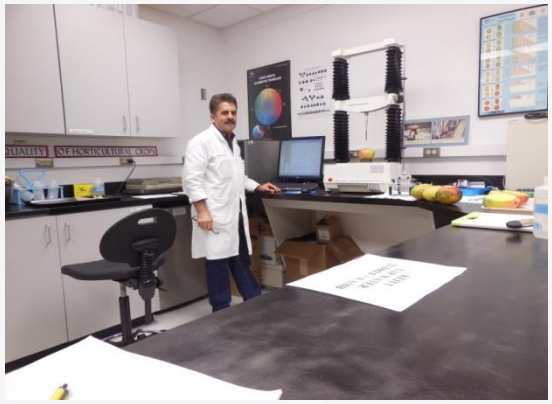


SABBATICAL PROJECT "EFFECTIVENESS OF AQUEOUS 1-METHYLCYCLOPROPENE (1-MCP) ON HEATED AND UNHEATED MANGO FRUIT: UNDERSTANDING THE MODE OF ACTION"

JORGE A. OSUNA GARCÍA. INIFAP-SANTIAGO IXCUINTLA EXPERIMENTAL STATION
HOSTS: JEFFREY K. BRECHT AND DONALD J. HUBER. HORTICULTURAL SCIENCES-UF

GAINESVILLE, FL. FEBRUARY 2014

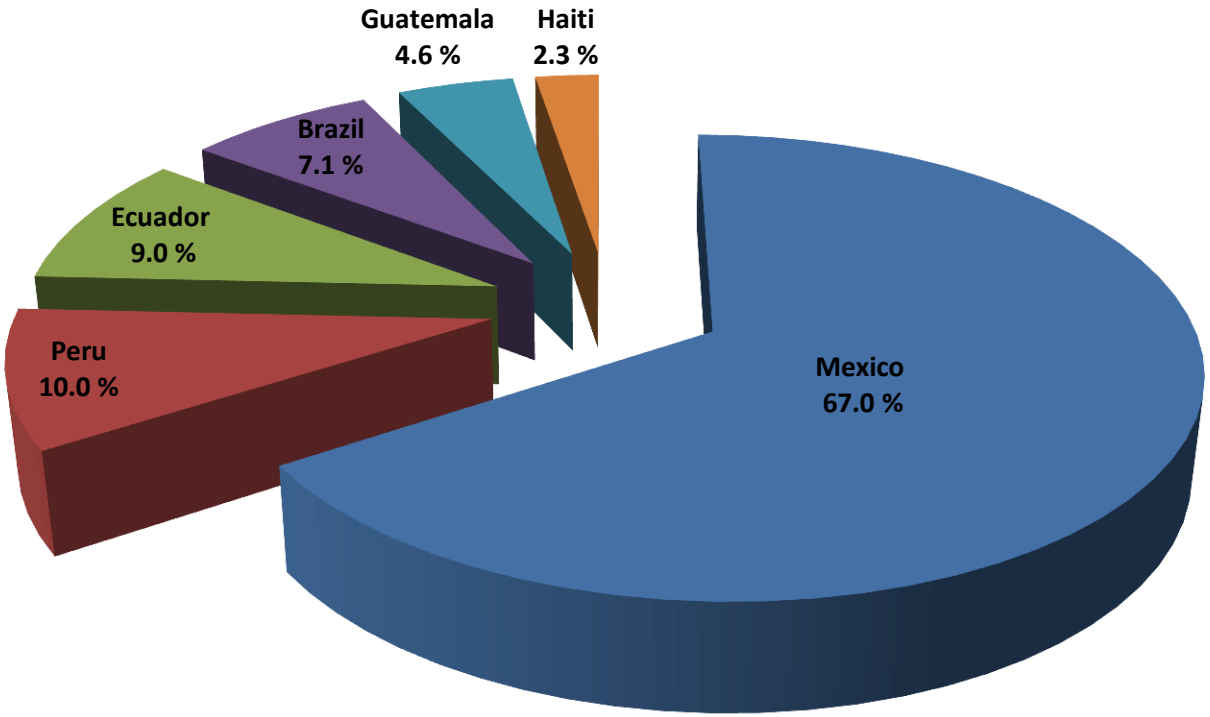
WHO I AM

- **Researcher since May, 1981. National Research Institute in Forestry, Agronomy and Livestock (INIFAP).**
- **Postharvest Ph.D. Agronomy and Horticulture Department. New Mexico State University. January, 1997.**
- **Since then, Postharvest and Food Safety Researcher. Santiago Ixcuintla Experimental Station. Nayarit, MEXICO.**
- **Publications:** Two books and two book chapters in Postharvest of Mango, Papaya and Sapote Mamey. Thirty eight articles in National and International Journals; 18 in extension articles in Proceedings of National and International Congresses, as well as, nine technical publications.
- **Congresses:** Thirty one presentations in National Congresses and 23 in International Congresses.
- **Thesis Advisor:** Thirteen Bachelor Degree, eight in Master degree, one in Ph. D. degree and 12 in University High Technical degree.
- **Awards:**

1. Dean's Award of Excellence. New Mexico State University. 1996.
2. National Researcher level I. National Research System. 1998 to date.
3. Three times winner of the Science and Technology State Award (1999, 2005 and 2009).
4. "The Best Paper Award". 8th International Mango Symposium. Sun City, South Africa, 2006.
5. Fulbright and CONACYT Scholarships for Sabbatical. Horticultural Sciences Department UF. 2013.

OVERVIEW

Mango is one of the favorite fruits in the US market, where consumption has doubled in the past 10 years. During the last three years (2010-2012) an average 76.3 million 10-pound boxes have been imported.



Source: **USDA Foreign Agricultural Service,** ***2013***

PROBLEMS

Exporter countries face several challenges in delivering high quality fruit because of:

- Quarantine hot water treatment (QHWT) to assure fruit fly control. Packers believe this is the main factor for fruit quality loss.

- With exception of Mexico, most countries require up to four weeks of refrigerated transport in sea containers leading to overripe and problems at retail level.

PREVIOUS RESEARCH

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- 1-MCP is a potent ethylene inhibitor that binds to ethylene receptors, blocking its action (Sisler and Serek, 1997, 1999) and approved by EPA in 2002.

- 1-MCP influences ripening and senescence of several fruits and vegetables by reducing ethylene production and respiration, affecting mainly softening and color changes (Watkins 2006; 2008).

- Beneficial effect of 1-MCP proven for several mango varieties. Gaseous formulation with doses from 100 to 1200 ppb applied for 12 or 24 h at 22-25 °C or while cooling at 12 °C. 1-MCP delayed the climacteric peak and decreased ethylene production, maintained pulp firmness longer, and delayed ripening related color changes (Jiang and Joyce, 2000; Hofman *et al*., 2001; Osuna-García and Beltran, 2002; Silva *et al*., 2004; Osuna and Beltran, 2004; Osuna-García and Muñoz-Ramírez, 2004; Osuna-García *et al*., 2005; Osuna-García, 2006; Osuna-García *et al*., 2009; Pereira-Bomfim *et al*., 2011).

- In spite of these encouraging results, the adoption of gaseous 1-MCP at the commercial level has been very limited mainly due to the difficulty of its application.

PREVIOUS RESEARCH

- The efficacy of gaseous 1-MCP in mango fruit is greatly affected by the extent of hot water treatment (Osuna-García *et al*., 2007).

- A new aqueous 1-MCP formulation applied as a postharvest dip (1 to 5 min) has shown the same effectiveness as a 9 to 12 h application of gaseous 1-MCP, delaying the ripening and softening process in mango, avocado, tomato, carambola, and pear fruits (Contreras-Martínez *et al*., 2007; Choi *et al*., 2008; Choi and Huber, 2008; Warren, 2009; Cheng *et al*., 2012).

- This new formulation could be easily incorporated into mango packinghouse processes than gaseous 1-MCP, just before or after the quarantine hot water treatment.

- If aqueous 1-MCP is successful, the mango industry will have a powerful tool to allow harvest of fully mature fruit, delaying ripening, extending shelf life, and maintaining fruit quality.

OVERALL OBJECTIVES

- Determine the effectiveness of aqueous 1-MCP on mango fruit with or without quarantine hot water treatment.
- Determine the best step during the mango packing process to apply aqueous 1-MCP.
- Evaluate the effect of aqueous 1-MCP on ripening processes, extension of shelf-life, and keeping fruit quality of ‘Kent’ and ‘Keitt’ mango varieties.
- Determine the metabolic and physiological processes involved in the mechanism of action of 1-MCP applied to heated or unheated mango fruit.

ACTIVITIES

1. EFFECTIVENESS OF AQUEOUS (1-MCP) ON MANGO FRUIT WITH AND WITHOUT QHWT (MEXICO).

2. EFFECTIVENESS OF AQUEOUS 1-MCP ON ‘KENT’ AND ‘KEITT’ MANGO WITH QHWT.

3. 1-MCP SORPTION BY ‘KENT’ AND ‘KEITT’ FRUIT:

    a. CAPACITY OF HEATED AND UNHEATED FRUIT TO BIND 1-MCP.
    b. CAPACITY OF WHOLE AND SLICED ‘KEITT’ FRUIT TO BIND 1-MCP.

4. EFFECT OF WATER SOURCE ON 1-MCP PERFORMANCE.

5. COMPARISON OF TWO SOURCES OF 1-MCP (AFXRD-038) FORMULATION.

6. CAPACITY OF HEATED AND UNHEATED WHOLE AND SLICED PAPAYA FRUIT TO BIND 1-MCP.

7. INGRESS OF 1-MCP FOR HEATED AND UNHEATED PAPAYA FRUIT.

8. INTERNAL GASEOUS 1-MCP IN HEATED AND UNHEATED PAPAYA FRUIT TREATED WITH AQUEOUS 1-MCP.

1. EFFECTIVENESS OF AQUEOUS (1-MCP) ON MANGO FRUIT WITH AND WITHOUT QHWT (MEXICO)

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METHODOLOGY

Dose of 1-MCP: 625 µg L^{-1} a.i. by dipping fruit for 5 min.
Treatments:

1. Absolute control (without QHWT; without 1-MCP)
2. Control 1-MCP (1-MCP applied to fruit without QHWT)
3. Control hydrothermal (only QHWT)
4. 1-MCP before QHWT
5. 1-MCP after QHWT
6. 1-MCP w/QHWT + hydrocooling

Design: Completely random with 20 reps for weight loss and 8 for other variables.

Varieties:

Variety	Origin	Harvest	Treatment	QHWT	Packinghouse
Kent	Pta Mangos, Nay	08/Jul/13	09/Jul/13	90 + 10’	ALEX
Keitt	Sauta, Nay	11/Jul/13	11/Jul/13	90 + 10’	HUGUIN

Ripening stage: Physiologically mature fruit. Pulp Color Table.pptx
Storage: Simulation of refrigerated shipment (3 weeks at 12 ± 1 °C; 90 ± 5 % RH) + Market simulation (22 ± 2 °C; 75 ± 10 % RH) until consumption stage.
Sampling: Initial, at the end of refrigerated period and then at day 4 and 7 of market simulation.
Variables measured: Weight loss, External Appearance, Firmness, Pulp Color, and Total Soluble Solids (°Bx).

1. EFFECTIVENESS OF AQUEOUS (1-MCP) ON MANGO FRUIT WITH AND WITHOUT QHWT

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KENT

1. EFFECTIVENESS OF AQUEOUS (1-MCP) ON MANGO FRUIT WITH AND WITHOUT QHWT

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KENT

1. EFFECTIVENESS OF AQUEOUS (1-MCP) ON MANGO FRUIT WITH AND WITHOUT QHWT

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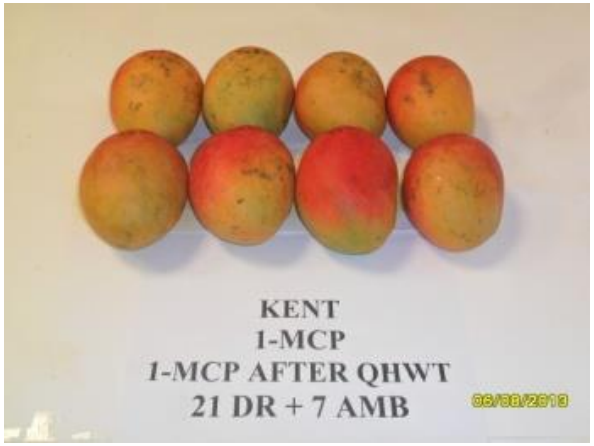
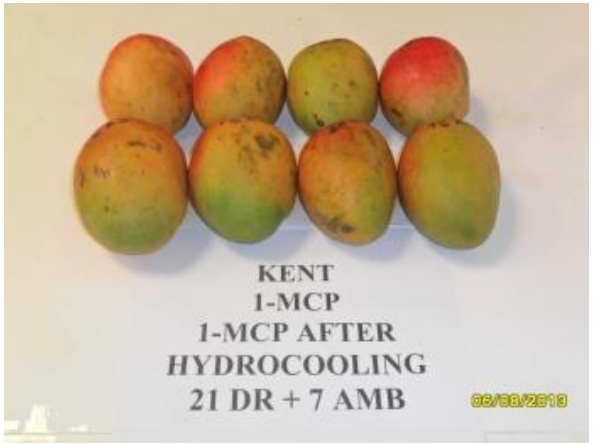
KENT





1. EFFECTIVENESS OF AQUEOUS (1-MCP) ON MANGO FRUIT WITH AND WITHOUT QHWT

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KEITT

1. EFFECTIVENESS OF AQUEOUS (1-MCP) ON MANGO FRUIT WITH AND WITHOUT QHWT

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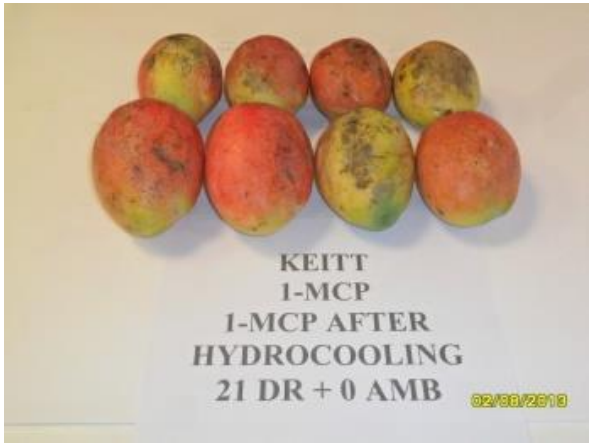
KEITT



1. EFFECTIVENESS OF AQUEOUS (1-MCP) ON MANGO FRUIT WITH AND WITHOUT QHWT

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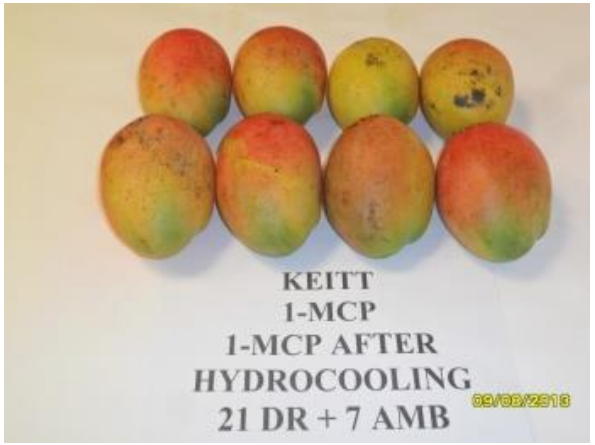
KEITT



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CONCLUSIONS

- For ‘Kent’, 1-MCP significantly affected most variables. It decreased water loss, maintained firmness longer, and delayed pulp color development, but negatively affected the external appearance (causing spots and lenticel blackening) when used in combination with QHWT. 1-MCP applied without QHWT didn’t affect the external appearance.

- For ‘Keitt’, 1-MCP without QHWT significantly decreased weight loss, maintained firmness longer, and delayed pulp color development without affecting external appearance. In contrast, 1-MCP in combination with QHWT showed a similar trend but it negatively affected the external appearance.

- It seems that 1-MCP is not a good alternative for mangos exported to the USA, but could be useful for countries that don’t demand mandatory QHWT.

2. EFFECTIVENESS OF AQUEOUS 1-MCP ON MANGO WITH QHWT

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METHODOLOGY

Dose of 1-MCP: 625 µg L^{-1} a.i. in 50 L DiWater; applied between 20 and 45 min after preparation by dipping fruit for 5 min.
Times for 1-MCP application: Before and after QHWT
Design: Completely random (10 reps for weight loss; 5 reps for other variables and 3 reps for Respiration and Ethylene)

Treatments:

1. Control (only QHWT + Hydrocooling)
2. 1-MCP after QHWT
3. 1-MCP before QHWT
4. 1-MCP w/QHWT + Hydrocooling

Varieties:

a. Kent (Lyons Farms, Homestead, FL). August-September, 2013.
b. Keitt (USDA-ARS, Miami, FL). August-September, 2013.
c. Keitt2 (Tropical Mangoes, Merrit Island, FL). September-October, 2013.

QHWT: According to USDA protocol (46.1 °C for 90 min); Hydrocooling (21-23 °C for 30 min)
Ripening stage: Physiologically mature fruit.
Storage: Simulation of refrigerated shipment (3 weeks at 12 °C) + Market simulation (20 °C) until consumption stage.
Sampling: Initial, at the end of refrigerated period and then at consumption stage.
Variables to measure: Weight loss, external appearance, firmness, pulp color, total soluble solids (°Bx), Respiration, and Ethylene.

2. EFFECTIVENESS OF AQUEOUS 1-MCP ON MANGO WITH QHWT

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Kent (Lyons Farms, Homestead, FL).

Variable	Initial		21 DR + 0 Amb		21 DR + 4 Amb	
Weight loss	NS		**		**	
External Appearance	NS		*		NS	
Firmness	NS		*		NS	
Pulp Color	*		*		*	
TSS	*		NS		*	
Respiration	NS	NS	NS	*	*	NS
Ethyl	NS	NS	*	NS	NS	NS
Sampling	Ini	21+0	21+1	21+2	21+3	21+4

NS = Non Significant * = Significant ($p \leq 0.05$) ** Highly significant ($p \leq 0.01$)

2. EFFECTIVENESS OF AQUEOUS 1-MCP ON MANGO WITH QHWT

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Kent (Lyons Farms, Homestead, FL).

2. EFFECTIVENESS OF AQUEOUS 1-MCP ON MANGO WITH QHWT

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Keitt (USDA-ARS, Miami, FL)

Variable	Initial		21 DR + 0 Amb		21 DR + 4 Amb	
Weight loss	NS		**		NS	
External Appearance	NS		**		NS	
Firmness	NS		*		NS	
Pulp Color	NS		NS		NS	
TSS	NS		NS		NS	
Respiration	*	NS	NS	NS	NS	**
Ethyl	NS	**	*	*	*	NS
Sampling	Ini	21+0	21+1	21+2	21+3	21+4

NS = Non Significant * = Significant ($p \leq 0.05$) ** Highly significant ($p \leq 0.01$)

2. EFFECTIVENESS OF AQUEOUS 1-MCP ON MANGO WITH QHWT

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Keitt (USDA-ARS, Miami, FL)

2. EFFECTIVENESS OF AQUEOUS 1-MCP ON MANGO WITH QHWT

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Keitt2 (Tropical Mangoes, Merrit Island, FL)

Variable	Initial		21 DR + 0 Amb		21 DR + 7 Amb	
Weight loss	NS		NS		NS	
External Appearance	NS		NS		NS	
Firmness	NS		*		-	
Pulp Color	NS		NS		NS	
TSS	NS		NS		NS	
Respiration	NS	NS	NS	NS	NS	NS
Ethyl	NS	NS	NS	NS	NS	NS
Sampling	Ini	7 DR	14 DR	21+0	21+2	21+4

NS = Non Significant * = Significant ($p \leq 0.05$) ** Highly significant ($p \leq 0.01$)

2. EFFECTIVENESS OF AQUEOUS 1-MCP ON MANGO WITH QHWT

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Keitt2 (Tropical Mangoes, Merrit Island, FL)

CONCLUSIONS

- In fruit of 'Kent', 1-MCP significantly affected most of the variables. When applied after the QHWT 1-MCP increased weight loss, maintained firmness longer, and delayed pulp color development, but negatively affected the external appearance of the fruit by causing lenticel blackening.

- When applied to 'Keitt' fruit, 1-MCP showed a similar trend as in 'Kent' fruit, except for weight loss, which was decreased. However, 1-MCP applied in combination with QHWT also negatively affected the external appearance of the fruit.

- The results found in the experiments conducted at the University of Florida showed the same trend as those in Mexico. 1-MCP delayed the ripening process by maintaining firmness longer and by delaying the pulp color development, but in combination with QHWT negatively affected the external appearance of the fruit.

- 1-MCP doesn't seem to be a good alternative for countries exporting mango the USA, where the QHWT is mandatory.

3. 1-MCP SORPTION BY ‘KENT’ AND ‘KEITT’ FRUIT

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METHODOLOGY

Capacity of heated and unheated ‘Kent’ and ‘Keitt’ mango fruit to bind 1-MCP.

1-MCP concentration: 20 µL L^{-1}

Varieties:

a. Kent (Lyons Farms, Homestead, FL). 16-17 August, 2013.
b. Keitt (USDA-ARS, Miami, FL). 28-29 August, 2013.

Treatments:

1. Control (1-MCP at 20 µL L^{-1} without fruit)
2. Unheated fruit
3. Heated fruit just after QHWT
4. Fruit with Hydrocooling for 30 min after QHWT
5. Heated ‘rest’ fruit for 24 h after QHWT

QHWT: According to USDA protocol (46.1 °C for 90 min); Hydrocooling (21-23 °C for 30 min).

Average fruit size: Kent: 853.3 g **Keitt:** 987.5 g

Plastic containers sealed with parafilm: 6.7 L

Variables to measure: 1-MCP depletion by a Varian CP-3800 GC.

Design: Completely randomized with 5 reps.

3. 1-MCP SORPTION BY ‘KENT’ AND ‘KEITT’ FRUIT

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METHODOLOGY

Capacity of whole and sliced ‘Keitt’ fruit to bind 1-MCP

1-MCP concentration: 20 µL L^{-1}

Varieties:

Keitt (USDA-ARS, Miami, FL). 29 August, 2013.

Treatments:

1. Control (1-MCP at 20 µL L^{-1} without fruit)
2. Whole fruit
3. Sliced fruit

QHWT: No

Average fruit size: 500.4 g **Plastic containers sealed with parafilm:** 6.7 L.

Variables to measure: 1-MCP depletion by a Varian CP-3800 GC.

Design: Completely randomized with 5 reps.

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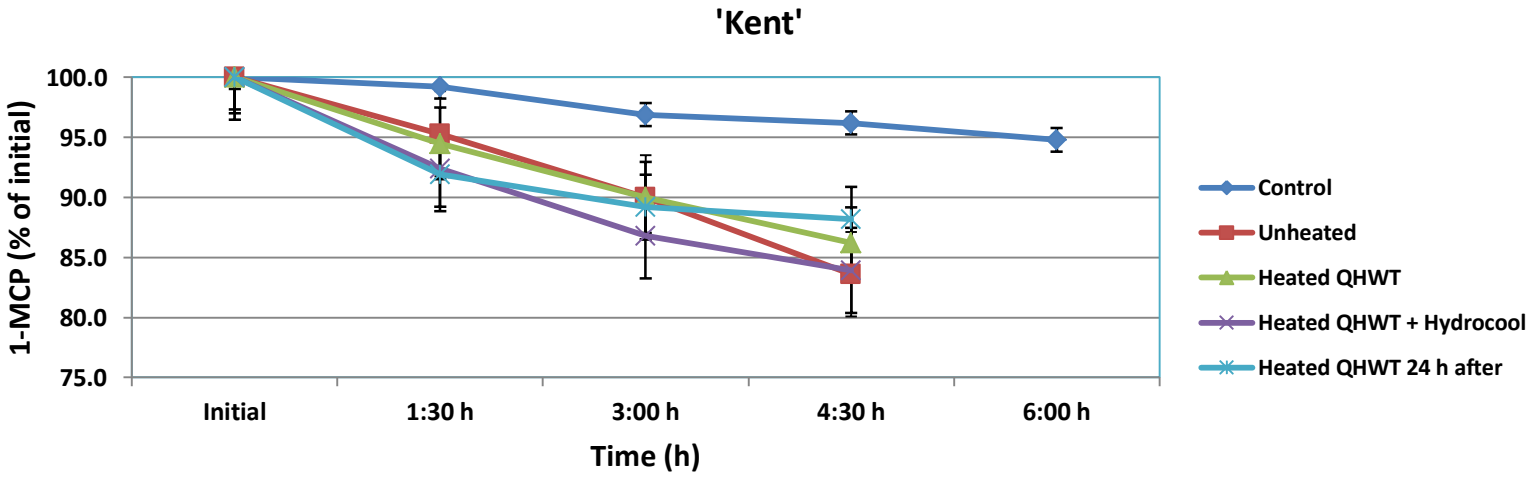
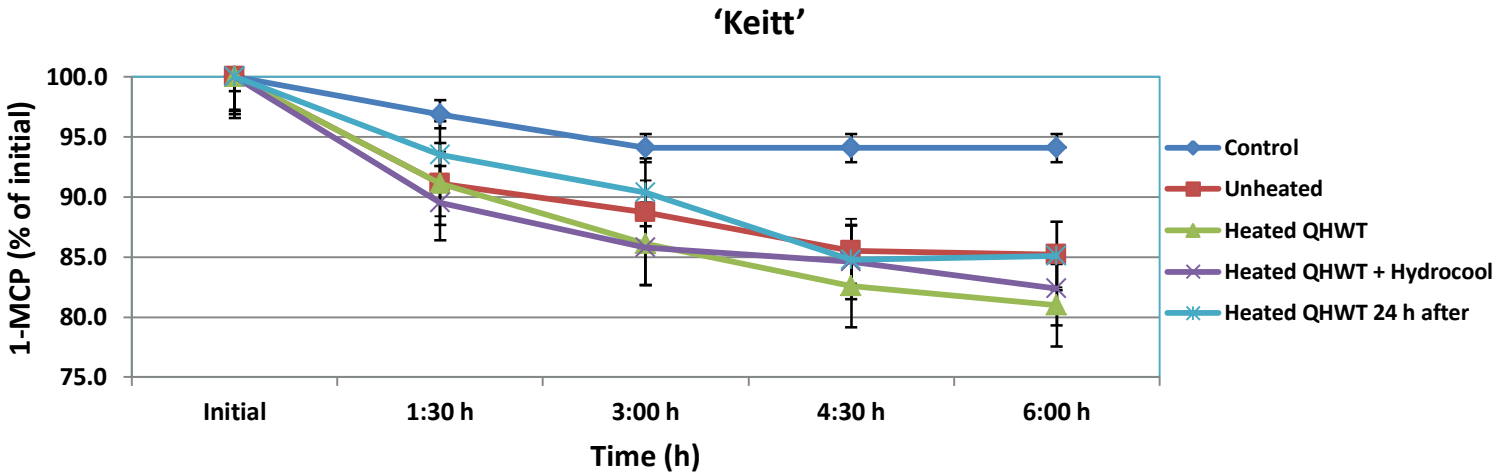
RESULTS: Capacity of heated and unheated ‘Kent’ and ‘Keitt’ mango fruit to bind 1-MCP.





3. 1-MCP SORPTION BY ‘KEITT’ FRUIT

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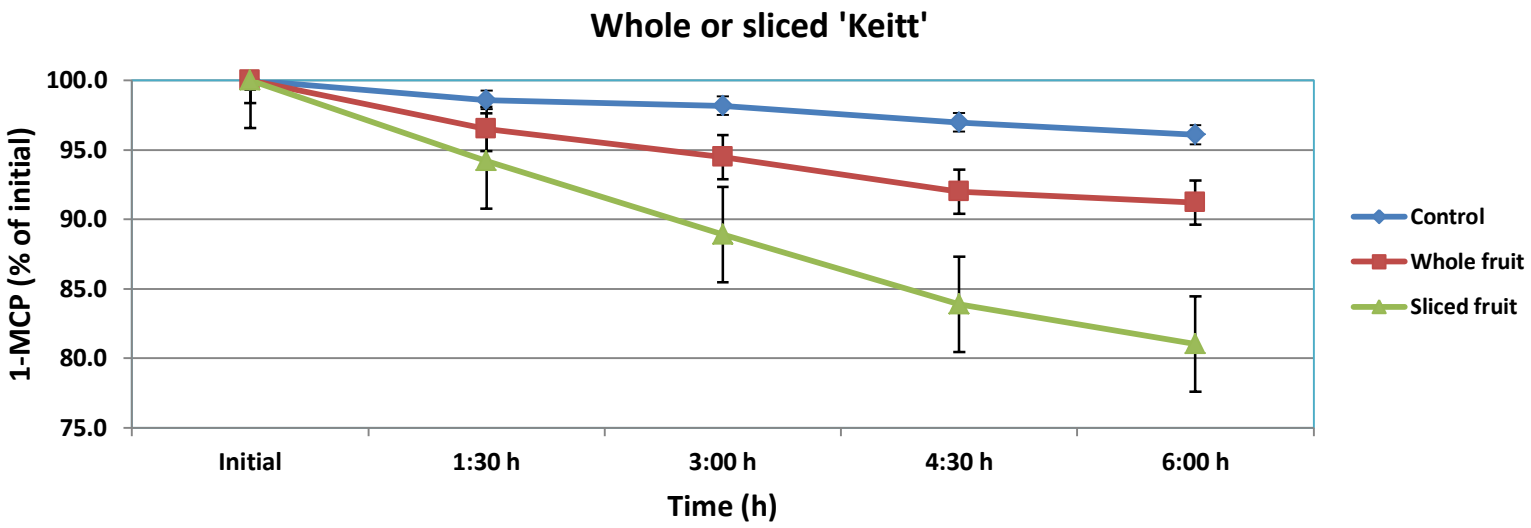
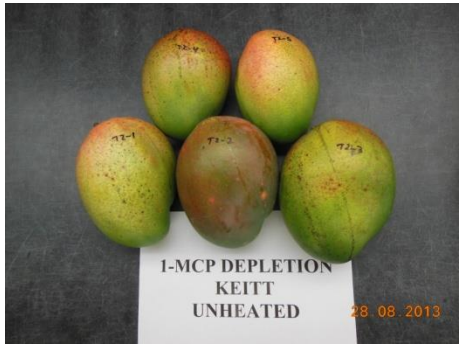
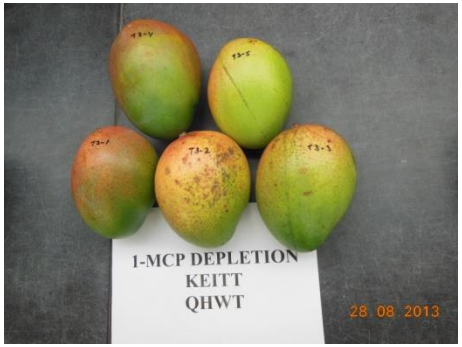
RESULTS:

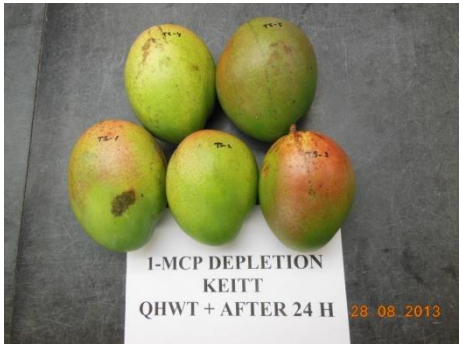
Capacity of whole and sliced ‘Keitt’ fruit to bind 1-MCP

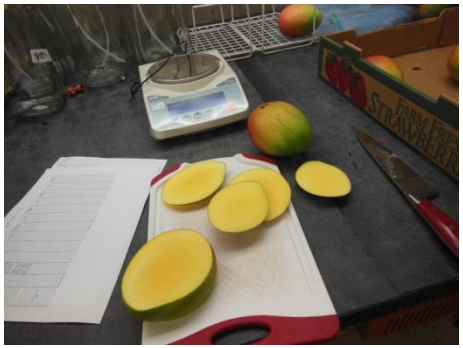


3. 1-MCP SORPTION BY KEITT' FRUIT









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CONCLUSIONS

- ‘Kent’ and ‘Keitt’ fruit showed a different pattern related to 1-MCP sorption. Unheated and heated fruit were very similar in the 1-MCP sorption rate, which was lower than that of fruit with QHWT + hydrocooling and fruit with 24 h rest after QHWT.

- In contrast, ‘Keitt’ fruit that were unheated or with 24 h rest after QHWT showed similar but lower 1-MCP sorption rates than those fruit that were heated or heated + hydrocooling.

- In addition, it was observed that sliced ‘Keitt’ fruit showed a 1-MCP sorption rate twice that of whole fruit.

METHODOLOGY

Dose of 1-MCP: 625 µg L^{-1} a.i. in 15 L water; applied 25 min after preparation by dipping fruit for 5 min.

Times for 1-MCP application: Before QHWT

Treatments:

1. DI water
2. Tap water
3. Chlorinated water (50 ppm)

Varieties: Keitt (USDA-ARS, Miami, FL). 30 August to 24 September, 2013.

QHWT: According to USDA protocol (46.1 °C for 75 min); Hydrocooling (21-23 °C for 20 min)

Ripening stage: Physiologically mature fruit.

Storage: Simulation of refrigerated shipment (3 weeks at 12 °C) + Market simulation (20 °C) until consumption stage.

Sampling: Initial, at the end of refrigerated period and then at consumption stage.

Variables to measure: External appearance, firmness, pulp color, total soluble solids (°Bx), Respiration, and Ethylene.

Design: Completely random (4 reps for all variables).

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RESULTS

Variable	Initial	21 DR + 0 Amb	21 DR + 4 Amb
External Appearance	NS	NS	NS
Firmness	NS	NS	-
Pulp Color	NS	*	-
TSS	NS	NS	-
Respiration	*	*	-
Ethylene	*	NS	-

NS = Non Significant * = Significant ($p \leq 0.05$) ** Highly significant ($p \leq 0.01$)

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RESULTS

Pulp color (Hue)

Treat	Initial	21 DRef + 0 Amb	21 DRef + 4 Amb
DI water	85.1 a	85.8 a	
Tap water	86.4 a	84.1 ab	
Chlorinated water (50 ppm)	85.1 a	81.5 b	

Means with the same letter within columns are not statistically different (Duncan $P \leq 0.05$)

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RESULTS

Respiration (ml CO_2/Kg-h)

Treat	Initial	21 DRef + 0 Amb	21 DRef + 4 Amb
DI water	121.3 a	21.0 b	
Tap water	82.4 b	29.5 a	
Chlorinated water (50 ppm)	78.5 b	27.3 a	

Ethylene (uL/Kg/h)

Treat	Initial	21 DRef + 0 Amb	21 DRef + 4 Amb
DI water	0.13 ab	0.6 a	
Tap water	0.03 b	0.5 a	
Chlorinated water (50 ppm)	0.30 a	0.6 a	

Means with the same letter within columns are not statistically different (Duncan $P \leq 0.05$)

4. EFFECT OF WATER SOURCE ON 1-MCP PERFORMANCE

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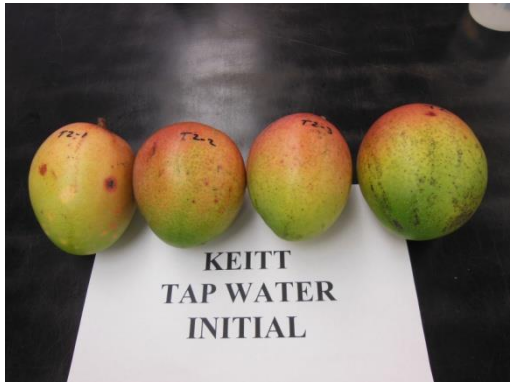
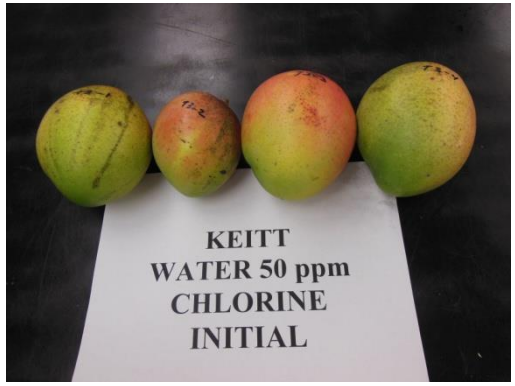
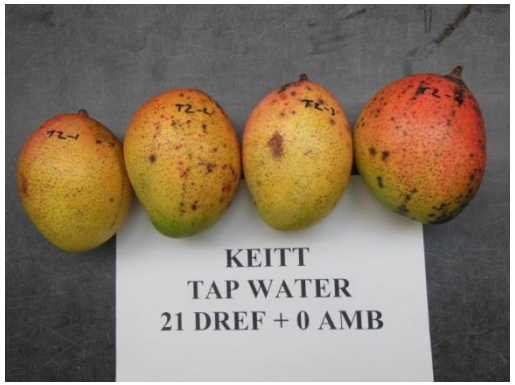
RESULTS







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CONCLUSIONS

- The water source for preparing the aqueous 1-MCP solution significantly affected pulp color, respiration and ethylene production. With respect to pulp color, the treatment containing chlorinated water showed the highest pulp intensity indicating a quicker ripening process.

- In relation to respiration rate, the fruit treated with 1-MCP prepared in distilled water showed the highest initial respiration rate but at the end of shipping simulation it was the lowest.

- With respect to ethylene production, the only significant differences were detected initially, when the fruit treated with 1-MCP dissolved in tap water showed the lowest rate.

- Results suggested that 1-MCP should be dissolved in distilled or tap water but not in chlorinated water because chlorine apparently disables 1-MCP function, likely through oxidative destruction.

5. COMPARISON OF TWO SOURCES OF 1-MCP (AFXRD-038) FORMULATION

Objectives:

- To compare the initial concentration of AFXRD-038 formulation used in Dr. Huber's lab versus the AFXRD-038 formulation used in Mexico.

- To compare the depletion rate of both formulations.

- To prove the AFXRD-038 formulation used in Mexico has at least the same performance as the formulation used in the UF lab.

METHODOLOGY

- 1-MCP sources:
  AFXRD-038 formulation got from Rohm and Haas in October, 2011.
  AFXRD-038 formulation got from Dow Chemical (formerly Rohm and Haas) in May, 2013.

- Initial concentration: 30,156 ppm (1 g AFXRD-038 dissolved in 50 mL distilled water in a 500 mL side arm flask).

- 1-MCP depletion was monitored every 2 hours for up 8 hours during the first day and then every 4 hours during the second and third day. A Varian CP-3800 GC was used. Three aliquots of the same sample were taken.

5. COMPARISON OF TWO SOURCES OF 1-MCP (AFXRD-038) FORMULATION

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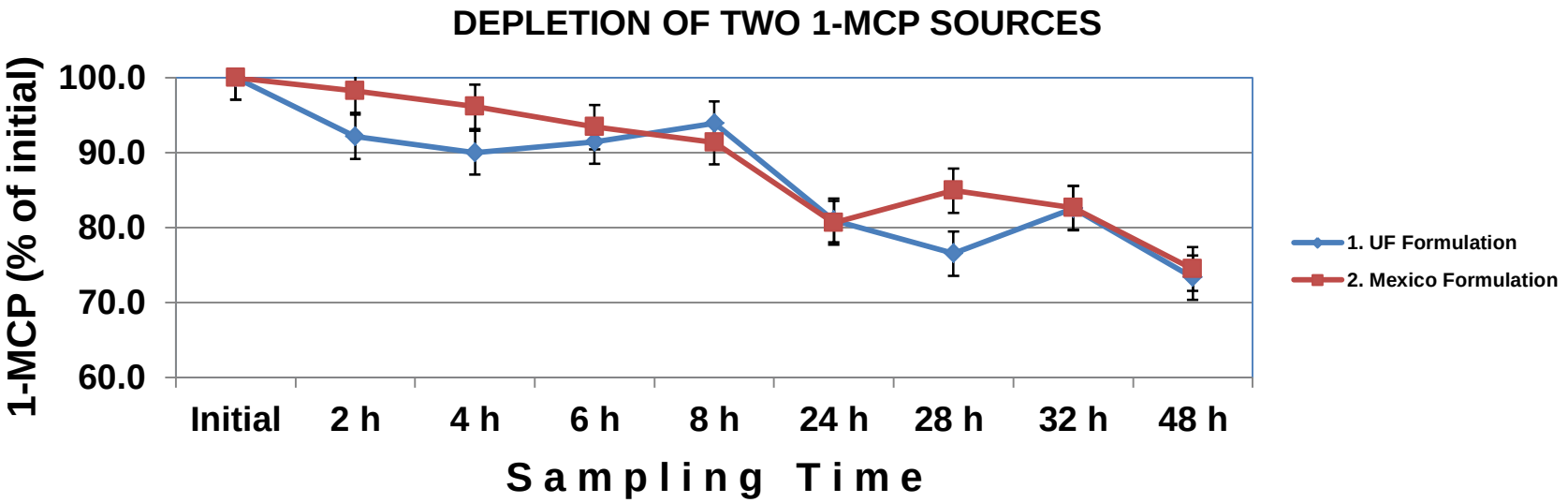
RESULTS:

INITIAL CONCENTRATION UF FORMULATION 24,141.27 ppm (80.0 %)
INITIAL CONCENTRATION MEXICO FORMULATION 25,205.70 ppm (83.6 %)



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CONCLUSIONS

- No significant differences were found for either the initial concentrations or the depletion rates of both formulations.

- The AFXRD-038 formulation used in Mexico showed the same or better performance than that used in Dr. Huber's lab.

6. CAPACITY OF HEATED AND UNHEATED WHOLE AND SLICED PAPAYA FRUIT TO BIND 1-MCP.

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Objectives:

- To measure the capacity of heated and unheated intact papaya fruit to adsorb 1-MCP.
- To measure the capacity of heated and unheated sliced papaya fruit to adsorb 1-MCP.
- To determine if there are differences in combined sorption and degradation of 1-MCP by heated and unheated, whole and sliced papaya fruit.

METHODOLOGY

- Papaya 'Solo' type. (December 2013 and January 2014)
- 1-MCP concentration: 20 µL L^{-1}
- Treatments:
    1. Control (1-MCP at 20 µL L^{-1} without fruit).
    2. 1-MCP at 20 µL L^{-1} applied to unheated whole fruit.
    3. 1-MCP at 20 µL L^{-1} applied to whole fruit treated with QHWT.
    4. 1-MCP at 20 µL L^{-1} applied to slices from unheated fruit.
    5. 1-MCP at 20 µL L^{-1} applied to slices from fruit treated with QHWT.
    6. 1-MCP at 20 µL L^{-1} applied to fruit slices heated in microwave oven.
- Design: Completely Randomized with 3 replications.

Note: Quarantine Hot Water Treatment (QHWT) applied according to the USDA protocol. At 118.4 °F (48.0 °C) for 75 min.

6. CAPACITY OF HEATED AND UNHEATED WHOLE AND SLICED PAPAYA FRUIT TO BIND 1-MCP.

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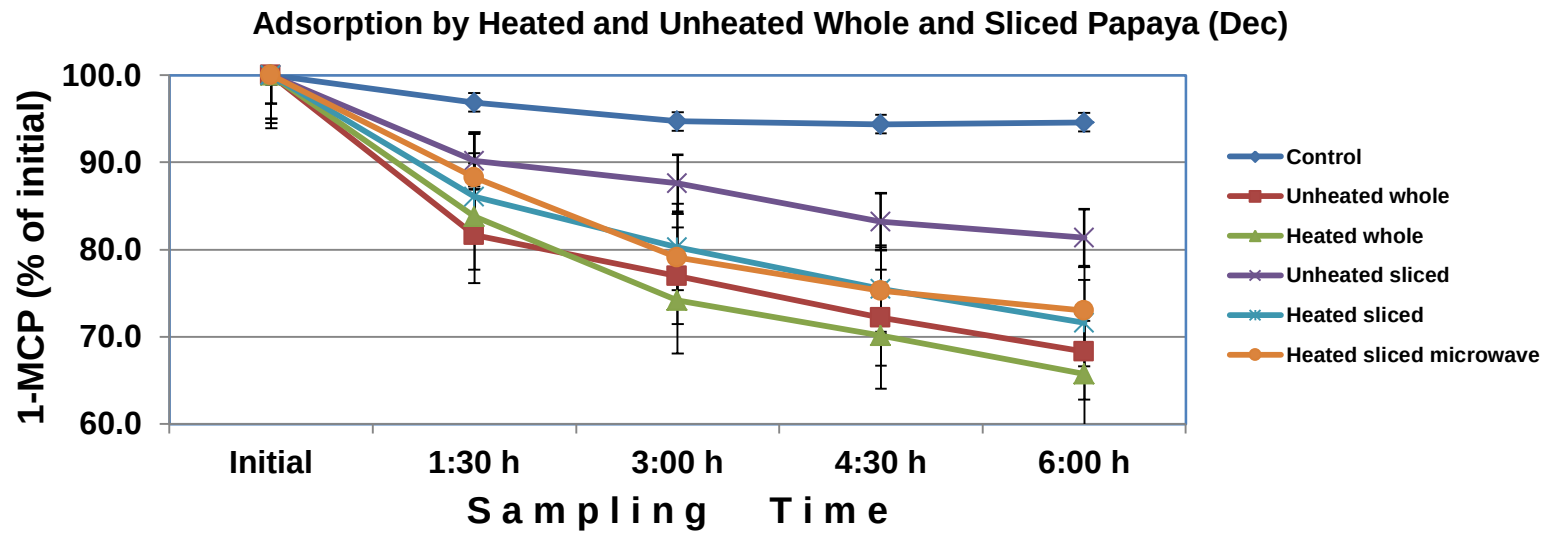
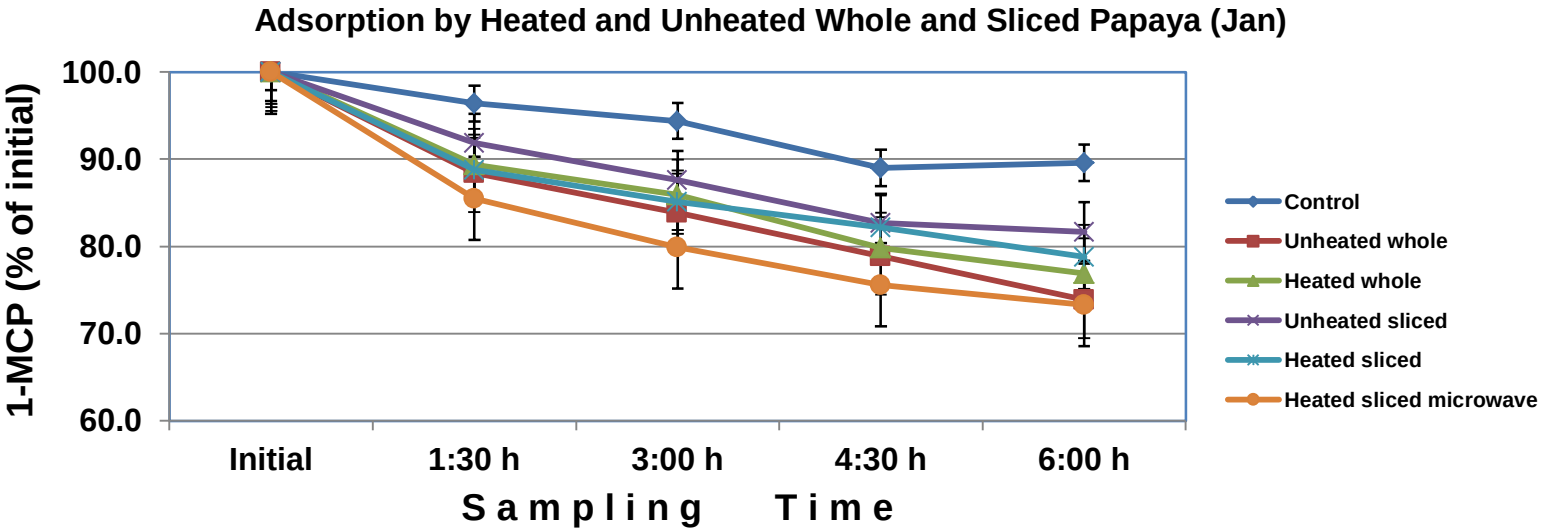
RESULTS:





CONCLUSIONS

- No significant differences in gaseous 1-MCP adsorption were detected for heated or unheated whole papaya fruit.

- No significant differences were found between unheated sliced and heated (HWT or Microwave) sliced papaya fruit.

7. INGRESS OF GASEOUS 1-MCP ON HEATED AND UNHEATED PAPAYA FRUIT.

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Objectives:

- To measure the ingress of gaseous 1-MCP for heated and unheated intact papaya fruit**.**
- To find if there are differences in the ingress of 1-MCP according to the region of the fruit.

METHODOLOGY

- Papaya 'Solo' type. (December 2013 and January 2014).
- 1-MCP concentration: 20 µL L^{-1}

Factors:

Factor A (heated or unheated)
Factor B (1-MCP exposure time: 1, 3, 6, and 24 h)

- **Treatments:**
  1. Heated + 1-MCP for 1 h
  2. Heated + 1-MCP for 3 h
  3. Heated + 1-MCP for 6 h
  4. Heated + 1-MCP for 24 h
  5. Unheated + 1-MCP for 1 h
  6. Unheated + 1-MCP for 3 h
  7. Unheated + 1-MCP for 6 h
  8. Unheated + 1-MCP for 24 h

- **Design:** Factorial with 3 replications.

Note: Quarantine Hot Water Treatment (QHWT) applied according to the USDA protocol. 118.4 °F (48.0 °C) for 75 min.

7. INGRESS OF GASEOUS 1-MCP ON HEATED AND UNHEATED PAPAYA FRUIT.

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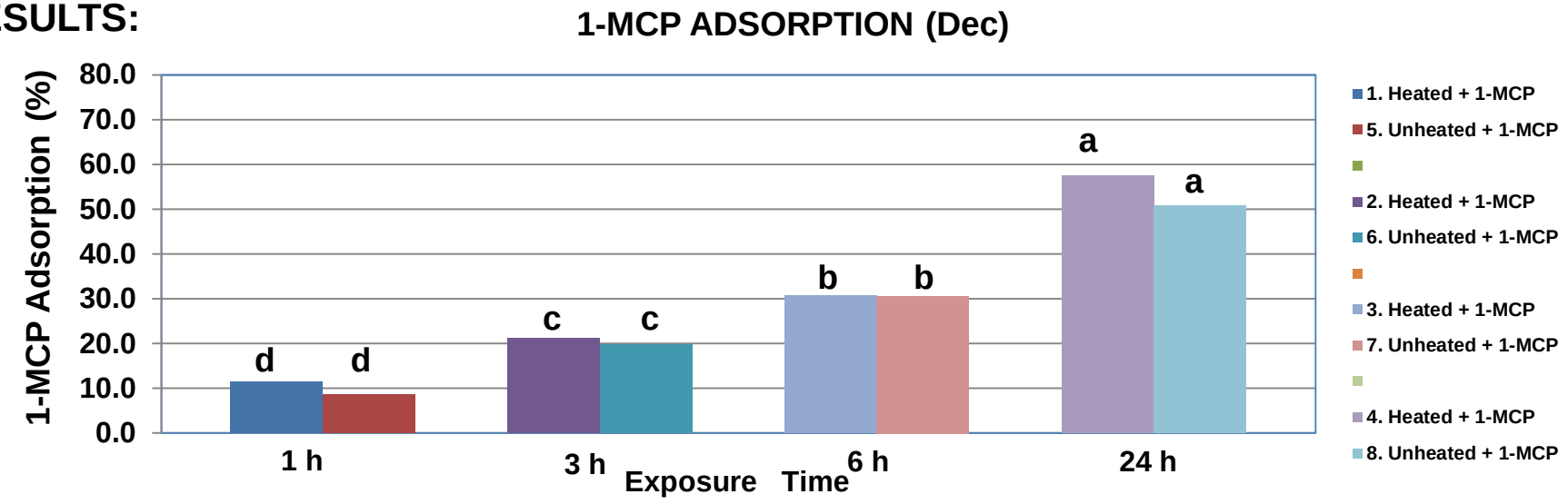
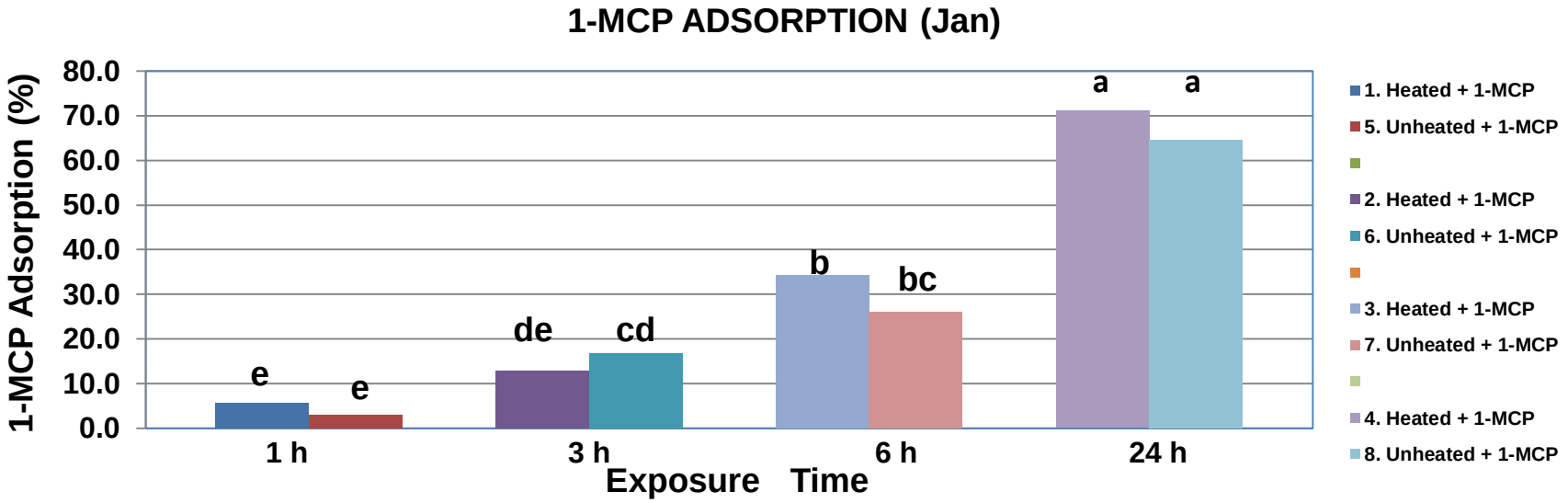
RESULTS:





7. INGRESS OF GASEOUS 1-MCP ON HEATED AND UNHEATED PAPAYA FRUIT.

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RESULTS:

1-MCP CONCENTRATION (nL L^{-1}) [Dec]

HWT		EXPOSURE TIME		SAMPLING REGION	
HEATED	183.0 a	1 h	152.0 a	APICAL	222.0 a
UNHEATED	71.0 b	3 h	97.0 a	MIDDLE	106.0 b
		6 h	140.0 a	BASAL	94.0 b
		24 h	119.0 a	CAVITY	86.0 b

1-MCP CONCENTRATION (nL L^{-1}) [Jan]

HWT		EXPOSURE TIME		SAMPLING REGION	
HEATED	181.0 a	1 h	107.0 b	APICAL	107.0 b
UNHEATED	84.0 b	3 h	144.0 ab	MIDDLE	60.0 b
		6 h	214.0 a	BASAL	84.0 b
		24 h	64.0 b	CAVITY	279.0 a

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CONCLUSIONS

- No significant differences in gaseous 1-MCP ingress were detected between heated and unheated papaya fruit.
- Significant differences were found among the gaseous 1-MCP exposure times. The longer the exposure time, the greater the 1-MCP ingress.
- The results for internal 1-MCP were not consistent between the experiments conducted in December 2013 and January 2014. In the first experiment the apical region showed the highest 1-MCP concentration while in the second experiment the highest 1-MCP concentration was in the cavity of the fruit.

8. INTERNAL GASEOUS 1-MCP IN HEATED AND UNHEATED PAPAYA FRUIT TREATED WITH AQUEOUS 1-MCP.

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Objectives:

- To measure the ingress of aqueous 1-MCP for heated and unheated intact papaya fruit**.**
- To find if there are differences in the ingress of 1-MCP according to the region of the fruit.

METHODOLOGY

- Papaya 'Solo' type. (December 2013 and January 2014).
- **Factors:**
  Factor A (heated or unheated)
  Factor B (1-MCP concentration: 1 and 3 mg L^{-1})
  Factor C (Exposure time: 1 and 5 min)
- **Treatments:**
  1. Heated and dipped at 1 mg L^{-1} for 1 min
  2. Heated and dipped at 1 mg L^{-1} for 5 min
  3. Heated and dipped at 3 mg L^{-1} for 1 min
  4. Heated and dipped at 3 mg L^{-1} for 5 min
  5. Unheated and dipped at 1 mg L^{-1} for 1 min
  6. Unheated and dipped at 1 mg L^{-1} for 5 min
  7. Unheated and dipped at 3 mg L^{-1} for 1 min
  8. Unheated and dipped at 3 mg L^{-1} for 5 min
- **Design**: Completely Randomized with 3 replications.

Note: Quarantine Hot Water Treatment (QHWT) applied according to the USDA protocol. 118.4 °F (48.0 °C) for 75 min.

8. INTERNAL GASEOUS 1-MCP IN HEATED AND UNHEATED PAPAYA FRUIT TREATED WITH AQUEOUS 1-MCP.

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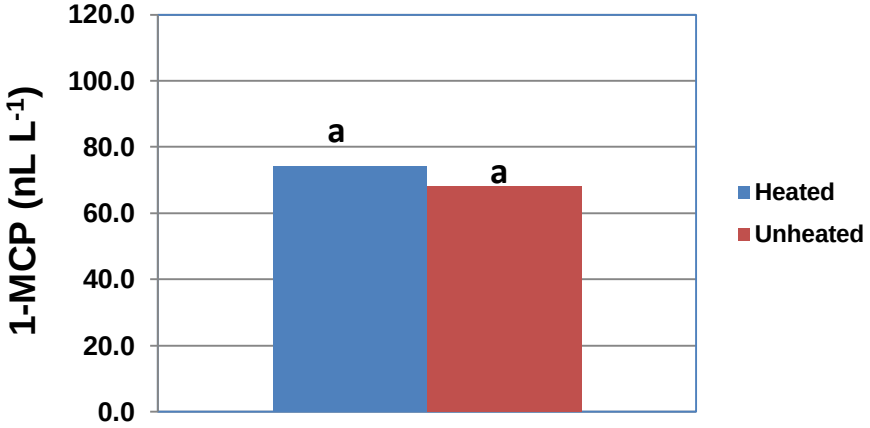
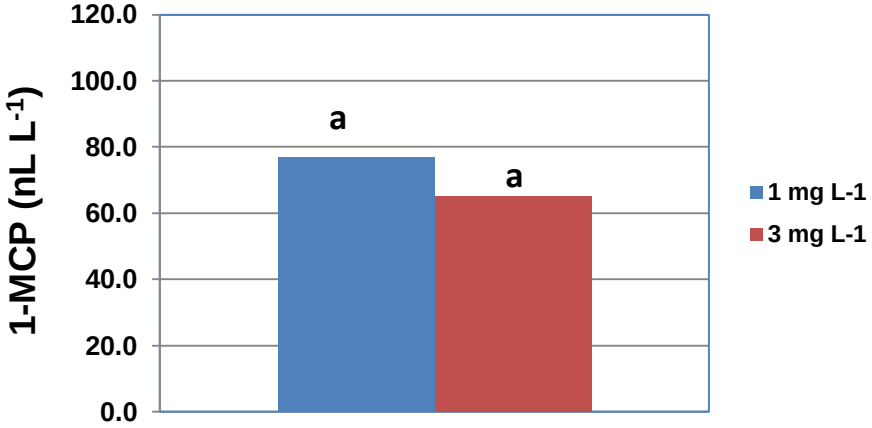
RESULTS: December, 2013.

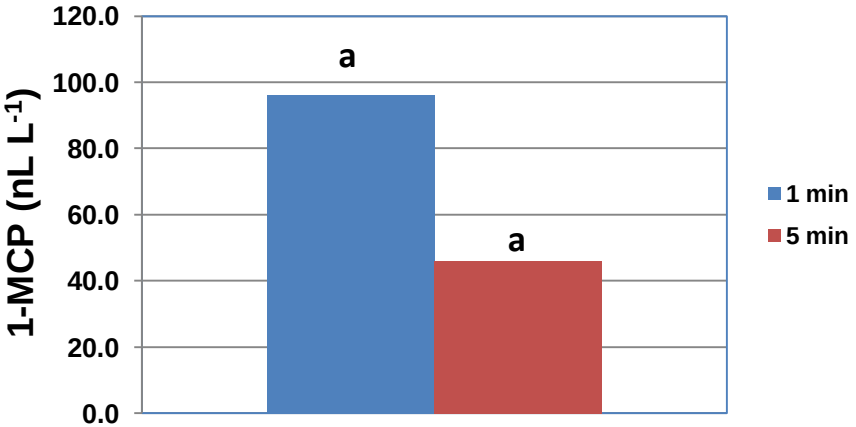
Effect of Hot Water Treatment



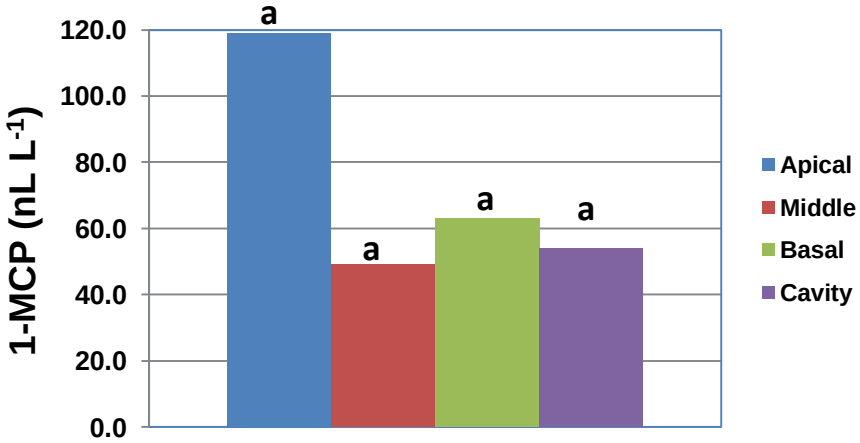
Effect of 1-MCP Concentration



Effect of Dipping Time



Effect of Sampling Region



8. INTERNAL GASEOUS 1-MCP IN HEATED AND UNHEATED PAPAYA FRUIT TREATED WITH AQUEOUS 1-MCP.

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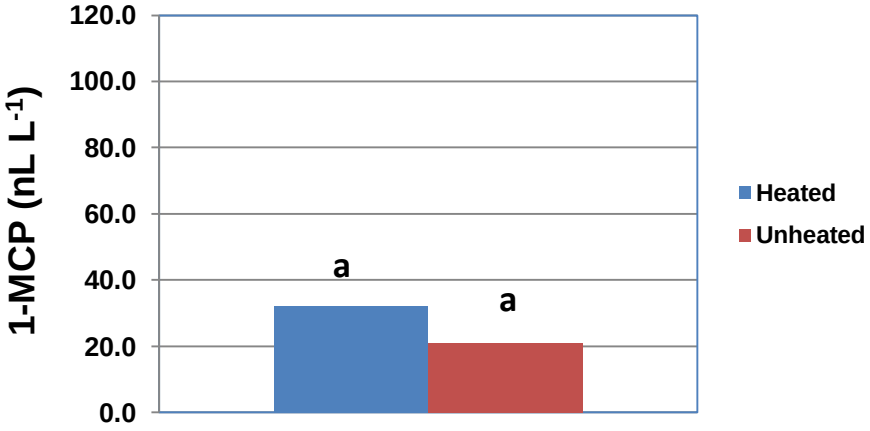
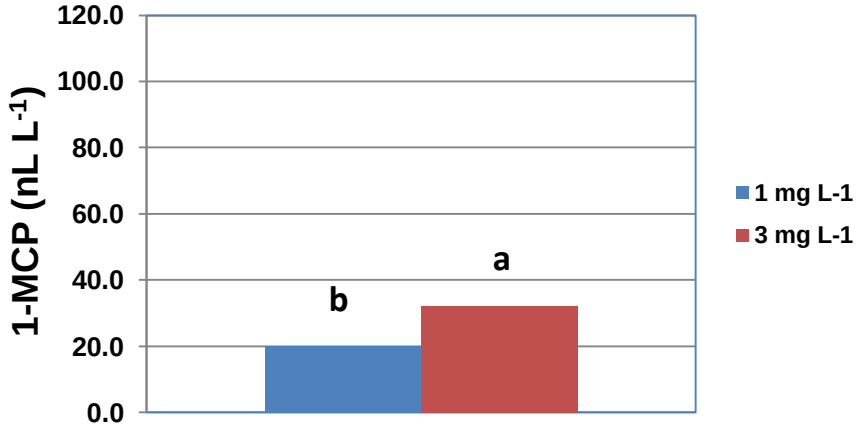
RESULTS: January, 2014.

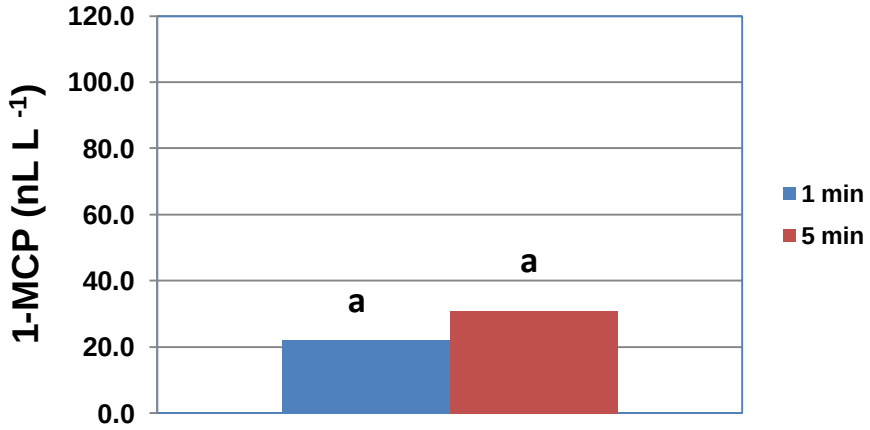
Effect of Hot Water Treatment



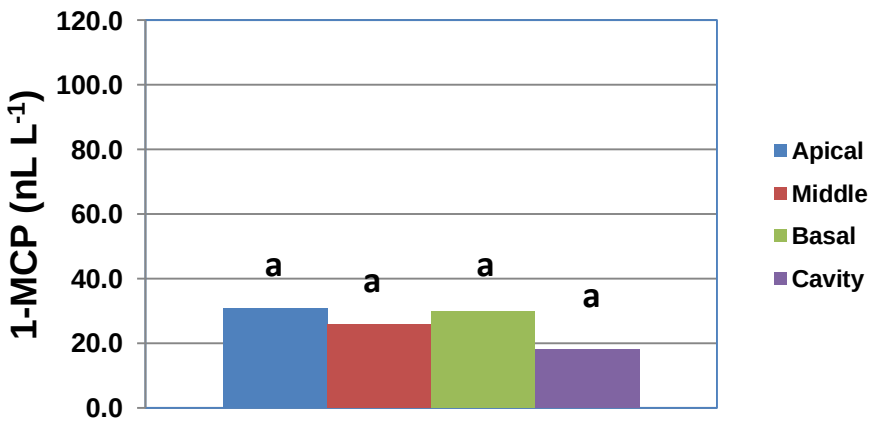
Effect of 1-MCP Concentration



Effect of Dipping Time



Effect of Sampling Region



CONCLUSIONS

- Different results were found according the date of the experiment. For the first experiment in December there were no differences in ingress of aqueous 1-MCP between heated and unheated fruit; and there were no differences between 1-MCP concentrations and dipping times. In addition, no significant differences were detected among the sampling regions of the papaya fruit.

- The results of the second experiment in January showed lower 1-MCP concentrations than found in the December experiment. A significant difference was observed only for the 1-MCP concentrations. The dose of 3 mg L^{-1} resulted in higher internal 1-MCP than 1 mg L^{-1}.

- These experiments showed the highest coefficient of variation because of the difficulty in taking the samples. Maybe the accuracy could be improved if the number of replications were to be increased as well.

T H A N K S !!

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Q U E S T I O N S ?

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