High Relative Humidity after Ethylene Gassing is Important to Banana Fruit Quality

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Summary. Bananas were held at 18C in all possible combinations of 65%, 75%, or 95% relative humidity (RH) before and after gassing with ethylene. Peel color, fruit firmness, starch loss, compression injury to peel and pulp, and overall peel scarring were measured. Peels were greener and the fruit were slightly firmer when fruit were held in the higher humidity combinations, particularly when the humidity was high after gassing with ethylene. Starch loss was not different among humidity treatments. Overall peel scarring was about twice as severe with 65% RH compared to 95% RH during the ripening phase. Low humidity before ethylene gassing had little effect on overall scarring. There were some instances where humidity had a significant effect on compression injury; high humidity caused less injury, but the effect was inconsistent.

Many of the practices in the banana industry are based on tradition, individual experience, or private research

conducted years ago. Often the details of the research are obscure or unavailable. Banana varieties, cultural techniques on the plantations, and shipping conditions have changed substantially since some of the older research was done. In considering industry needs and advances in technology, it appears that some of the parameters of banana ripening may need to be reexamined.

Bananas are grown under tropical conditions, then shipped green in fiberboard cartons with plastic liners to their destination ports. After arrival in the United States, they are sent to ripening facilities where they are ripened by exposure to ethylene gas in chambers. They may be gassed immediately on arrival at the ripening facility or held for several days before gassing. Banana ripening often is considered as much an art as a science. One school of thought is that humidity should be kept constantly high because bananas are sold at the retail level by weight and this strategy gives the best-looking banana. Another philosophy is that humidity should be kept high initially, then reduced to avoid disease problems. Newer ripening facilities are capable of precise temperature and humidity control, and there is a need to have information on what can be expected under different ripening strategies. The purpose of this study was to evaluate combinations of three relative humidity (RH) levels—65%, 75%, or 95%—before or after ethylene gassing on ripening characteristics and injury of bananas. Banks and Joseph (1991) studied temperature and humidity ef-

fects on banana compression and impact bruising immediately after harvest. Akkaravessapong et al. (1992) concluded that RH did not influence bruising, ethylene production, starch, or sugar content, but influenced water loss. To provide information for banana ripeners, our study expands their work in that we looked at the effect of humidity on bananas that already had been shipped from the tropics and the conditions that would be encountered in the United States after arrival. We used different combinations of the three RHs before and after gassing with ethylene to determine the most critical times for maintaining RHs once bananas reach the United States.

Chiquita bananas from Honduras were obtained from a commercial warehouse immediately on their arrival by truck. Green, ungassed bananas were stored for 5 days in 65%, 75%, or 95% RH at 18C. Bananas then were placed in sealed plastic containers and gassed with 200 µl ethylene/liter for 24 h at 1 SC. Humidity was not controlled during gassing. After gassing, bananas were returned to the three humidity levels such that a factorial experiment was set up using all combinations of before- or after-gassing humidities. At six intervals, as the bananas were ripening, five bananas were removed from the chamber and given compression injuries. A fruit firmness tester mounted on a drill press was used to deliver 18,36, or 53 N (4.8, or 12 lb) injury. When most bananas had reached color stage 5 (Chiquita Brands, no date), we evaluated 15 bananas from each treatment combi-

Table 1. The effect of different humidity combinations of 65%, 75%, or 95% relative humidity (RH) at 18C, before or after gassing with ethylene, on peel color, fruit firmness, starch loss, and overall peel scarring of bananas.

Humidity treatment (% RH)	Peel color ² (1-6)	Fruit firmness ³ (N x 10 ³) (1-10)	Starch loss ⁴ (% of peel)	Overall scarring
65%, 65%	6.0 a ⁵	31.4 cd	6.9	22 a
65%, 75%	5.7 ab	33.3 ab	6.6	15 cde
65%, 95%	5.6 b	33.3 ab	6.4	11 def
75%, 65%	5.8 ab	30.4 d	6.5	19 abc
75%, 75%	5.7 ab	31.4 cd	6.5	14 cde
75%, 95%	5.6 b	32.4 abc	6.5	11 def
95%, 65%	5.9 a	30.4 d	7.0	20 ab
95%, 75%	5.7 ab	32.4 abc	6.5	16 bcd
95%, 95%	5.5 b	33.3 ab	6.7	10 f
LSD ^{0.05}	0.3	0.2	NS	5

¹Scale of 1 = green, 6 = full-yellow ripe.

²Measured with a 0- to 500-g tip.

³Scale of 1 = all starch remaining, 10 = most starch lost.

⁴Mean separation within columns by Duncan's multiple range test at $P < 0.05$.

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nation for ripeness. The amount of injury caused by the compression bruises on the pulp and peel of the bananas was rated on a scale of 1 to 5, with 1 = none and 5 = severe. The percentage of overall peel scarring included any other injury such as abrasion. Starch loss was evaluated using a starch-staining technique (Blankenship, 1993). Fruit firmness was measured using a 0- to 500-g tip on a McCormick Dynamometer (resembling an Effigi firmness tester) on peeled fruit.

The humidity combinations produced bananas significantly different in peel color, firmness, and percentage overall scarring (Table 1). Peel color was most affected by humidity after gassing; 95% RH resulted in greener bananas. Bananas in high humidity before gassing but 65% RH after gassing responded like bananas that had been in constant 65% RH. Bananas that had been in 65% RH before gassing but were ripened in 95% RH responded like fruit that had been in constant 95% RH. Fruit firmness decreased as peel color became more yellow; bananas in higher ripening humidities had slightly firmer fruit. Starch rating was not significantly affected by any treatment. Percentage overall peel scarring was most affected by humidity during ripening. Bananas ripened in 65% RH showed about double the overall scarring as bananas ripened in 95% RH. Ripening in 75% RH gave intermediate results. Bananas that had been held in 65% RH before ripening, but then ripened at a high humidity, compared favorably with bananas that had been held in constant high humidity.

The pulp and peel injury caused by compression bruising was generally not significantly different among the humidity treatments, regardless of when the injury took place (data not shown). In the few instances in which a significant difference was found, the

95% RH treatments produced less-visible injury. The effect of humidity on compression bruising was inconsistent. Banks (1991) found that freshly harvested bananas held in 95% RH had more resistance to bruising. However, even in Banks' study, the results were significant only on the second day of 3 days tested. Akkaravessapong et al. (1992) found no significant effect of humidity on compression injury. It appears that RH does not have a great or consistent effect on visible compression injury and probably is not of commercial significance.

We feel that the best humidity recommendation for bananas after transport is to keep the fruit at a constant high humidity of 95% RH, particularly during the ripening cycle. It does not appear that a brief period of lower humidity before gassing causes a decline in quality, as long as ripening humidities are high. High humidity may delay ripening slightly, but the advantage of reduced scarring outweighs this small delay. From our studies, it does not seem necessary to reduce humidity during ripening to avoid disease problems, and this practice may be detrimental to overall fruit quality.

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