c
	$CaCl_2$	7.00 c	6.22 b	7.00 c	8.33 a	7.44 a	7.44 b
	1-MCP	7.67 b	7.00 b	7.67 b	7.22 b	7.88 a	6.55 b
	$CaCl_2$ + 1-MCP	9.00 a	9.00 a	9.00 a	7.66 ab	7.67 a	7.88 a

Means of each column for every separate factor and interaction followed with the same letters are not significantly different according to Duncan multiple range test at the probability of 0.05 levels

Effect of $CaCl_2$ and 1-MCP on physical characters

The same data in Table 6 shows the most beneficial treatments of the best physical characters were $CaCl_2$+1-MCP and 1-MCP followed by $CaCl_2$ treatment in the two seasons. Additionally, it was evident that control treatments were of the least scores for all physical parameters in the two seasons. Loss of water may be increasing the withering, loss of quality and texture changes. The loss of texture in the final products along with storage period is one of the determining factors that reduce the shelf life of fresh cut products (Beaulieu and Gorny, 2001).

Effect of interaction on bacterial count

The interaction treatments of fresh-cut had significant differences on bacterial count during 9 days of storage at 4°C (Table 7). Untreated cubs without rind increased significantly bacterial count from 8,141 cfu to 13,748 cfu after 3 DAS, 27,969 cfu after 6 DAS and finally reached to 824,188 at 9 DAS (average two seasons), as comparison with other treatments. Watermelon slices and triangles with rind and treated with $CaCl_2$+1-MCP did not increase significantly in bacteria count from day 0 to day 9. Zhou *et al*. (2006) indicated that sole application of 1-MCP had direct effect on the development of bacteria and indirect affect by inhibiting the ethylene production that increase the population of aerobic bacteria, lactic acid bacteria, molds and yeasts. 1-MCP can also reduce alcohol fermentation of watermelon fresh cut products and subsequently reduction of bacterial count (Mao *et al*., 2004; Bernardino *et al*., 2016).

Effect of cutting shapes on bacterial count

Slices with rind of fresh cut watermelon had significant reduction in bacteria count followed by triangle with rind and cubes without rind after 3, 6 and 9 DAS at 4°C in both seasons. The absence of rind reduced the storage stability of watermelon cubes and improved storage behavior of slices for marketing and retail market when stored at 4°C for 9 days (Petrou *et al*., 2013). During different storage period, cubes without rind may increase juice leakage and subsequently grow and populate of the bacteria due to the increase of cut surfaces, in this case.

Effect of $CaCl_2$ and 1-MCP on bacterial count

At the initial time of fresh-cut processing, bacterial count was zero with dual application $CaCl_2$+1-MCP cfu or separate treatments, compared to the control. $CaCl_2$+1-MCP treatment of watermelon fresh cut gave the lowest significant values of bacteria count at 3, 6 and 9 DAS, in comparison with the control and the two single treatments (Table 7). In this regards, Mao *et al*., (2004) found that 1-MCP can suppress the microbial growth and development of full fruits of watermelon and slices. Dual application of 1-MCP and $CaCl_2$ reduced the softening, respiration rates, and microbial growth, under modified atmosphere condition (Aguayo *et al*., 2006).

Table 7.Total count (C.F.U.*) of bacteria in fresh cut watermelon as affected by 1-methyl cyclopropene and calcium chloride during different storage periods at 4°C in 2014 and 2015 seasons.

Treatments / Days of storage		0		3		6		9	
	Seasons	2014	2015	2014	2015	2014	2015	2014	2015
Slices with rind	Control	130.0 b	113.0 c	493.7 c	580.0 c	500.7 c	675.7 c	50,000.0 c	50,000.0 c
	$CaCl_2$	0.0 c	0.0 d	0.0 e	0.0 f	10.0 ef	20.0 f	20.0 gh	40.0 g
	1-MCP	0.0 c	0.0 d	0.0 e	0.0 f	25.0 ef	24.3 f	50.0 ef	30.0 h
	$CaCl_2$+ 1-MCP	0.0 c	0.0 d	0.0 e	0.0 f	0.0 f	0.0 g	0.0 h	0.0 i
Triangle with rind	Control	150.0 b	130.0 b	572.7 b	858.3 b	660.3 b	981.7 b	760,049.7 b	520,001.7 b
	$CaCl_2$	0.0 c	0.0 d	0.0 e	0.0 f	26.3 ef	30.0 f	46.7 ef	40.0 g
	1-MCP	0.0 c	0.0 d	0.0 e	0.0 f	35.0 ef	20.0 f	60.0 e	70.0 c
	$Cacl_2$+ 1-MCP	0.0 c	0.0 d	0.0 e	0.0 f	0.0 f	0.0 g	0.0 h	0.0 i
cubbies without rind	Control	8,500.0 a	7,782.0 a	18,700.7 a	8,797.8 a	27,944.3 a	27,994.7 a	825,209.3 a	823,167.7 a
	$CaCl_2$	0.0 c	0.0 d	15.0 e	20.0 e	50.0 e	70.0 e	70.0 e	160.0 d
	1-MCP	0.0 c	0 .0 d	55.0 d	63.3 d	123.3 d	150. d	153.3 d	160.0 d
	$CaCl_2$ + 1-MCP	0.0 c	0.0 d	0.0 e	0.0 f	10.0 ef	20.0 g	30.0 fg	50.0 f
Slices		32.5 b	28.3 c	123.4 c	145.0 c	133.9 c	180.0 c	12,517.5 c	12,517.5 c
Triangle		37.5 b	32.5 b	143.2 b	214.6 b	180.4 b	252.9 b	190,039.1 b	130,027.9 b
Cubbies		2125 a	1943.5 a	4692.7 a	2,220.3 a	7,031.9 a	7,058.7 a	206,365.7 a	205,884.4 a
	Control	2,926.66 a	2,672.4 a	6,589.0 a	3,412.1 a	9,701.8 a	9,884.0 a	545,086.3 a	464,389.8 a
	$CaCl_2$	0.0 b	0.0 b	5.0 bc	6.7 c	28.8 c	40.0 c	87.8 b	80.0 c
	1-MCP	0.0 b	0.0 b	18.3 b	21.1 b	61.1 b	58.1 b	45.6 c	86.7 b
	$CaCl_2$ + 1-MCP	0.0 b	0.0 b	0.0 c	0.00 d	3.3 d	6.7 d	10.0 d	16.7 d

Means of each column for every separate factor and interaction followed with the same letters are not significantly different according to Duncan multiple range test at the probability of 0.05 levels. *C.F.U.: colony forming unit

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خصائص الجودة وتقليل الحمل الميكروبى لأشكال مختلفة من قطع البطيخ الطازج المجزأ واستجابتها لـ: ١ - ميثيل سيكلوبروبين وكلوريد الكالسيوم.

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أجريت هذه الدراسة في محطة بحوث البساتين بالمنصورة أثناء الموسميين الصيفيين ٢٠١٤ و ٢٠١٥م بغرض تقييم المعاملة ب١- مثيل سيكلوبروبين بتركيز ٠.٥% (الثمار الكاملة)، محلول كلوريد الكالسيوم بتركيز ١.٥% (القطع المجزأة الطازجة)، المعاملة المزدوجة بالمركبين وكذلك الكنترول الغير معامل بالتداخل مع ثلاث أشكال تقطيع مختلفة (شرائح بالقشرة ، مثلثات بالقشرة ومكعبات بدون قشرة) وتأثير ذلك علي زيادة الجودة وتقليل الفقد في الوزن والمحتوي الميكروبي تحت فترات التخزين البارد المختلفة. أظهرت معاملة التفاعل ب ١- مثيل كلورو سيكلوبروبين وتجزئة نفس الثمار لشرائح بقشرة البطيخ مع غمرها في محلول كلوريد الكالسيوم إلي حدوث زيادة معنوية فى المواد الصلبة الذائبة الكلية وصبغة الليكوبين الكلية والسكريات الكلية والالدهيدات الكلية وتحسين اللون والطعم والقوام، كما أدت نفس المعاملة الى خفض النسبة المئوية للفاقد فى الوزن ونضح السوائل والكحولات الكلية والتعداد البكتيرى لمدة ٩ أيام، يليها نفس المعاملة مع المثلثات بقشرة الثمرة والتخزين لمدة ٦ أيام، والمكعبات بدون قشرة والتخزين لمدة ٣ أيام بالإضافة المزدوجة للمركبين المستخدمين مقارنة بالمعاملات الفردية ومعاملة الكنترول عند التخزين البارد علي ٤ درجة مئوية والرطوبة النسبية ٩٨%، وانعكس ذلك على صفات الجودة والقدرة التخزينية والخصائص المظهرية.توصي هذه الدراسة بمعاملة ثمار البطيخ ب ١- مثيل سيكلوبروبين بتركيز ٠.٥%، ثم تقطيعها بالقشرة لشرائح وغمرها في محلول كلوريد الكالسيوم بتركيز ١.٥%، وتخزينها لمدة ٩ أيام علي درجة ٤ مئوي ورطوبة نسبيه ٩٨% لحفظها وتخزينها في أسواق التجزئة.