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EFFECT OF CALCIUM CARBIDE ON RIPENING OF "EMBUL" BANANA (*MUSA* spp)

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ABSTRACT

An experiment was conducted to study the effectiveness of acetylene generated from calcium carbide (1g in 4 l volume space) as a ripening agent in "embul" banana. Results showed that this concentration initiates ripening process with excellent peel colour development, without any adverse effect on quality parameters of the pulp. Since acetylene initiated peel colour development more than the ripening process of the pulp, the table ripe stage should be more than colour index CI-6 (full yellow). Uniform colour development, brighter colour of peel and early ripening, with acetylene make banana more attractive and also reduce postharvest losses. Inability to attain proper peel colour development in prolonged modified atmosphere (MA) stored banana could also be improved by using acetylene generated from calcium carbide at the same concentration.

KEY WORDS : Acetylene gas, Calcium carbide, Modified atmosphere,
Peel colour, Quality parameters,, Ripening

INTRODUCTION

Bananas are generally ripened by the traditional practice of smoking for 24 — 36 hrs, and subsequently storing at room temperature. Smoking appears to accelerate ripening process in green and unripe bananas due to the presence of acetylene (C_2H_2) and ethylene (C_2H_4) in the smoke. Burnt scars, bruises, microbial infections and poor appearance of smoked ripe fruits however lower consumer attraction. Use of C_2H_4 as a ripening agent in banana is widely practised in developed countries. Since C_2H_4 is expensive, C_2H_2 which is less expensive is gaining popularity as a ripening agent. Acetylene which is 100 times less effective than C_2H_4 was found to initiate ripening process in "Cavendish" banana (Thompson and Seymour, 1982).

Calcium carbide (CaC_2) is a readily available source of C_2H_2 . CaC_2 reacts with water absorbed from transpiring fruits and releases C_2H_2 , as shown below :



Use of C_2H_2 released from CaC_2 as a ripening agent in "Cavendish" banana, "Carabao" mango and avocado has been reported (Bautista, 1987). Previous studies showed that when "embul" banana was subjected to modified atmosphere (MA), the peel colour development was poor when the storage period was prolonged (Sarananda, 1989). This study was conducted to determine the response of "embul" banana to acetylene gas as a ripening agent and to improve the peel colour development in bananas which have been stored under MA.

MATERIALS AND METHODS

The following experiments were carried out at the Horticulture Division, Gctambe :

Effect of calcium carbide as a ripening agent of "embul" banana

A freshly harvested mature green bunch of banana, Cv. "embul" obtained from Horticulture Farm, Gannoruwa was used for this experiment. All the hands were separated into two halves and mixed. One half was exposed to room temperature ($23 \pm 3^\circ\text{C}$) for ripening while remaining half was treated with calcium carbide at a rate of 1 g/4 l volume space. Closely-woven bamboo baskets of 22 l volume were used in the study. Calcium carbide was wrapped with newspaper (to absorb moisture in order to release acetylene) and placed at the bottom of the basket which was lined with newspapers. Bananas were placed over the wrapped calcium carbide and covered with newspaper in such a manner so as to trap the acetylene released from calcium carbide. This was a partially ventilated system which is widely practised for banana ripening in the Philippines (UPLB, 1984). After 2 days, bananas were exposed to room environment to ensure ventilation in order to admit more oxygen to aid peel colour development. Peel colour development was monitored daily until fruits reached CI—7 stage (overripe). At the table ripe stage (full-yellow) few fruits were tasted by an untrained taste panel consisting of 5 members to assess quality parameters. Treatments were in 5 replicates and experiment was carried out for 9 days.

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Effect of calcium carbide on ripening of MA stored "embul" banana

An experiment carried out previously in this laboratory showed that longer the time period in sealed polyethylene bag (PEB), poorer the peel colour development, when fruits were allowed to ripen at room temperature (Sarananda, 1989). Since, calcium carbide treatment initiated peel colour development and softening of the pulp, similar treatment was tried to improve peel colour development after removal from PEB.

Freshly harvested bunch of 'three-quarter full' mature green banana was used for this experiment. Dehanded banana separated into individual fingers and dipped in benlate solution (500 ppm) for 3 min. was air-dried. Four fingers were kept in each PEB (0.05 mm, high density) and sealed. Sealed bags (20) were stored at ambient temperature ($27 \pm 3^\circ\text{C}$). Every 3 day-interval, 5 such bags were opened and treated with calcium carbide (1g/4 l space) to induce ripening by acetylene released from carbide up to 12 days of storage. Peel colour development and quality parameters were monitored at CI—6 stage.

Peel colour development was monitored daily using numerical colour index developed by the United Fruit Sales Corporation (U. K.). Quality of the ripened fruits was evaluated by a taste panel. Flesh colour, taste, flavour and overall acceptability were recorded using numerical index, 1=poor, 2=acceptable and 3=very good. Sensory firmness of the fruits were also measured using numerical scale where, 1=firm, 2=slightly soft, 3=soft and 4=very soft.

RESULTS AND DISCUSSION

Effect of calcium carbide on ripening of "embul" banana

Peel colour development in treated and untreated banana is given in Fig. 1. In treated banana, peel colour development initiated at 2 days after treatment and maximum colour development (CI—7) was attained 5 days after treatment. Additional 4 days time was taken to reach CI—6. stage in untreated fruits. Results show that calcium carbide initiated early peel colour development. Although untreated fruits attained CI—7 the treated fruits were much more brighter in colour than untreated fruits. Also uniform peel colour development was observed in treated fruits while untreated fruits showed non-uniform colour development.

Softening index of treated and untreated banana is shown in Fig. 2. Softening in both calcium carbide treated and untreated fruits followed the same pattern and softening in calcium carbide treated fruits occurred about 2 days earlier. Softening of the fruits and peel colour development appear to be closely related (Fig. 1 and 2). Similar results have been reported in "Cavendish" banana (Peacock, 1966).

Fruit softening in naturally ripened fruits is initiated in response to ethylene that is produced by the fruit tissue (Ables, 1973). Early softening in calcium carbide treated banana showed that acetylene also triggers banana ripening. That acetylene initiates ripening has also been shown in "Cavendish" banana by Thompson and Seymour (1982). Thus calcium carbide could be used to treat banana to induce ripening through acetylene.

Quality parameters of the ripened fruits at the stage of CI-6 are given in Table 1. Untreated fruits showed excellent flesh colour, flavour, taste and overall acceptability compared to calcium carbide treated fruits. These results show that the fruits ripened with calcium carbide (CI-6) has poor quality compared to untreated fruits. However, treated fruits were also able to attain quality parameters similar to untreated fruits one day later. This is a very important factor, because calcium carbide enhance early peel colour development compared to ripening process of the flesh. Therefore, it is essential to give the required time allowance (i. e. one day more) before the consumption of ripened banana treated with calcium carbide.

Taste panel was not able to differentiate treated fruits from untreated fruits, when they were given one day after CI-6 stage. This clearly indicates that there is no impairment of quality with calcium carbide treatment. Comparative effects of acetylene and ethylene gases on the initiation of ripening in "Cavendish" banana have shown that fruits at the same stage of ripening were equally palatable (Thompson and Seymour, 1982).

Effect of calcium carbide on MA-stored "embu" banana

Peel colour development of MA-stored (12 days) banana, with and without calcium carbide treatment compared to fruits kept open is given

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in Fig. 3A. Calcium carbide treated fruits attained CI-6 within 6 days. There was no distinct time difference of peel colour development in treated fruits (kept sealed) and fruits kept in the open.

In untreated fruits longer the storage period in MA, the time taken to peel colour development was longer, when exposed to normal environmental conditions (Fig. 3A—3D). Similar result was obtained in a previous study (Sarananda, 1989). This may be the inhibitory effect of high carbon dioxide and low oxygen in chlorophyll breakdown. However, with the supply of acetylene using calcium carbide, maximum peel colour development was observed in prolonged MA-stored banana (Fig. 3B—3D).

CONCLUSIONS

Acetylene released from calcium carbide could be used as a ripening agent in "embul" banana (1 g/4 l space). Since peel colour development is faster than ripening process of the pulp, required time allowance (one day extra) should be given to obtain better quality fruits. Quality parameters of the acetylene treated fruits and untreated fruits were comparable. Inability to attain maximum peel colour development in MA-stored banana when the storage period is prolonged, could be overcome by using the same concentration of calcium carbide after removal from MA. A commercial scale experiment has to be conducted to use this technique in large scale banana ripening.

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Table 1. Quality parameters of the ripened fruits at CI-6 stage

<i>Treatment</i>	<i>Flesh colour</i>	<i>Flavour</i>	<i>Taste</i>	<i>Overall acceptability</i>
Untreated	3.0	3.0	3.0	3.0
Treated with CaCl_2	2.7	2.6	2.6	2.8

1 = poor; 2 = acceptable; 3 = very good

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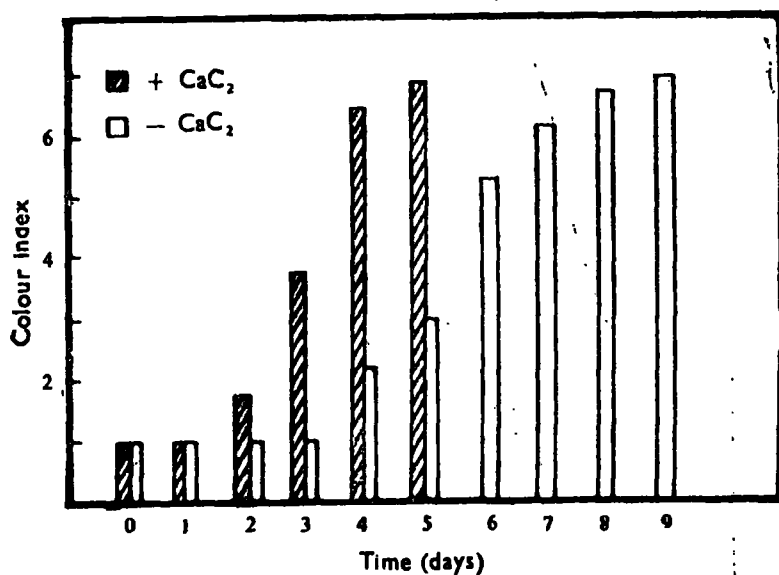


Fig. 1. Peel colour development in CaC_2 treated and untreated banana. Colour, index : 1=green, 2=Colour break, 3=more green than yellow 4=more yellow than green, 5=yellow with green tip, 6=full yellow and 7=over ripe.

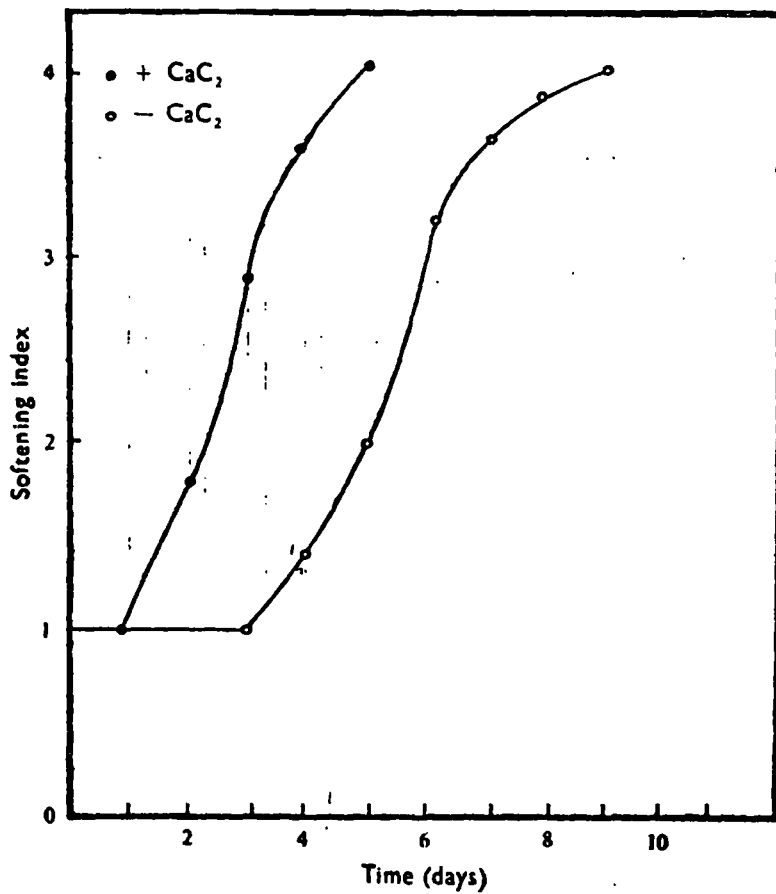


Fig. 2. Softening index (sensory firmness) of banana with and without CaC₂.
Softening index : 1=firm, 2=slightly soft, 3=soft and 4=very soft.

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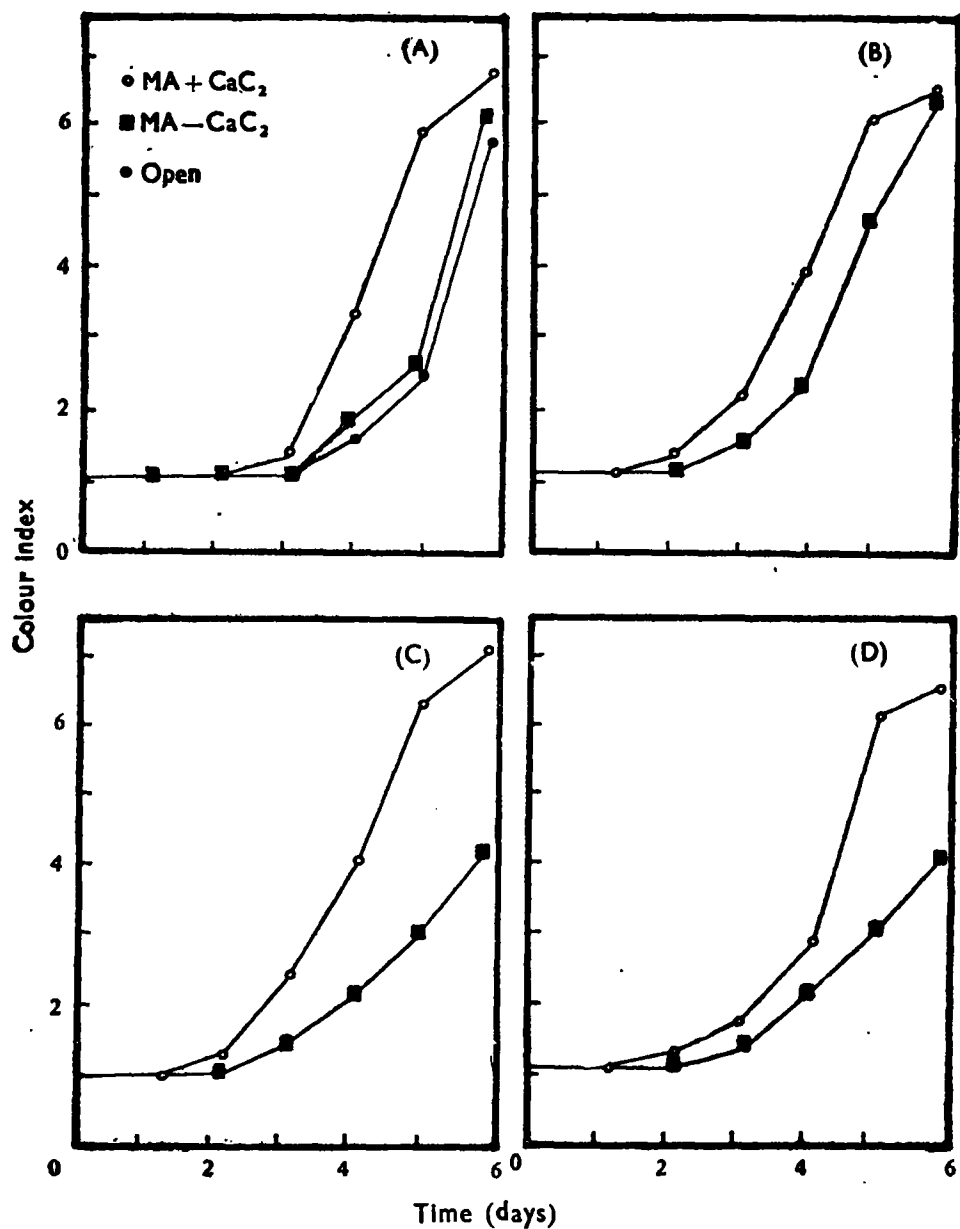


Fig. 3. Peel colour development of modified atmosphere (MA) stored banana for 3 days (A), 6 days (B), 9 days (C) and 12 days (D). Each data point represents the mean of 5 observations. Colour index : 1=green, 2=colour break, 3=more green than yellow, 4=more yellow than green and 5=yellow.