Tropical Agricultural Research Vol. 11 1999, 54-60

Effect of Calcium Carbide Treatment on Ripening and Quality of Velleicolomban and Willard Mangoes

R. Amarakoon, D.C.K. Illeperuma[1] and K.H. Sarananda[2]

Postgraduate Institute of Agriculture
University of Peradeniya
Peradeniya, Sri Lanka

ABSTRACT. *Non-uniformity and delayed ripening have been identified as the major constraints of natural ripening of mangoes at room temperature. Use of high doses of calcium carbide to induce ripening of mangoes has become a problem to the consumer. This study was conducted to determine the optimum dose of calcium carbide required to induce ripening of 'Velleicolomban' and 'Willard' mangoes. The effect of dose of calcium carbide on the organoleptic properties and the differences in chemical and organoleptic properties between artificial and natural ripening were studied. The optimum dose of calcium carbide required to induce ripening with the highest overall acceptability was found to be 1 g/kg fruit. At this level of calcium carbide, there was no difference in the total soluble solids content, titratable acidity and taste between artificially and naturally ripened fruits. A method for proper use of calcium carbide was recommended.*

INTRODUCTION

Mango is harvested when mature in bulk in a single picking, which includes fruits of different stages of maturity. Natural ripening of these fruits is unpredictable and not uniform (Nagaraj and Ramana, 1984), thus contributing to 40-60% postharvest losses as reported by Wilson Wijeratnam (1994). This also limits the marketing potential of fresh mangoes. To overcome these problems, mangoes can be exposed to ethylene (Barumore, 1974), acetylene (Mann and Dhillon, 1974), or propylene for a short period which initiates the ripening process.

---

1 Department of Food Science and Technology, Faculty of Agriculture, University of Peradeniya, Peradeniya, Sri Lanka.

2 Food Research Unit, P.O. Box 53, Department of Agriculture, Peradeniya, Sri Lanka.

Use of ethylene gas on commercial basis is expensive. Therefore, use of acetylene gas, which functions, as an ethylene analogue is popular locally. Calcium carbide liberates acetylene and is used to obtain uniformity in ripening of bananas (Salem *et al.*, 1976; Khan *et al.*, 1977), citrus fruits (Bondad and Mendoza, 1972) and tomatoes (Bondad *et al.*, 1971; Bondad and Pantastico, 1971). The reports on use of calcium carbide to induce ripening of mangoes are conflicting. Uniform ripening without any adverse effect on the quality of mangoes (Mann and Dhillion, 1974) and impairment of chemical and organoleptic properties of certain varieties such as 'Pairi', 'Alponso', 'Banganpalli', 'Totapuri' and 'Langra' have been reported (Krishnamurthy and Rao, 1981). Different doses of calcium carbide, such as 2 g/kg for 'Alphonso' mangoes (Nagaraj and Ramana, 1984) and 4-8 g/kg for 'Dashehari' mangoes (Mann and Dhillon, 1974) have been used to initiate ripening.

At present, in Sri Lanka high doses of calcium carbide is used commercially which results in mangoes of inferior quality that are unacceptable to the consumer. The method of application of calcium carbide in commercial practise is important because there are impurities such as phosphorous hydride and arsenic hydride present in commercial grade calcium carbide which could cause health hazards (Delpierre, 1974). One should take precautions as to prevent the contact of fruits with calcium carbide because these hydrides are fat soluble, and may dissolve in the wax layer of fruits. Therefore, this study was carried out to find out the optimum dose of calcium carbide required to initiate ripening of 'Velleicolomban' and 'Willard'. Recommendations on the method of application to prevent contact of the fruits with calcium carbide after liberating acetylene were also made.

MATERIALS AND METHODS

'Velleicolomban' and 'Willard' mangoes were obtained from the Maha Illupallama research station, North Central Province and Gannoruwa farm, Central Province of Sri Lanka. Three trees per cultivar were tagged at flowering stage and, the fruits were harvested 12 weeks after flowering. The fruits were divided into three lots and subjected to three levels of calcium carbide treatments *viz.* 1 g, 5 g and 10 g/kg of fruits to induce ripening.

A number of ways of treating the fruits with calcium carbide was tried out, and the commercial applicability of these methods was studied in the preliminary experiments. The method described below was successful and used for the study. Calcium carbide was wrapped in a paper and kept at the

bottom of a plastic container. The size of the container varied with the volume of the fruits to be treated. The fruits were packed and covered tightly with a newspaper to prevent leakage of acetylene (Figure 1). Calcium carbide was moistened with a drop of water before placing the fruits in the container to release the gas. After 24 hours, the packets of calcium carbide were removed from the container, and the fruits were uncovered and allowed to ripen. The chemical and organoleptic properties of fruits ripened as above were compared with those of naturally ripened fruits.

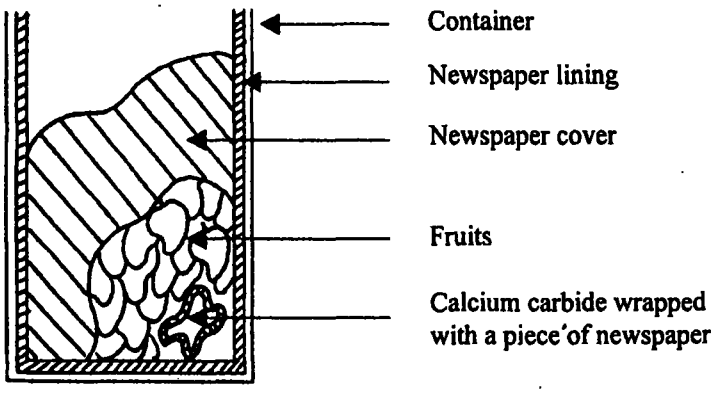

Figure 1. A cross section of a container of fruits treated with calcium carbide.

Samples from all experiments were analysed for total soluble solids (TSS) and titratable acidity (TA). Middle part of the mesocarp was macerated in a mortar and pestle, and the pulp was filtered through a muslin cloth. Total soluble solids (TSS) of the juice was directly measured using a hand refractometer and reported as °Brix. Pulp extract (1 ml) was diluted in 10 ml distilled water and titrated against 0.1 N NaOH using phenolpthalene as an indicator to determine the titratable acidity (TA). The acidity was expressed as percentage citric acid (Rangana, 1986).

Organoleptic evaluation was carried out for the fruits ripened naturally and artificially with three doses of calcium carbide. The effect of dose of calcium carbide on pulp colour, aroma, off odour, balance of sweetness and sourness, taste and overall acceptability were evaluated using

a trained panel. Five trained panelists from Food Research Unit participated in the taste panel. Unstructured line scale of 10 cm was used with anchored points "not at all" and "very much". Middle parts of the mesocarp were cut into cubes and served in salad cups by coding with three digit random numbers. The optimum dose of calcium carbide was selected, and a 'triangle' test was conducted to find out whether the artificial ripening changes the taste of mangoes using 13 panelists.

Experimental design and analyses

A complete randomised block design was used with three replications. The data were subjected to variance analysis using the SAS package. Least square means procedure was used to separate treatment means when differences were significant ($P<0.05$). The sensory evaluation data were analyzed by Friedman test using the Minitab statistical package.

RESULTS AND DISCUSSION

The results of the present study are in agreement with previous reports that carbide treatment induces ripening of mangoes (Nagaraj and Ramana, 1984; Mann and Dhillon, 1974; Krishnamurthy and Rao, 1981). The method developed in this study to treat the fruits with calcium carbide (Figure 1) was successful, inexpensive, simple and commercially applicable. It allowed uniform ripening of mangoes and completely prevents the contact of the fruits with calcium carbide. Thus, this method could be applied avoiding health risks and be recommended for commercial use.

The organoleptic properties such as colour, aroma, off odour, taste, balance in sweetness & sourness, and acceptability of 'Willard' and 'Velleicolomban' mangoes when artificially ripen with 1 g, 5 g and 10 g of calcium carbide per kg of mangoes are presented in Table 1. With the increase in dose of calcium carbide, the sum of ranks decreased significantly with respect to taste, balance in sweetness & sourness, and acceptability. It increased with respect to off odour development. Both the cultivars gave similar results for these sensory attributes. However, the dose of calcium carbide did not significantly affect the aroma of 'Willard' and 'Velleicolomban' mangoes. The effect of dose of calcium carbide on the pulp colour depends on the cultivar. No significant change was observed for 'Willard' and a significant increase was observed for 'Velleicolomban'. Calcium carbide at 1 g/kg of fruits gave the highest sum of ranks with respect to most of the

Table 1. Taste panel study of 'Willard' and 'Velleicolomban' treated with calcium carbide at different doses.

Variety	Sensory attribute	Dose (g calcium carbide / kg fruit)			
		1	5	10	
Willard	Colour	9	7	14	p=0.075
	Aroma	14	9	7	p=0.075
	Off odour	6	10	14	p=0.041
	Taste	15	9	6	p=0.015
	Balance in sweetness and sourness	14	11	5	p=0.015
	Acceptability	15	8	7	p=0.023
Velleicolomban	Colour	7	12	11	p=0.247
	Aroma	14	8	9	p=0.087
	Off odour	6	10	14	p=0.040
	Taste	15	8	8	p=0.024
	Balance in sweetness and sourness	14	10	6	p=0.041
	Acceptability	13	9	8	p=0.247

Each rank sum datum was obtained by the mean percentage value given by five trained panelists.

quality attributes. The optimum dose of calcium carbide for initiation of ripening of both 'Velleicolomban' and 'Willard' mangoes was 1 g/kg of fruits. This dose is 50% lower than that reported for other cultivars of mangoes (Nagaraj and Ramana, 1984; Mann and Dhillon, 1974).

The results of the 'triangle test' suggest (Table 2) that there was no significant difference at $p<0.05$ in taste between naturally ripened and artificially ripened 'Velleicolomban' and 'Willard' mangoes. There was no

significant difference in the TSS content and TA% between the fruits ripen naturally and artificially (Table 3), further supporting the results of the 'triangle test'.

Table 2. Acceptability of naturally and artificially ripened 'Velleicolomban' and 'Willard' mangoes from the 'triangle test' performed with 13 panelists in each case.

Variety	Number of panelists identified the odd sample	Number of panelists not identified the odd sample	Minimum judgements need for significance at ($p<0.05$)
Velleicolomban	7	6	n.s.
Willard	5	8	n.s.

Significance was determined by using the Table for 'triangle test' (given in the appendix). n.s. = not significant.

Table 3. Total soluble solids (TSS) and percentage titratable acidity (%TA) of naturally ripened and calcium carbide treated (1 g/kg fruit) mangoes.

Variety	Treatment	TSS °Brix	%TA
Velleicolomban	Naturally ripen floaters	15.00a	0.53a
	Carbide treated floaters	14.90a	0.54a
	$LSD_{.05}$	0.45	0.03
	Naturally ripen sinkers	18.50a	0.30a
	Carbide treated sinkers	18.00a	0.30a
	$LSD_{.05}$	0.86	0.00
Willard	Naturally ripen sinkers	21.00a	0.21a
	Carbide treated sinkers	20.80a	0.23a
	$LSD_{.05}$	0.86	0.05

Each data point represents the mean of three replicates.
Means with the same letter are not significantly different at $P<0.05$.

Krishnamurthy and Rao (1981) reported that ripening of 'Pairi', 'Alponso', 'Banganpalli', 'Totapuri' and 'Langra' mangoes using calcium carbide impairs the chemical and organoleptic properties. This may be due to differences in the cultivars or dose of calcium carbide used in that study. Our results revealed that 'Velleicolomban' and 'Willard' mangoes could be artificially ripened by using 1 g of calcium carbide per kg of fruit without altering the chemical and organoleptic properties of the fruit.

REFERENCES

Bondad, N.D., Medazoa, R.C. and Pantastico, Er. B. (1971). Postharvest ripening of tomato fruits with 2-chloro ethyl phosphonic acid and calcium carbide. Proc. Crop Sci. Soc. Phillip. 2: 79-83.

Bondad, N.D. and Pantastico, Er. B. (1971). Response of tomato fruits to acetylene and calcium carbide treatments. Phillip Agric. 55: 333-336.

Bondad, N.D. and Mendoza, D.B.Jr. (1972). Degreening of citrus fruits. Agric. Los Bonos.

Barumore, C.R. (1974). Ripening of mangoes with ethylene and ethyphon. Proc. Fla. State Hort. Soc. 87: 331-334.

Delpierre, M. (1974). Manual de Laboratory Annual Report 1938-39. pp. 41-43.

Khan, A., Singh, U.R. and Singh, G. (1977). Effect of ethrel and calcium carbide in artificial ripening and changes in biochemical quality indices of banana. Punjab. Hort. J. 17: 84-89.

Krishnamurthy, S. and Rao, G.K. (1981). Impairment of mango quality due to ripening by calcium carbide. II Indian Convention of Food Scientists and Technologists, Mysore, India.

Mann, S.S. and Dhillon, B.S. (1974). Effect of ethrel and calcium carbide on ripening of mango. Prog. Hort. 6: 59-64.

Nagaraj, P. and Ramana, K.V.R. (1984). Effects of calcium carbide on ripening and quality of Alphonso mangoes. J. Food Sc. 21: 278-282.

Rangana, S. (1986). Manual of fruits and vegetables products. Tata Mc Graw Hill Publ. Co. Ltd., New Delhi.

Salem E.A., Rizk, S.S., Eissawy, M.T. and Yahia, M.H. (1976). Banana fruit ripening 1. Comparative study of the conventional methods used in Egypt. Agric. Res. Rev. 54: 77-80.

Wilson Wijeratnam, R.S. (1994). Post harvest handling procedures, principles and practices. Personal Communication.