1-MCP Prolongs the Shelf-Life and Changes the Aroma Profile of Guava (Psidium guajava L.) Fruit

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1-MCP Prolongs the Shelf-Life and Changes the Aroma Profile of Guava (*Psidium guajava* L.) Fruit

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Abstract

Guava fruit are highly perishable and deteriorate within 2 to 4 days. Moreover, these fruit are highly aromatic to the point that some consumers do not purchase it due to their overly strong aroma. We examined the potential of modified atmosphere packaging and 1-MCP treatments to improve storage life and reduce the biosynthesis of volatiles. Various quality parameters were also assessed and the aroma profile was investigated using SPME-GCMS. 1-MCP significantly retards the ripening process, as indicated by greener, and firmer fruit compared to untreated fruit. The main consequence of this slowed ripening was prolonged shelf-life. Moreover, 1-MCP treatment resulted in a highly reduced biosynthesis of aroma volatiles and significantly altered the odour-volatiles composition. Key volatiles that were reduced were: ethyl acetate, ethanol, hexanal, p-cymene, β-bisabolene, caryophyllene oxide, (+)-α-terpineol, cinnamyl acetate, carveol, γ-eudesmol. On the other hand, the biosynthesis of the following volatiles remained higher with 1-MCP treatment: α-pinene, β-myrcene, D-limonene, eucalyptol, trans-β-ocimene, 3-carene, caryophyllene, 7-epi-α-selinene, α-muurolene, and spathulenol.

INTRODUCTION

Guava fruit are of tropical origin, and are produced widely in various regions in the world. Usually fruit are picked at an early stage of ripening, although fruit may be picked at mature green stage and ripened subsequently. Mature green guavas are usually hard in texture, starchy and acidic in taste and sometimes astringent. After ripening, fruit become softer, sweeter, less acidic, less astringent, and flavour increases (Bashir and Abu-Goukh, 2003). During ripening many physiological, biochemical and structural changes occur. This includes the degradation of starch to sugars, synthesis of pigments and volatile compounds, and partial solubilisation of cell wall (Dhawan et al., 2003).

Ethylene plays an important role in ripening (Abeles et al., 1992). 1-MCP (SmartFresh™), an effective ethylene inhibitor (DeEll et al., 2002; Watkins et al., 2000), delays the ripening of guava fruit (Bassito et al., 2005). Sing and Pal (2007) found that for 'Allahabad Safeda' guava, 1-MCP treatment slowed ripening in a dose dependent manner, and that 1-MCP at 600 nl L^{-1} for 12 h, in combination with cold storage (10°C) seems to be a promising way to extend the storage life of guava.

In Palestine, guava is mainly cultivated in northern districts of the West Bank and the Gaza strip. Guava is considered a very rich source of nutraceuticals, especially the content of antioxidants (Harb, unpublished). Moreover, guava is very aromatic in the latter stages of ripening, and the shelf life of these fruit is too short (only 2-4 days), which makes it difficult to effectively market the fruit. Our preliminary survey indicated that the intense aroma of guava is perceived negatively by most consumers. Reducing the biosynthesis of aroma volatiles in guava may have a positive impact on marketing. In addition, the decay caused by various fungi causes a further constraint in marketing of these fruit. Previous studies in our lab (unpublished data) reveal that modified atmosphere packaging (MAP) prolongs the shelf life by approximately one week, but longer periods would be beneficial. Consequently, the objective of this research was to study the impact of 1-MCP on prolonging shelf-life as well as the impact on the biosynthesis of aroma volatiles directly after harvest and after storage for 10 days.

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MATERIALS AND METHODS

Plant Material and Treatments

Mature green guava fruit ('Ben Dov') were picked from a commercial farm near Qalqilya city in the northern West Bank. Fruit were selected for uniformity and absence of decay and external injuries and treatments carried out on the same day. The experiment included 4 treatments, namely 1-MCP treated and 1-MCP untreated fruits, and fruits of each main treatment were divided into 2 lots; the first lot stored at room temperature and the second lot at 12°C. The 1-MCP treated fruits were subjected to 1-MCP at a concentration of 650 nl L^{-1}. Following treatment, fruits were assessed for various quality parameters at frequent intervals as described by Harb et al. (2006). In addition, sensory analysis was conducted by five trained panelists. For the modified atmosphere packaging treatment a low-density polyethylene (LDPE) plastic film was used.

Determination of Aroma Volatiles

Fruit sections were ground to a fine powder in liquid nitrogen. Forty five grams of the powder were added to 20 ml of saturated NaCl solution, which were stirred for 30 min before SPME fibers (a fused-silica fiber coated with 100 µm polydimethyl siloxane) were exposed in sealed vials for 60 min. Fibers were injected directly into a GC-MS as described by Harb et al. (2007).

RESULTS AND DISCUSSION

Decay Incidence

Decay is the most important criterion that influences the shelf life of guava. Decay incidence increased steadily in control fruit, and the combination of MAP and 1-MCP significantly reduced decay (Fig. 1).

Quality Parameters

Fruit firmness is the second most important quality parameter. Storing fruit at relatively low temperature (12°C) was superior to holding fruit at room temperature (RT). 1-MCP treatment significantly maintained fruit firmness for almost two weeks at 12°C. MAP maintained firmness compared to control, but much less effective than MAP in combination with 1-MCP treatment (Fig. 2). In addition, 1-MCP slowed the yellowing of fruit, also for about two weeks (Fig. 3).

Sensory Assessment

In previous experiments, the 'off-flavor' was found to be a major issue for guavas in modified atmosphere liners, probably due to the accumulation of odor volatiles inside the package. After storing fruit for 13 days at 12°C, taste panelists evaluated control fruit as very poor, which were mainly related to the advanced senescence of fruit. However, 1-MCP treated fruit were considered to be of acceptable quality (Fig. 4).Thus, 1-MCP may be effective in extending the shelf life for 7-10 days, which is sufficient for producers.

Odor Volatiles

The 1-MCP treatment significantly changed the aroma profile of fruit (Tables 1 and 2), and the intensity of the aroma decreased highly upon 1-MCP treatment. However, the aroma compounds, which can be considered as the most effective in defining the distinct aroma profile of guava, as well as their biosynthetic pathways, are largely unknown; currently, the identification of these compounds as well as further unknown compounds is running in our labs using the NMR technique. The 1-MCP treatment can extend the shelf-life of guava, but with a significant reduction in eating quality. Literature about the impact of 1-MCP on guava is limited (Larrigaudiere, 2008; Bassetto et al., 2005). Ortiz-Hernandez et al. (2010) found that total aroma was clearly higher in control samples (9.6 and 24.0 mg kg^{-1}) than treated fruit (4.7 and 8.9 mg kg^{-1}), and that sensory analysis confirmed these results. In this respect, 1-MCP, in combination with MAP, is recommended for farmers in developing countries to maintain the postharvest quality of such perishable products. However, further research is needed to fine tune the 1-MCP application and further refine the modified atmosphere packaging.

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Tables

Table 1. Aroma volatiles produced highly by 1-MCP treated yellow guavas after 13 days at 12°C.

Ethyl acetate
Ethanol
Hexanal
Benzene, 1-methyl-4-(1-methylethyl)-
p-Cymene
4,11-selinadiene
Bicyclo[3.1.0]hexane, 6-isopropylidene-1-methyl-
Eudesma-4(14),11-diene
(+)-Valencene
Beta-bisabolene
Bicyclo[4.4.0]dec-6-en-9.beta.-ol, 1,7-dimethyl-4.alpha.-isopropenyl-
Eudesma-3,7(11)-diene
Oxime-, methoxy-phenyl-
Decanal
Pentanoic acid, 2,2,4-trimethyl-3-carboxyisopropyl, isobutyl ester
Cyclohexane, 1,5-dimethyl-2,3-divinyl-
2,5,9-Trimethylcycloundeca-4,8-dienone
3-Phenyl-1-propanol, acetate
Caryophyllene oxide
1,2-Dihydropyridine, 1-(1-oxobutyl)-
Carveol (fr.1)
Humulane-1,6-dien-3-ol
Selina-6-en-4-ol
γ-Eudesmol
1,1,4a-Trimethyl-5,6-dimethylenedecahydronaphthalene
Tetracyclo[6.3.2.0(2,5).0(1,8)]tridecan-9-ol, 4,4-dimethyl-
1-Hexanol
2-Furanecarboxylic acid, 3,5-dimethylcyclohexyl ester
1-Octanol
Benzaldehyde, 4-methyl-
(+)-α-Terpineol
Cinnamyl acetate

Table 2. Aroma volatiles produced highly by 1-MCP treated mature green guavas after 13 days at 12°C.

alpha-Pinene	alpha-Bisabolene
beta-Myrcene	Di-epi-.alpha.-cedrene
D-Limonene	Nerol acetate
Eucalyptol	β-Sesquiphellandrene
trans-beta-Ocimene	α-Cadinene
3-Carene	Aromadendrene, dehydro-
(+)-Camphene	Acetic acid, 2-phenylethyl ester
Acetic acid, hexyl ester	(-)-Calamenene
3-Hexen-1-ol, acetate, (Z)-	alpha-Calacorene
(4E,6Z)-allo-Ocimene	Cadala-1(10),3,8-triene
Isoledene	Epiglobulol
Copaene	Ledol
Caryophyllene	Germacrene B
7-epi--.alpha.-Selinene	Nerolidol
Humulen-(v1)	(-)-Globulol
β-Santalene	Guai-1(10)-en-11-ol
1,4,7,-Cycloundecatriene, 1,5,9,9-tetramethyl-, Z,Z,Z-	Spathulenol
Nopyl acetate	Cubenol
alpha-Muurolene	γ-Muurolene
(+)-Ledene;	1β-Cadin-4-en-10-ol
Epizonarene	

Figures

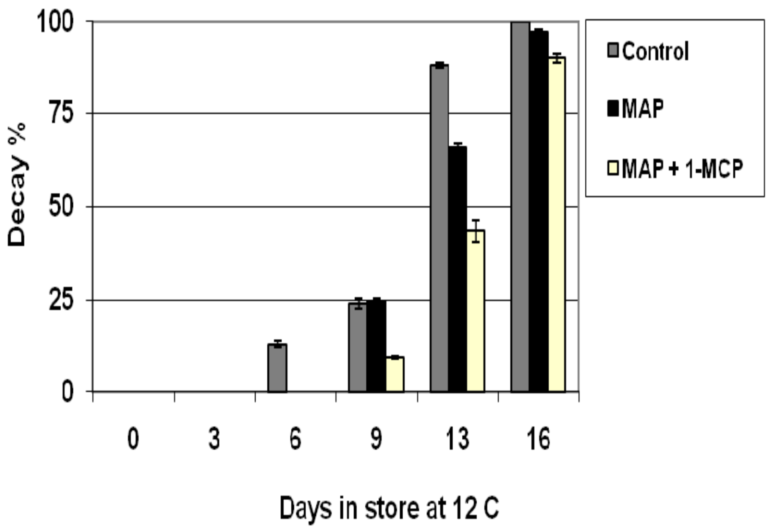

Fig. 1. Influence of 1-MCP treatment and MAP on decay development on guavas stored at 12°C.

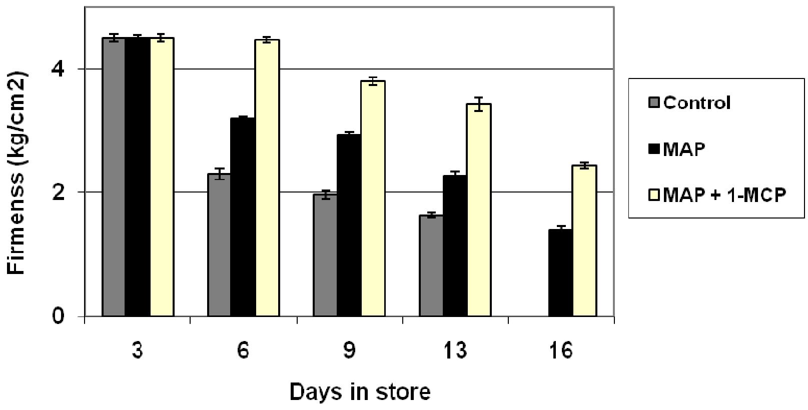

Fig. 2. Influence of 1-MCP treatment and MAP on firmness of guavas stored at 12°C.

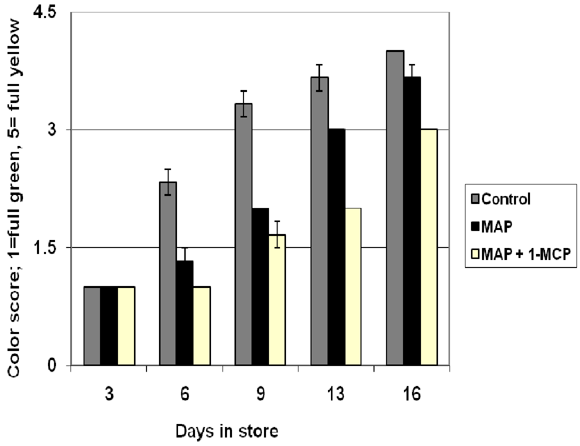

Fig. 3. Influence of 1-MCP treatment and MAP on color of guavas stored at 12°C.

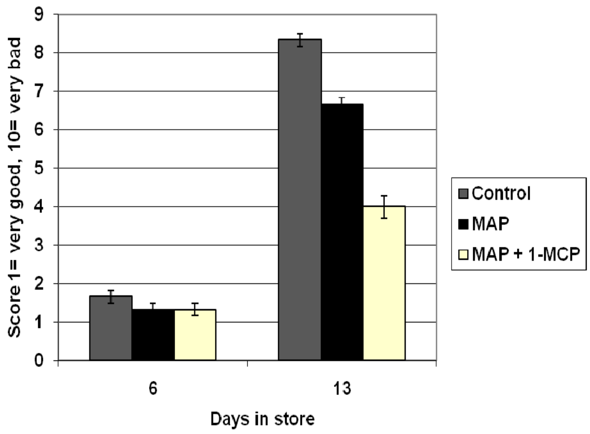

Fig. 4. Influence of 1-MCP treatment and MAP on the sensory quality of guavas stored for 6 and 13 days at 12°C.