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ROLE OF ETHYLENE AND TEMPERATURE ON RIPENING AND QUALITY OF BANANA FRUITS IN RELATION TO AGE

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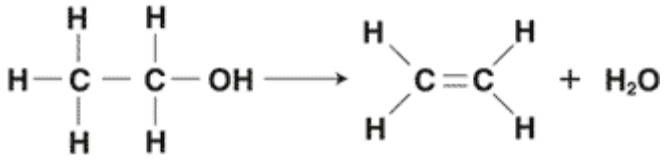
Abstract

Studies were carried out in Cranfield University, UK to investigate how bananas of different maturity stages response to ethylene and temperature during ripening. Bananas harvested at four different maturity stages were treated with 1000 ppm ethylene for 24 hours and kept at 16°C and 13°C for ripening. Bananas of all maturity stages which were kept at 16°C ripened at the same time showed that higher temperature enhanced the response of bananas to applied ethylene. Immature bananas at higher temperature (16°C) completed their ripening processes, faster and quicker than mature bananas. Immature bananas need higher concentration of ethylene for a long period at 13°C. Bananas harvested at three quarter (early stage of maturity) showed greater weight loss (10.4%) during ripening due to the higher rate of respiration and transpiration. Chilling injury symptoms were more pronounced at 13°C in advanced stage of ripening. Symptoms were even greater in immature bananas. Panelists preferred full quarter bananas due to their better flavour, sweetness and appearance.

INTRODUCTION

Banana (*Musa* cavandishii), a typical climacteric fruit, is commercially ripened by treatment with exogenous ethylene (Inaba and Nakamura, 1986) It is because fruits have been classified as climacteric and non-climacteric on the basis of their patterns of respiration and ethylene production during maturation and ripening (Biale and Young, 1981). In climacteric fruits, it has been accepted that ethylene plays an important role in ripening in that a massive production of ethylene commences at the onset of the respiratory climacteric period, and exogenously applied ethylene induces ripening and endogenous ethylene production. In the ripening process, bananas are closely stacked in individual rooms and then ethylene is introduced. The typical exposure time is about 24 hours. Two common ways to introduce ethylene include high-pressure gas cylinders and ethylene generators. The ethylene generators convert ethanol into ethylene by a catalytic process.

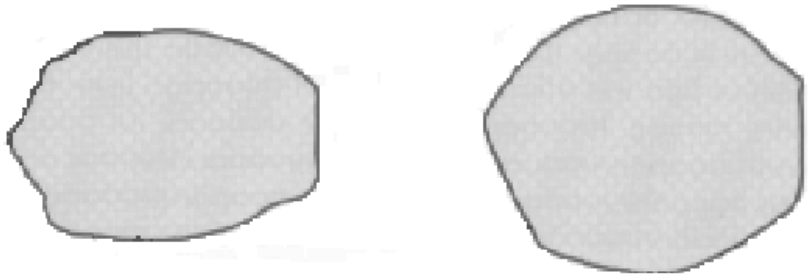


Ethanol Ethylene

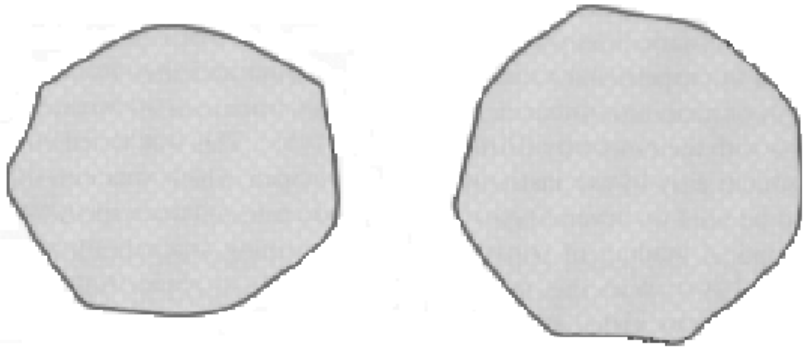
The treatment of exogenous ethylene in climacteric fruits advances the onset of the irreversible rise in respiration and rapid ripening. The pattern of respiration and ripening of banana fruit depends on the amount of ethylene, and duration of ethylene treatment, as well as temperature and the stage of harvest maturity. Bananas are harvested at the different maturity stages according to the need of the postharvest life and nature of the market. Therefore this study was started to investigate the response of different maturity bananas and their effect on quality.

MATERIALS AND METHOD

Pre-climacteric Cavendish bananas were obtained from C.E. Wilkinson in Bedford UK. Banana were selected according the maturity as recommended by Stover and Simmonds (1987), who divided the maturity of banana into four stages according to the changes in angularity of the finger (A - three-quarters, B - light full three-quarters, C - full three-quarters and D - full).



Stage A (Three quarters) Stage B (Light-full three-quarters)



Stage C (Full three-quarters) Stage D (Full)

These four type fruits were collected and separated into fingers. Twenty four fingers were selected in each treatment (type). The experiment was divided into two parts in first 16°C and in second 13°C temperature was used for ripening. Fruits were analyzed when they reached colour score 6 (fully yellow). Ripening of banana fruit was assessed according to peel colour changes

compared to a colour chart as described by Thompson (2003). The quality of ripe fruit was assessed when they reached at colour stage 6.

The peel colour was measured by colorimeter (Minolta Modal (CR-200/CR-200). Results were recorded in a* and b* values. A positive a* corresponding to the degree of redness and negative value corresponds to the degree of greenness. A positive b* value represents the degree of yellowness and negative one represents the degree the blueness. Peel firmness was measured using an Instron Universal Testing Machine (Modal 2211) with an 8 mm cylindrical probe. Total soluble solids (TSS) was measured using a refractometer (Atago Co.Ltd refractometer PR-1). In these experiments one extra quality pear meter (sensory evaluations) was also carried out to test the quality of ripe fruit. A panel of eight assessors was selected from the college and the tests involved individual in isolated tasting conditions under a standard light source. Judges were asked to assess pulp flavour, sweetness, off flavour, astringency and acceptance on the five pointed scale as follows: 1= low, 2 = moderate, 3= moderate to high, 4= good/high and 5=very good/very high.

The averages were calculated and presented in the form of tables. Data were processed and analyzed of variances (ANOVA) was carried out based on Randomized Completely Designs (RCD) using MSTATE, a PC based programme. LSD at P=0.05 was used to test for significant differences of results where applicable.

RESULTS AND DISCUSSION

All bananas which were kept at 16°C ripened at the same time after 6 days of ethylene treatment but significant difference was found between the bananas which were kept at 13°C (Table 1). Full mature bananas ripened after 18 days but three quarter bananas could not reach the colour stage 6 after 28 days due to the chilling injury. Ripening of bananas at the same time indicated that temperature plays an important role in ripening in spite of ethylene it is because; lower temperature reduced the response of bananas to ethylene. It means 1000 ppm ethylene for 24 hours was not enough to initiate the ripening at 13°C for all maturities. The three quarter bananas showed higher weight loss which was due to the higher respiration and transpiration of immature fruits. These findings have previously been reported by the Thompson et al., (1972). The colour at 16°C showed non-significant results but a variation was found at 13°C which was due to the chilling injury. The findings of Lipton and Aharoni, 1979 support the current investigation. Fruit firmnesses were measured and showed the same trend therefore only peel firmness in presented. Fruits harvested at advanced stage of maturity were significantly firmer when ripe at 16°C. More softening of immature fruit could be due to the greater weight loss that affects the turgidity of the skin (Thompson, 1996). However, ripening at 13°C showed opposite results. The firmer immature fruits at 13°C were might be due to the chilling injury. This is because chilling injury impeded the ripening process and thus impeded softening as softening is part of the ripening process (Thompson and Burden, 1995). Therefore immature fruits took more time to reach the colour stage 6, due to chilling injury. Fully mature fruits (Table 1) showed highest total soluble solids contents. This is indicated that total soluble solids contents increased with the maturation. It has previously been found that sugar contents of fruits remained constantly low during growth and then exhibited a sharp increase at more advanced maturity stage (Munasque et al., 1990). Same results were also reported by the Thompson et al. (1972). Bananas harvested at full had significantly higher flavour, sweetness and acceptability than those harvested at other three stages. It is because of greater development of volatile compounds/chemical enzymes associated with flavour and total soluble solids contents. The finding of Sanchez Nieva et al. (1971) support the current findings where they reported that mature fruits of plantains showed better appearance, flavour and quality than immature fruit.

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Table 1: Effect of ethylene and temperature on the different quality parameters where bananas were harvested at four different maturity stages and after ethylene treatment kept at 13°Cand 16°C for ripening

Factor studied	16°C				13°C			
	Stage A	Stage B	Stage C	Stage D	Stage A	Stage B	Stage C	Stage D
Ripping period	6.0	6.0	6.0	6.0	21.0 a	18.0 c	18.0 c	15.0 b
Weight loss (%)	10.9d	6.5c	5.5a	5.9b	4.0c	3.5b	3.5b	3.0a
Peel colour a	-1.4	-1.3	-1.5	-1.8 NS	-5.0	-4.5	-4.28	-4.0 NS
Peel colour b	+36.8a	+38.2b	+41.0c	+40.8c	+46.0 a	+48.2 b	+49.0 c	+48.5 b
Firmness (N)	3.06a	5.8b	6.1c	6.8c	6.10b	5.20b	4.85a	4.50a
TSS (%)	18.1a	19.0b	19.5b	20.0c	17.4a	18.5b	18.5b	19.2c
Favour	2.5a	3.0b	4.0c	4.5c	1.9a	2.0a	2.5b	2.5b
Sweetness	2.5a	2.5a	3.0b	4.0b	1.5a	2.0b	2.0b	2.5c
Astringency	2.5a	2.5a	1.5b	1.5b	3.0c	2.8b	2.8b	2.0a
Acceptability	2.5a	3.0b	3.5c	4.5d	1.0a	1.0a	2.0b	2.0b