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**M Roy**
B.N. College of Agriculture, AAU, Biswanath Chariali, Assam, India

**S Langthasa**
B.N. College of Agriculture, AAU, Biswanath Chariali, Assam, India

**DN Hazarika**
B.N. College of Agriculture, AAU, Biswanath Chariali, Assam, India

**Corresponding Author:**
**M Roy**
B.N. College of Agriculture, AAU, Biswanath Chariali, Assam, India

# Indigenous ripening methods for banana cv. Amritsagar

**M Roy, S Langthasa and DN Hazarika**

## Abstract
The experiment was conducted with a aim to study the effect of indigenous ripening method on banana fruit quality and shelf life. The ripening methods *viz*. ripening in covered pit with smoke; ripening with ripe tomato fruit; ripening with paddy straw; ripening in covered pit without smoke; ripening with calcium carbide and ripening naturally at room temperature. The result revealed that among the methods used for ripening, fruit ripened with ripe tomato retained maximum TSS (21.75%), reducing sugar (5.12%), total sugar (6.15%), moisture content (73.85%), calcium (17.38 mg/100g),magnesium (58.47 mg/100g) and potassium (427, 28mg/100g). In case of fruit ripened with calcium carbide recorded highest acidity (0.34%) and phosphorus (74.81mg/100g) whereas ascorbic acid was maximum in fruit ripened with paddy straw. Similarly, maximum shelf life was obtained in control (10.67days) with longest ripening period of 12 days, whereas calcium carbide treated fruit had shortest (2days) ripening period. The preferential score in terms of flavor and taste was highest in banana fruit ripened with tomato while maximum score for colour was obtained in calcium carbide ripened fruit.

**Keywords:** banana, Amritsagar, ripening, calcium carbide, quality, shelf life

## Introduction
Banana is unique due to its high calorie and nutritive value and plays significant role in human diet by supplying vitamins, minerals and dietary fibre (Khader *et al*., 1990) [19]. It is a member of Musaceae family and important commercial fruit crop grown in tropical and sub-tropical climate of the world. It stood second to citrus in world fruit trade There are many varieties of bananas, all differing in flavour and appearance and are eaten when ripe (Dadzie and Orchard, 1997) [8]. Banana is one of the major fruits of Assam and among different cultivars, Amritsagar (AAA) is one of the most popular cultivars of North
Bank Plain Zone of Assam. The climate of Assam is very much suitable for cultivation of banana and their production is also high. Again from the social and economic point of view, this cultivar plays an important role and they are easily available in the market. In recent times, there is much concern about artificial ripening. Various artificial methods of fruit ripening have been observed mostly to meet consumers' demand and other economic factors. Consumption of chemically ripened (calcium carbide) fruits is hazardous in nature and poses great health risk to consumers (Rahim, 2012) [25]. Fruit sellers particularly of Assam usually ripen green fruits artificially to meet the high demand and make high profit of seasonal fruits. Transporting and distributing fruits from the farmers' orchards to consumers' baskets may take several days. During this time, the naturally ripened fruits may get damaged during harsh condition of transportation. It indeed increases great economic loss for the fruit sellers and therefore, to minimize the loss, fruit sellers sometimes prefer collecting immature fruits and artificially ripen the fruits before selling to the consumers (Mursalat *et al*., 2013) [23].
Banana fruits once harvested, it is highly perishable, with short shelf life leading to high post-harvest losses of about 20-50 per cent due to poor handling. In order to reduce the high post-harvest losses, banana is harvested at green, mature stage and artificially ripened when needed with the use of ripening agents. These include ethylene gas, ethephon, ethylene glycol, ethrel and calcium carbide (Singal *et al*., 2012) [29]; African bush mango fruit (*Irvingia gabonesis*) and *Jatropha curcas* leaves, palm nut, Cassia leaves, yellow papaya leaves, torch light battery, calcium carbide, potash ash and *newbouldia* leaves (Ajayi and Mbah, 2007; Adewole and Duruji, 2010) [4, 2]. The adverse potential of calcium carbide as a ripening agent has been established (Singal *et al*., 2012) [29] while other chemicals used as ripening agents like ethephon, ethrel and ethylene glycol are also considered hazardous to human health and they have to use within recommended safe limits. The use of artificial agents might give more acceptable colour than naturally ripened fruits (Hakim *et al*., 2012) [15] but it might increase the risk of contamination of food materials.

Calcium carbide has many health hazards and having carcinogenic properties due to traces of arsenic and phosphorous hydride (Rahman *et al.*, 2008) [26]. Therefore, the present study was undertaken to find out the alternative option and to compare natural ripening agents with chemical (calcium carbide) on nutritional composition, ripening and shelf life of banana fruit.

## Materials and Methods

### Sample preparation and treatment details

Banana fruits of cultivar 'Amritsagar' (AAA) was collected at green stage and the bunches were dehanded, washed with chlorinated water and air dried. Uniform size fruits were selected for the various postharvest treatments under the study. Treatments were arranged in complete randomized block design with three replications. The ripening methods were $T_1$: Ripening in covered pit with smoke; $T_2$: Ripening with ripe tomato fruit; $T_3$: Ripening with paddy straw; $T_4$: Ripening in covered pit without smoke; $T_5$: Ripening with chemicals; $T_6$: Ripening naturally at room temperature

### Quality Analysis

Physico-chemical qualities of banana fruits including colour, physiological loss in weight were determined at alternate days and TSS, acidity, sugars and ascorbic acid at acceptable ripe stage. Ripening period and shelf life were determined considering the changes in the physico-chemical qualities.

**Ripening period:** Ripening period was determined based on the changes in colour, firmness and TSS value of banana (Dadzie and Orchard, 1997) [8]. Ripening period for fruit in each treatment was recorded as the number of days until fruit attained full ripe stage (Colour stage 6).

**Shelf life:** Shelf life was assessed by visual inspection of fruits at alternate days; it was calculated as the period between commencement of ripening and end of saleable life or edible life (Dadzie and Orchard, 1997) [8].

**Colour of banana peel:** Colour of banana peel was visually determined using a standard colour chart. A scale of 1- 8 was used to indicate the stages of colour of banana peel (Collin and Dalnic, 1991) [7]. The scale with corresponding stage of colour *viz*. 1: Hard green; 2: Green with a trace of yellow; 3: More green than yellow; 4: More yellow than green; 5: Green tipped; 6: Fully yellow; 7: Yellow flecked with brown; 8: Browning and Overripe

**Pulp-peel ratio:** The pulp to peel ratio of banana was determined by dividing pulp weight to the peel weight. Pulp and peel was separated, weighed and expressed as pulp to peel ratio (Dadzie and Orchard, 1997) [8].

**Specific gravity of fruit:** The specific gravity of banana fruit was determined by dividing the weight of each fruit by the volume of water displaced by it and expressed in g/cc

$$\text{Specific gravity} = \frac{\text{Weight of fruit (g)}}{\text{Volume of water displaced by the fruit (cc)}}$$

**Physiological loss in weight:** Physiological loss in weight (PLW) was determined according to the methods described by Mohammed *et al*. (1999) [22]. Weight loss was calculated by dividing the final weight with that of initial fruit weight and expressed as percentage

$$\text{WL (\%)} = \frac{\text{Wi} - \text{Wf}}{\text{Wi}} x\ 100$$

Where, $W_i$ = initial weight
$W_f$ = final weight

**Biochemical properties**

The total soluble solids was estimated using an Erma hand refractometer and expressed as °Brix (Ranganna, 1986) [27]. Titratable acidity, Sugars, moisture and ash content were estimated as per method of AOAC (1980) [1]. Ascorbic acid content was determined by the visual titration method using 2,6dichloro-phenol indophenol dye (Freed, 1966) [12]. Calcium, Magnesium and Phosphorus were estimated from pre digested sample by following wet ashing method (Saini *et al*., 2012) [28]. Potassium was analyzed from pre digested sample as per Ward and Johnson (1962) [35].

**Sensory Evaluation:** Sensory evaluation was carried by a panel judges using a nine-point Hedonic scale rating (Amerine *et al*., 1965) [5]. A score of 5.5 and above was considered as acceptable.

## Results and Discussions

### Phenological and physical characters

The findings of the study (Table 1) showed that banana fruits treated with calcium carbide attained fully ripe stage within 2.5 days with shortest shelf life of 5.33 days. The faster ripening in calcium carbide treated fruits might be due to acceleration of the ripening process as acetylene initiates ethylene. The results were in conformity with Sogo-Temi *et al.* (2014) [31] in banana. The application of calcium carbide also increases the rate of respiration, release more heat which caused rapid ripening and eventually leads to faster deterioration or shorter shelf life of the banana fruits. The longest ripening period with longest shelf life was observed in fruits that were ripened naturally (control. Similar results were also reported by Adeyemi *et al.*, (2018) [3] in mango and Thompson and Seymour (1982) [32] in banana. Faster colour initiation was observed in banana fruits ripened with calcium carbide and the colour initiation was very slow in fruits without any treatment ($T_6$). This might be due to loss of green colour in the peel due to the continuing degradation of the chlorophyll structure during ripening (Tourky *et al.*, 2014) [33] in banana. Ripening agents accelerated ripening process faster than the fruits ripened naturally. Similar findings were also recorded by Adewole and Duruji (2010) [2] in plantain; Hakim *et al.* (2012) [15] and Singal *et al.* (2012) [29] in banana.

The pulp-peel ratio of banana was highest in fruits ripened with tomato. The increase was related to accumulation of moisture in the pulp derived from carbohydrate breakdown and osmotic transfer from peel to pulp. The results were in line with Narasimhan *et al.* (1971) [24]. Similarly, higher specific gravity (1.12%) and lowest pulp-peel ratio (1.83) was observed in fruit ripened in pit without smoke. The high correlation between pulp-peel ratio and specific gravity revealed that migration of bio-chemical compound from peel to pulp might cause the increase in specific gravity. Similar observations had been reported in sapota by Parwar *et al.* (2011). A progressive increase in PLW of banana fruit with an increase in ripening period was observed. The maximum physiological loss in weight was recorded in calcium carbide ripened fruits. This increase in PLW in calcium carbide treated fruits during ripening could be due to upsurge in respiration rate leading to faster and uniform ripening compared to other treatments. Dharmasena and Kumari (2005) [10] remarked that energy produced from the respiration process in the form of heat was released from the fruits by evaporation of water which caused weight loss. Venkasubbiah *et al.* (2013) [34] also reported the similar findings in banana fruits.

**Table 1:** Effect of ripening methods on phonological and physical character of banana fruit

| Treatment | Ripening Period (days) | Shelf life (days) | Colour Initiation (days) | Pulp-peel ratio | Sp. Gravity (g/cc) |
|---|---|---|---|---|---|
| $T_1$ | 4.0 | 7.0 | 3.0 | 1.82 | 1.23 |
| $T_2$ | 5.0 | 9.33 | 3.0 | 2.21 | 1.15 |
| $T_3$ | 9.0 | 9.33 | 7.0 | 1.54 | 0.97 |
| $T_4$ | 8.0 | 10.25 | 5.0 | 1.53 | 1.29 |
| $T_5$ | 2.0 | 4.33 | 2.0 | 1.70 | 1.20 |
| $T_6$ | 12.0 | 10.67 | 10.0 | 1.76 | 1.29 |
| LSD (P= 0.05) | 1.29 | 1.34 | 0.77 | 0.21 | NS |

**Biochemical characters**

In the present study, the biochemical characters (Table 2) were studied and observed that TSS (21.75˚Brix), reducing sugar (5.12 %), total sugar (6.15 %), and moisture (73.85 %) were highest in fruits ripened with ripe tomato while the lowest values of these parameters were found in calcium carbide treated fruits. The increase in TSS, reducing sugar and total sugar during ripening might have resulted from an increase in concentration of organic solutes as consequences of water loss and hydrolysis of starch into soluble sugars as sucrose, glucose and fructose. Similar results were also revealed by Gama *et al.* (2015) [13] and Mebratie *et al.* (2015) in banana fruits. The increase in moisture in fruits might be due to the carbohydrate breakdown and osmotic transfer from peel to pulp (John and Marchal, 1995) [17]. Similar results were also reported earlier by Gunasekara *et al.* (2015) [14] in banana. On the other hand, calcium carbide treated fruit showed highest titratable acidity and this might be due to faster ripening leading to incomplete hydrolysis of starch during the ripening of fruits. This result was in conformity with the work of Das and Balamohoan (2013) [9] in mango fruit. Among the ripening methods, the ascorbic acid content was recorded maximum (5.19 mg/100g) in banana fruits ripened with paddy straw. As per ripening chemistry, ascorbic acid decreases with increase in temperature. The fruits treated with calcium carbide ($T_5$) recorded minimum ascorbic acid content which could be due to the effect of increase in temperature and the storage duration. Gunasekara *et al.* (2015) [14]; Izundu *et al.* (2016) [16] reported least ascorbic acid in the banana fruits treated with calcium carbide which confirms the findings of the present investigation. The higher ash content (1.84 %) was observed in banana fruits kept in pits without smoke ($T_4$) and the lower ash content was recorded in fruits ripened with calcium carbide (1.17 %). Lower ash contents in fruits might be due to loss of fruit weight through respiration where significant carbon was lost. According to Kulkarni *et al.* (2004) [21], calcium carbide increased the metabolism of the fruits resulting reduced ash content.

**Table 2:** Effect of ripening methods on biochemical characters of banana fruits

| Treatment | TSS (ºBrix) | Titratable acidity (%) | Ascorbic acid (mg/100g) | Reducing sugar (%) | Total sugar (%) | Moisture (%) | Ash content (%) |
|---|---|---|---|---|---|---|---|
| T1 | 20.33 | 0.313 | 4.43 | 4.93 | 6.32 | 70.73 | 1.65 |
| T2 | 22.0 | 0.313 | 3.06 | 4.81 | 7.55 | 74.64 | 1.89 |
| T3 | 23.13 | 0.223 | 4.93 | 5.66 | 5.65 | 69.50 | 1.66 |
| T4 | 22.50 | 0.268 | 4.50 | 4.36 | 4.97 | 71.95 | 1.91 |
| T5 | 20.83 | 0.346 | 3.10 | 3.71 | 3.28 | 70.04 | 1.17 |
| T6 | 19.0 | 0.179 | 3.83 | 3.84 | 3.57 | 73.03 | 1.44 |
| LSD (P=0.05) | 1.62 | 0.063 | 0.88 | 0.56 | 0.72 | 2.40 | 0.23 |

**Mineral composition**

The mineral composition (Table 3) such as calcium, magnesium, phosphorous and potassium) of ripe banana pulp were significantly influenced by different ripening methods. The maximum calcium (17.05mg/100g), magnesium (46.55mg/100g) and potassium content (419.88mg/100g) were recorded in fruits ripened with ripe tomato while the highest phosphorous content (81.96 mg/100g) was exhibited by calcium carbide treated fruits. Among the different ripening methods, the most abundant mineral composition of banana fruits was potassium followed by phosphorous. The variation in the mineral compositions might be due to the application of different ripening treatments. The variation in calcium and magnesium was reported by Smitha *et al.* (2015) [30]; Fonad (1996) [11] in banana. Similarly, highest potassium content in fruits ripened with tomato was in close agreement with findings of Jyothirmayi and Rao (2015) [18] in banana. The phosphorous content was found to be the highest in the fruits ripened by using calcium carbide. It could be due to the increased rate of production of energy rich phosphate compounds during ripening (Khan *et al.*, 1972) [20].

**Table 3:** Effect of ripening methods on mineral composition of banana fruit

| Treatment | Calcium (mg/100g) | Magnesium (mg/100g) | Potassium (mg/100g) | Phosphorus (mg/100g) |
|---|---|---|---|---|
| T1 | 11.07 | 39.24 | 410.03 | 7.086 |
| T2 | 17.05 | 46.55 | 419.88 | 73.46 |
| T3 | 12.90 | 33.19 | 401.13 | 76.82 |
| T4 | 13.74 | 42.31 | 397.91 | 73.60 |
| T5 | 8.38 | 38.61 | 398.62 | 81.96 |

| | | | | |
|---|---|---|---|---|
| T6 | 8.53 | 38.42 | 406.78 | 70.65 |
| LSD(P=0.05) | 1.85 | 2.31 | 5.52 | 2.49 |

**Sensory evaluation**

Consumer's acceptability of banana fruits depends on colour, aroma and Taste. It was observed that banana fruits ripened with calcium carbide had the highest score for colour. Fruits ripened with calcium carbide had good peel colour development with poor flavor (Singal *et al.*, 2012) [29]. Similarly, in terms of flavour and taste, banana fruits ripened with ripe tomato was able to score highest in fruits treated with ripe tomato than rests of the ripening methods. This increase in taste score might be due to conversion of starch, organic acid into sugars as occurred in ripening stage. It was supported by Anthey and Philip (2005) [6]. On the other hand, the increase in flavour during ripening might be due to the formation of organic acids, alcohols, soluble sugars and other volatile compounds.

**Conclusion**

The result obtained from the study indicated that banana fruits can be ripened effectively either by chemical or indigenous methods. But the calcium carbide ripened fruits showed faster colour change with bright yellow colour, short shelf life and inferior taste. The use of carbide is known to be carcinogenic as reported earlier; thus an alternative method to induce ripening of banana fruits by using ripe tomato or ripening in covered pits with smoke may be considered as effective methods with desirable quality, short ripening period and longer shelf life.

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