

## Application of apple as ripening agent for banana

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Commercial ripening is an essential part of fruit business as ripe fruits are not suitable to carry and distribute due to their fast rotting. Therefore, fruit traders pick unripe fruits and utilize different methodologies to fasten the ripening process of fruits. The present study is aimed at investigating potential of apple as a ripening agent as an alternative to the indiscriminately used ripening agent, calcium carbide, which is reported to be carcinogenic in nature. The study indicated that apple can also hasten the ripening process of banana similar to the synthetic chemicals and can be exploited as a natural and safer mode for fruit ripening.

**Keywords:** Calcium carbide, Ethylene, Ripening agent, Banana, Artificial ripening, Apple.

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### Introduction

Ripening is the final stage of development of a fruit which involves series of physiological and biochemical events leading to changes in colour, flavour, aroma and texture that make the fruits both attractive and tasty. It imparts numerous quality and nutritional characteristics to fruits which are a significant component of the human diet<sup>1</sup>. It is a natural process in fruits that causes them to become more edible. In general, a fruit becomes sweeter, less green and softer as it ripens. Though the acidity as well as sweetness rises during ripening, the fruit still tastes sweeter<sup>2</sup>.

### Biochemical and physical changes during ripening

Fruit ripening is a highly controlled and programmed developmental event, involving the co-ordination of a multitude of metabolic changes<sup>3</sup> and involves the activation and inactivation of various genes leading to various biochemical and physiological changes within the tissue<sup>4-7</sup>. Fruits may be classified as climacteric or non-climacteric depending on its respiration rate. Climacteric fruits are characterized by transient increase in both ethylene synthesis and respiration at an early stage of ripening. The peak of ethylene production rate is proportional to the peak respiration rate. Fruit softening, color changes, development of taste and

flavour and a number of other parameters of ripening process are associated with the climacteric cycle. The climacteric fruits are avocado, banana, cherimoya, mango, kiwifruits, apple, apricot, cucurbit, jackfruit, papaya, peach, pear, plum and tomato. Non-climacteric fruit does not show any increase in respiration and ethylene synthesis during ripening. In fact, non-climacteric fruits show decline in their respiration rate and ethylene production throughout the ripening process. Non-climacteric fruits are citrus fruits, cherry, cucumber, grape, lemon, orange, pepper, pineapple, strawberry, etc.

### Ripening agents

These are the substances which hasten the ripening process. Since the fruits are sent to different places, requiring several days at ordinary or refrigerated transportation, only firm, but mature fruits are least damaged during marketing. As a part commercial practice these are ripened at the destination markets before retailing. Artificial ripening of fruits for the commercial purposes is achieved utilizing different chemicals as ripening agents. Thus ripening agents allow many fruits to be picked prior to ripening. Various chemicals generally employed as ripening agents are as follows:

**Ethylene:** Ethylene is thought to regulate fruit ripening by coordinating the expression of genes responsible for enhancing a rise in the rate of respiration, autocatalytic ethylene production,

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chlorophyll degradation, carotene synthesis, conversion of starch to sugars and increased activity of cell wall-degrading enzymes<sup>8</sup>. Ethylene plays a central role in physiological and developmental processes, such as germination, growth, flower initiation and opening, senescence of leaves and flowers, organ abscission and fruit ripening<sup>9</sup>. It is applied artificially also to the plants. It is used in ripening and coloring fruit, including bananas, pears, mangoes, tomatoes and citrus<sup>10</sup>. It also induces flowering in pineapples when applied in the field and used to improve growth and appearance of bean sprouts. It is applied artificially using gas emission systems or ethylene generator systems.

**Ethephon:** Ethephon is known as one of the most common ethylene-generating chemical and used in post-harvest treatments. Ethephon is (2-chloroethylphosphonic acid), which penetrates into the fruit and decomposes to ethylene. Ethephon is used to promote pre-harvest ripening of top fruit, soft fruit, tomatoes, sugar beet, fodder beet, coffee and many other products. It is also used to facilitate the harvest of fruit and berry crops (by loosening the fruit) and to accelerate post-harvest ripening (e.g. bananas) prevents lodging in cereals, maize and flax<sup>11</sup>.

**Ethylene glycols:** Ethylene reacts with hydrogen peroxide to produce the agent ethylene glycol<sup>12</sup>. Ethylene glycol is colorless, odorless and sweet tasting liquid which is found in everyday materials used in the present day, such as coolant, antifreeze. In case ethylene glycol is applied (after being diluted with water) to various fruits, then it will speed up the ripening process on the fruits in colder climactic conditions, cutting down at least a quarter of the time it usually takes for the fruits to ripen.

**Ethrel:** Ethrel is a natural ripening agent of fruits<sup>13</sup>. On dipping the mature fruits in ethrel, it enters fruit cells, releases ethylene and hastens the ripening process. Changes in ascorbic acid content may occur

with ethrel spray which influences the carbohydrate metabolism in related fruits<sup>14</sup>.

**Calcium carbide:** Calcium carbide (available as grayish black powder) is commercially intended for welding purpose but its use in the artificial ripening of climacteric fruits is rampant in many developing countries. Calcium carbide, once dissolved in water, produces acetylene which acts as an artificial ripening agent. There are reports that in developing countries like Bangladesh, India and Pakistan. Table 1 summarizes the safety concern of the various ripening agents used:

Fruits ripened with calcium carbide are soft and have good peel colour development but are poor in flavour. Calcium carbide, popularly known as *masala*, is used extensively in mangoes, bananas and papayas and sometimes in apples and plums. Being cheap (one kg of this chemical costs Rs. 25-30, which can ripen 10 tonnes of fruit), it is indiscriminately used by the traders in preference to other recommended practices of inducing ripening like dipping fruits in a solution of ethephon, or exposure of fruits to ethylene gas.

However, treatment of fruits with calcium carbide is extremely hazardous because the chemical is known to contain traces of arsenic and phosphorous. Acetylene gas produced by calcium carbide may affect the neurological system by inducing prolonged hypoxia gradually culminating to headache, dizziness, mood disturbances, sleepiness, mental confusion, memory loss, cerebral edema and seizures. A case of calcium carbide poisoning in a 5 year old girl with no chronic disease have been reported<sup>16</sup>.

As per the rule 44 AA of the Prevention of Food Adulteration Rules 1955<sup>(Ref.17)</sup> “No person shall sell or offer or expose for sale or have in his premises for the purpose of sale under any description, fruits which have been artificially ripened by use of acetylene gas, commonly known as carbide gas.” In spite of such a restriction, calcium carbide is often utilized as a ripening agent in commercial front.

Table 1—Safety concerns of the various ripening agents

S. No.	Artificial ripening agent	Safety concern
1.	Ethylene	Ethylene is regarded legally as a pesticide for regulatory purposes. It must be registered with the EPA and appropriate state agencies <sup>15</sup> . Allowed for post-harvest use on bananas only.
2.	Ethephon	Ethephon in the range of 100-200 parts per million (ppm) is acceptable as per the Indian Council for Agricultural Research (ICAR) <sup>11</sup> .
3.	Ethylene glycol	Poisonous, can cause kidney failure if ingested <sup>12</sup> .
4.	Ethrel	Limited if applied as 0.25% solution.
5.	Calcium carbide	Extremely hazardous, contains traces of arsenic and phosphorus, carcinogenic and strictly banned <sup>2</sup> .

The present study compares the use of calcium carbide as an artificial ripening agent with apple which can be a safer and natural option for commercial fruit ripening.

## Materials and Methods

### Plant source

The plant material was procured from the local market. Calcium carbide was received as a gift sample from Chemie International, Ghaziabad.

### Processing

Four bunches of unripe bananas labeled A, B, C and D containing six bananas each, were exposed to similar environmental conditions maintained at temperature of 15-25°C and 85% RH. The relative humidity of 85% was achieved by utilizing saturated solution of potassium bromide<sup>18</sup>. The bunches were exposed to environment with varying amounts of ripening agents. Thus while Batch A and B was ripened with 1 g and 2 g of calcium carbide, respectively, Batch C was ripened using a single apple and Batch D was allowed to ripen naturally. The changes, if any, in extent of ripening were observed regularly and recorded. The change in the skin colour of the fruit from green to yellow brown was considered as stage of ripened fruit.

## Results and Discussion

The number of days taken for ripening are presented in Figure 1. While it took 5 days and 4 for

the bananas in batch A and batch B to ripen, respectively (batch B having higher concentration of calcium carbide). In contrast to this, fruits kept in batch C, which were ripened with apple as a ripening agent, took merely 3 days to ripen. Fruits in batch D however took 10 days for ripening without any ripening aid. The photo shoots of fruits in different batches are presented in Plate 1.

The adverse potential of calcium carbide as a ripening agent is well established. Waking up to the dangers associated with the prevailing practice of artificial ripening of fruits, the Food Safety and Standard Authority of India (FSSAI) has recently circulated advisory to state authorities to raise their vigil against the use of carbide gas for ripening fruit<sup>19</sup>.

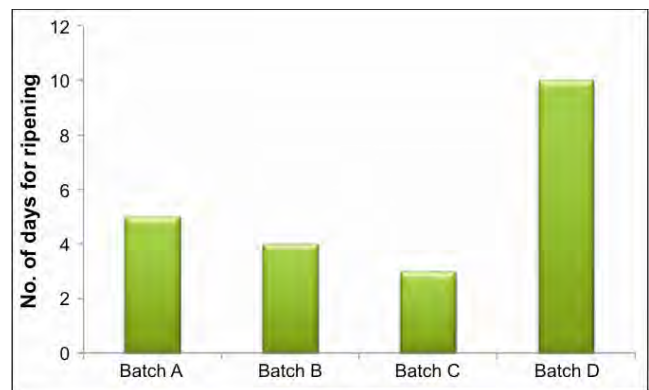


Fig. 1—Showing number of days taken for ripening for different batches of banana fruits

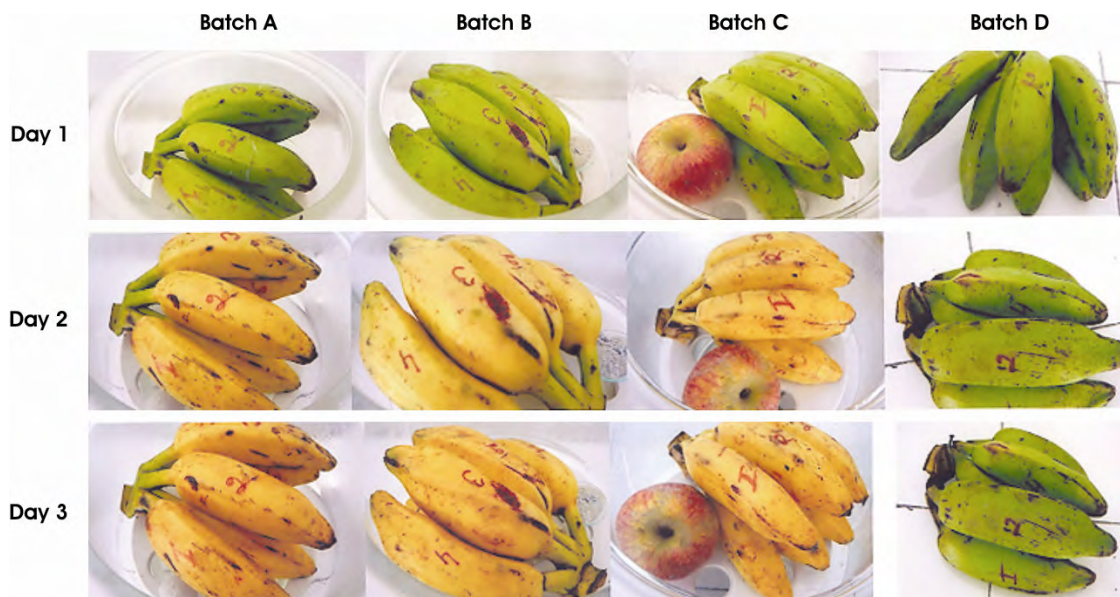


Plate 1—Photographs showing banana fruits after exposure to different ripening agents for varying number of days

The data clearly shows that apple is a useful ripening agent owing to faster ripening as compared to the use of controversial calcium carbide. The adverse potential of calcium carbide as a ripening agent is well established. Waking up to the dangers associated with the prevailing practice of artificial ripening of fruits, the ministry of health and family welfare has shot off letters to state authorities to raise their vigil against the use of carbide gas for ripening fruit. Thus apple can be exploited as a natural, safe and faster ripening agent to facilitate ripening of fruits. *Although it is well known that one rotten apple spoils the whole bushel, the same attribute can be of immense importance when applied technically.*

In order to fasten the ripening of fruits, chemicals and ripening agents are used by retailers. Although many techniques are employed to ripen mature fruits, the most practice prevalent in developing world including India is the use of calcium carbide. Calcium chloride is basically used in gas welding for steel good and is known to possess carcinogenic potential.

### Conclusion

The present study indicates that apple can considerably reduce the time taken for the ripening of fruits. Now a days, there are so many synthetic products in market, it is worth an effort to switch to a safe, fast and natural ripening agent; an apple without any adverse effects.

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