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Postharvest Quality of *Carica papaya* var. Eksotika after Foliar Feeding Treatment

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ABSTRACT

A field study was conducted to determine the effects of foliar feeding using of two Frumone® formulations on postharvest quality of Eksotika papaya. The treatments consisted of water (control), Frumone® and Frumone®+neem oil (2 $mL.L^{-1}$ water) applied by foliar spraying to one-year-old plants at 30-d intervals for 4 months. Green with trace of yellow fruits at ripening stage (RS) 2, were harvested and then ripened using calcium carbide (10 $g.kg^{-1}$ fruit) at 27°C for 24 h. Fruit quality at RS 2, 4 and 6 were evaluated. In comparison to the control treatment, the two formulations of Frumone® treatments did not affect peel colour, pulp firmness, soluble solids concentration (SSC), vitamin C content and titratable acidity of Eksotika papaya fruit. However, the pH of the fruit was significantly affected by the treatments. Fruit peel colour, flesh firmness, SSC, vitamin C content, pH and titratable acidity were significantly affected by RS. There were significant interaction effects of foliar feeding x RS on C* values, flesh firmness, SSC and pH. As fruits ripened, h° values correlated positively with pulp firmness and negatively with SSC. This indicated that during fruit ripening, the change in fruit peel colour, from green to yellow, was followed by fruit softening and increase in sweetness. In conclusion, foliar feeding using Frumone® and Frumone®+neem oil did not affect postharvest quality of Eksotika papaya fruit.

Keywords: Foliar feeding, postharvest quality, neem oil, colour, soluble solids concentration

INTRODUCTION

Foliar feeding provides supplemental doses of minor and major nutrients, plant hormones, stimulants and other beneficial substances to plant foliage and stem, via spraying. Plant response is rapid and efficient, with less of its product being needed per feeding (Oosterhuis *et al.*, 2000). Radioisotope studies indicated that foliar feeding was 8-20 times more effective compared to soil fertilizer application for a plant (Anon, 1985). Foliar fertilizer application increased yield and resistance to disease and insect pests, improved drought tolerance and enhanced crop quality. Foliar potassium applications during cantaloupe fruit development and maturation increase fruit firmness, sugar content, ascorbic acid and beta-carotene levels (Lester *et al.*, 2007). However, plant response to foliar feeding depends on species, fertilizer form, concentration and frequency of feeding and stage of plant growth (Kuepper, 2003). Thus, any new foliar fertilizer that is introduced to the agricultural chemical market has to be evaluated before it can be claimed to be beneficial. This is true for the new foliar fertilizer called Frumone® that is claimed to improve fruit set and fruit quality of papaya.

Frumone®, a water-base product, contains a variety of ingredients including phosphorous, potassium, chelated micro nutrients (boron, copper, iron, manganese, molybdenum and zinc), amino acids, synthetic plant hormones, and naturally derived plant growth promoters and adjuvant. Another formulation of Frumone® contains neem oil that has been extracted by cold pressing of the neem (*Azadirachta indica*) seeds. Neem oil has antimicrobial properties and the ability to improve soil fertility

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(Gajalakshimi and Abbasi, 2004). The objective of this study was to determine the effects of the two foliar fertilizer formulations, Frumone® and Frumone®+neem oil, on the postharvest quality of 'Eksotika' papaya fruit.

MATERIALS AND METHODS

The study was carried out from April to July 2005, at the papaya farm of the Department of Agriculture, Serdang, Selangor, Malaysia. Treatments, consisting of Frumone® and Frumone®+neem oil at the rate of 2 $mL.L^{-1}$ water, were applied by foliar spraying on 36 one-year-old papaya plants (selected randomly) at 30 days intervals. The control plants were only sprayed with water. Fruits at ripening stage (RS) 2 that were green with traces of yellow were harvested and then ripened using CaC_2 (10 $g.kg^{-1}$ fruit) at 27°C for 24 h. Fruit qualities at RS 2, 4 and 6 were evaluated.

Determination of Peel Colour

Peel colour was determined using a Minolta CR-300 Chroma Meter (Minolta Corp., Osaka, Japan) using the Illuminate C (CIE, 1976) and results were expressed as lightness (L*), chroma (C*) and hue (h°). The L* value ranges from 0 = black to 100 = white. The h° is an angle in a colour wheel of 360°, with 0°, 90°, 180° and 270° representing the hues red, yellow, green and blue, respectively, while C* is the intensity or purity of the hue. Measurements were carried out at three locations of every fruit of the papaya.

Determination of Flesh Firmness

Flesh firmness was evaluated using the Bishop Penetrometer FT 327 (Alfonsine, Italy). The force required for an 11-mm probe to penetrate the cut surface in two opposite locations to a depth of 5 mm was recorded. The penetration force was expressed in newton (N).

Determination of Soluble Solids Concentration (SSC)

Ten grams of fruit was macerated and the tissue was homogenised with 40 mL of distilled water using a kitchen blender. The mixture was filtered with cotton wool. A drop of the filtrate was then placed on the prism glass of a refractometer (Model N1, Atago Co., Ltd., Tokyo, Japan) to obtain the %SSC. The readings were corrected to a standard temperature of 20°C by adding 0.28% to obtain %SSC at 27°C.

Determination of pH

The remainder of the juice from the SSC determination was used to measure juice pH by using a glass electrode pH meter (model Micro pH 2000, Crison Instruments, Spain).

Determination of Vitamin C Content

Vitamin C content of flesh was determined according to the method of Ranggana (1977) and reading was expressed as $mg.100\ g^{-1}$.

Determination of Titratable Acidity

The remainder of the juice from the SSC determination was used to measure titratable acidity by titrating with 0.1 $mol.L^{-1}$ NaOH and using 1% phenolphtalein as an indicator. The results were calculated as percentage citric acid [(ml NaOH x 0.1 $mol.L^{-1}$/weight of sample titrated) x 0.064 x 100].

Statistical Analysis

The experimental design was a completely randomized design with three replications. Each replicate consisted of four plants with five fruits per plant. Data were analyzed using analysis of variance (SAS, 1998) and means were separated by LSD. Correlation analysis by means of Pearson's correlation matrix was performed to establish any association between peel colour, flesh firmness, SSC, vitamin C content, pH and titratable acidity.

RESULTS AND DISCUSSION

Foliar feeding using Frumone® and Frumone®+neem oil did not affect peel colour of the papaya fruit (Table 1). The main effect of RS indicated that L* and C* values increased while h° values decreased significantly as papaya fruit ripened from RS 2 to 6. The h° values of the peel decreased from green to yellow as the fruit attained ripeness. There was a significant interaction effect of foliar feed x RS on the C* values.

Flesh firmness of the papaya was not affected by foliar feeding of Frumone® and Frumone® +neem oil (Table 2). This is similar to studies on the effects of copper and calcium sprays on cherry and apple fruit quality whereby the foliar sprays had no effect on the flesh firmness of the fruits (Brown *et al.*, 1996). As expected, flesh firmness decreased significantly as fruit ripened from RS 2 to 6 (Table 2). The decrease could be due to polyuronide

TABLE 1
Main and interaction effects of foliar feeding and ripening stage on the peel colour (L*, C* and h°) of Eksotika papaya fruit

Factor	Peel Colour		
	L*	C*	h°
Foliar Feeding (FF)			
Control	54.48 a[z]	32.64 a	103.69 a
Frumone®	53.22 a	31.34 a	104.97 a
Frumone®+neem oil	53.72 a	31.31 a	102.61 a
Ripening Stage (RS)			
2	46.20 c	21.39 c	125.62 a
4	53.09 b	31.18 b	102.12 b
6	62.12 a	42.73 a	85.53 c
Interaction			
FF x RS	NS	*	NS

[Z] Mean separation within columns and factors by LSD at $P \leq 0.05$.
[NS,*]Non significant or significant at $P \leq 0.05$.

solubilization in the fruit during ripening (Selamat, 1993). The flesh firmness correlated positively with h° values (Table 3) indicating that as the green peel turned yellow, the flesh became soft.

Foliar feeding did not affect the SSC of papaya fruits (Table 2). Similar findings were reported in cherries and apples (Brown *et al.*, 1996), and tomatoes (Chapagain and Wiseman, 2004). As fruits ripened, the SSC of papaya fruit increased significantly with the maximum value occurring at RS 4. This was followed by a significant decrease of 9.88% in SSC as fruit ripened from RS 4 to 6. This has been reported in papaya whereby the SSC stagnates or decrease once fruits attain a certain degree of ripeness (Sim, 1988). The SSC of the fruits correlated negatively with h° values and firmness (Table 3), indicating that as fruits ripened, with the peel colour changing from green to yellow, the fruits became sweeter and softer.

The fruit pH was significantly affected by foliar feeding (Table 2). The pH decreased at RS 4 and then increased significantly at RS 6 as

TABLE 2
Main and interaction effects of foliar feeding and ripening stage on flesh firmness, SSC, pH, vitamin C content and titratable acidity of Eksotika papaya fruit

Factor	Firmness (N)	SSC (%)	pH	Vitamin C (mg.100 g^{-1})	Titratable acidity (%citric acid)
Foliar Feeding (FF)					
Control	1.28 a[z]	12.06 a	5.45 b	84.19 a	13.65 a
Frumone®	1.14 a	11.53 a	5.52 a	77.00 a	12.55 a
Frumone®+neem oil	1.21 a	12.53 a	5.42 b	86.38 a	12.12 a
Ripening Stage (RS)					
2	2.40 a	9.39 c	5.56 b	75.07 b	7.36 b
4	0.74 b	14.06 a	4.99 c	95.95 a	10.10 b
6	0.49 c	12.67 b	5.83 a	76.56 b	20.87 a
Interaction					
FF x RS	*	*	*	NS	NS

[Z] Mean separation within columns and factors by LSD at $P \leq 0.05$.
[NS],* Non significant or significant at $P \leq 0.05$.

fruit ripened. For fruit pH, there was a significant interaction effect of foliar feeding x RS. The vitamin C content of papaya fruits was not affected by foliar feeding treatment but increased significantly as fruits ripened from RS 2 to 4, then decreased significantly at RS 6 (Table 2).

The titratable acidity of the fruits was not affected by foliar feeding (Table 2). This was in agreement with the findings of foliar feeding in cherries and apples (Brown *et al.*, 1996), and tomatoes (Chapagain and Wiseman, 2004). The titratable acidity increased significantly as fruits ripened from RS 2 to 6 (Table 2). Similar findings were reported in acerola (Vendramini and Trugo, 2000) and passion fruit (Shiomi *et al.*, 1996). This could be due to an increase in the succinic acid as well as the presence of citric, oxalic, fumaric and malic acids in the papaya fruit during ripening (Ali *et al.*, 1994).

CONCLUSIONS

In comparison to the control, the two formulations of Frumone® treatments did not affect peel colour, pulp firmness, SSC, vitamin C content and titratable acidity of Eksotika papaya fruits. However, the fruit pH was significantly affected by the treatments. Fruit peel colour, flesh firmness, SSC, vitamin C content, pH and titratable acidity were significantly affected by RS. There were significant interaction effects of Frumone® x RS on C* values, flesh firmness, SSC and pH. During fruit ripening, the change in fruit peel colour, from green to yellow, was followed by fruit softening and the increase of fruit sweetness. In conclusion, foliar feeding using Frumone® and Frumone®+neem oil did not affect the postharvest quality of Eksotika papaya fruits.

TABLE 3
Correlation coefficients for peel colour (h°), flesh firmness (Firmness), soluble solids concentration (SSC), pH, vitamin C and titratable acidity (TA) of Eksotika papaya fruit in response to foliar feeding

	h°	Firmness	SSC	pH	Vitamin C	TA
h°	—					
Firmness	0.87**	—				
SSC	-0.60**	-0.73**	—			
pH	-0.22	0.07	-0.40**	—		
Vitamin C	-0.22	-0.25	0.52**	-0.49**	—	
TA	-0.77	-0.61**	0.32*	0.48**	0.04	—

n = 54.
*,** Significant or highly significant at $P \leq 0.05$ and $P \leq 0.01$, respectively.

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REFERENCES

Ali, Z.M., Lizada, M.C.C. and Lazan, H. (1994). Ripening and senescence. In R.M. Yon (Ed.), *Papaya fruit development, postharvest physiology, handling and marketing in ASEAN* (pp. 56-74). Kuala Lumpur: ASEAN Food Handling Bureau.

Anon. (1985). TNA principles of foliar feeding. TransNational Agronomy, Grand Rapids, MI. 2 p.

Brown, G.S., Kitchener, A.E., McGlasson, W.B. and Barnes, S. (1996). The effect of copper and calcium spray on cherry and apple fruit quality. *Scientia Horticulturae, 67*, 219-227.

Chapagain, B.P. and Wiseman, Z. (2004). Effect of Nutri-Vant-PeaK foliar spray on plant development, yield and fruit quality in greenhouse tomatoes. *Scientia Horticulturae, 102*, 177-188.

Gajalakshimi, S. and Abbasi, S.A. (2004). Neem leaves as a source of fertilizer cum-pesticide vermicompost. *Bioresource Technology, 92*(3), 291-296.

KUEPPER, G. (2003). Foliar fertilization. Appropriate Technology Transfer for Rural Areas. 10 p. website: atra.ncat.org/attar-pub/PDF/foliar.pdf

LESTER, G.E., JIFON, J.L. and STEWART, W.M. (2007). Foliar potassium improves cantaloupe marketable and nutritional quality. *Better Crops, 91*(1), 24-25.

OOSTERHUIS, D.M., GOMEZ, S.K. and MEEK, C.R. (2000). Effects of CoRoN™ slow release foliar nitrogen fertilization on cotton growth and yield. In D.M. Oosterhuis (Ed.), *Proc. of 2000 Cotton Research Meeting* (pp. 106-108). Arkansas: Arkansas Agricultural Experiment Station.

RANGGANA S. (1977). *Manual of Analysis of Fruit and Vegetable Products*. New Delhi: McGraw-Hill Publishing Co Ltd.

SAS. (1998). Cary, NC, United States, SAS Institute Inc.

SELAMAT, M.K. (1993). Effects of modified atmosphere and storage temperature on ripening of papaya (MS Thesis, Universiti Kebangsaan Malaysia, Bangi).

SHIOMI, S., KUBO, Y., WAMOCHO, L.S., KOAZE, H., NAKAMURA, R. and INABA, A. (1996). Postharvest ripening and ethylene biosynthesis in purple passionfruit. *Postharvest Biology and Technology, 8,* 199-207.

SIM, W.C. (1988). Effects of wrapping with polyethylene film on shelf-life and polygalacturonase activity of papaya cv. Eksotika (BS Thesis, Universiti Kebangsaan Malaysia, Selangor, Malaysia).

VENDRAMINI, A.L. and TRUGO, L.C. (2000). Chemical composition of acerola fruit (*Malphigia punicifolia* L.) at three stages of maturity. *Food Chemistry, 71,* 195-198.