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Low cost ripening chamber is boon to small and marginal farmers for ripening of mangoes

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Abstract
The low cost ripening chamber is commercially used for ripening of Mango where ethylene gas is used and Temperature, Relative humidity and other parameters are maintained during ripening process. The cost of ripening chamber and operating cost are the major limiting factors for its adoption by small and Marginal farmers or traders. In this technology the mixture of water (1.0 litre), Etherel (0.95 ml) and sodium hydroxide (0.6 g) was used for release of ethylene gas in the chamber. The chamber capacity is about 1.5 to 2 tons. The unripe mature Mangoes (Alphonso) in plastic crates were kept inside the air tight ripening chamber for 24 h for enhancing ripening process. This technology was demonstrated as Field Level Demonstration (FLD) to Mr Ashok, Rampua, Kolar tq in 2017-18, and 2018 -19 he was ripened the Mangoes by conventional method by 1 ton and demonstrated technology by 1.5 tons and 4 tons and he received net profit of Rs. 90,000/- and Rs. 3,35,000/- respectively. In the conventional ripening method the ripening time (days), TSS (O Brix), shelf life and Colour were recorded as follows 14, 14.33, 7.33 and More Green Patches and small black spots respectively and meanwhile the demonstration technology values as follows like 5.33, 19.33, 12.33 and Light pale yellow colour and less green patches respectively. In the year 2019-20 and 2020-21 this technology was demonstrated to Mr. Venkatesh Gowda, Kasavanahalli, Srinivasapura Tq. He was ripened the Mangoes by using the demonstrated technology by 6 ton and 8.5 tons respectively and he has received net profit of Rs. 5,78,000/- and Rs 7,52,000/- respectively. The demonstration technology ripening time (days), Colour, TSS (O Brix), and shelf life were recorded as follows 13.33,15.33, 6.0 and More Green Patches and small black spots respectively and meanwhile the values as follows like 5.33, 18.33, 11.66 and Light pale yellow colour and less green patches respectively. The cost of ripening chamber for 1000 kg fruits on per day interest and ethylene gas was considered for calculating the cost of ripening. The sensory study showed that Mangoes ripened with ethylene gas were superior to untreated ones. Hence, Low cost ripening chamber has been demonstrated to farmers to ripen and marketing of Mangoes. The operating cost for mango ripening was 0.89 paise per kilogram.

Keywords: Mango, ripening chamber, ethylene, ethereal, sensory quality

Introduction
Mango (*Mangifera indica* L.) is an important fruit crop in India and popularly called the 'King of Fruits'. Approximately 50 percent of all tropical fruits produced worldwide are Mangoes. Mango is the most widely cultivated fruit in India. India is the major Mango growing country, contributing nearly 49.62 percent of world's area and 42.06 percent of world's production respectively. Lack of suitable marketing avenues and channels decreases the margin for the Mango growers. Mango is cultivated throughout Kolar District. However, the large scale cultivation of Mango is concentrated in Srinivaspur taluk, contributed about 22,325 ha of area and 81,100 tonnes of production in the district. As producers do not generally undertake wholesale distribution, it is a common practice to lease out the orchards who take care of watch and ward of the crop till maturity and then dispose the produce as it suits them.
Ethylene gas can be generated from various sources. Due to high cost and scarce availability of ethylene gas, traders often use unsafe and banned ripener like carbide gas which can be potentially harmful to our health. The purpose of this guidance note is to create awareness among food business operators/traders, consumers and food safety of ethylene gas and its reliable sources (Anonymous 2013) [1].
Fruit ripening is a combination of physiological, biochemical, and molecular processes which lead to changes in colour, sugar content, acidity, texture, and aroma. In general, it is a physiological process which makes the fruit edible, palatable and nutritious. Fruits are classified into two categories according to the ripening pattern. Climacteric fruits and Non-climacteric fruits.

Artificial ripening is the process by which ripening is controlled to achieve desired characteristics intended for better consumer acceptance and improving sales. It is generally done climacteric fruits such as Mango, Papaya, Banana, etc. to achieve faster and uniform ripening characteristics. Globally, artificially ripened fruits are considered as safe for human consumption if done using safe ripening agents.

The Industrial-grade calcium carbide, popularly known as "Masala" is often used by some unscrupulous traders to release acetylene gas for artificial ripening of fruits like Mango, Banana, Papaya etc. Calcium carbide contains traces of arsenic and phosphorus which is harmful for humans and may cause dizziness, frequent thirst, irritation, weakness, difficulty in swallowing, vomiting, skin ulcer, etc. The acetylene gas released from calcium carbide is equally harmful for handlers. There are chances that calcium carbide may come in direct contact with fruits during application and leave residues of arsenic and phosphorus on fruits. Thus, use of this chemical for ripening of fruits is banned in India.

Considering the issue of rampant use of banned calcium carbide and non-availability of alternative ripening agent, Food Safety & Standards Authority of India (FSSAI) permitted the use of ethylene gas for ripening of fruits in India vide notification dated 23.08.2016.

Ethylene is a hormone naturally produced within the fruit and regulates fruit ripening by initiating and controlling a series of chemical and biochemical activities. The treatment of unripe fruits with ethylene gas triggers the natural ripening until the fruit itself starts producing ethylene in large quantities.

Ripening is a complex physiological process resulting into changes in softening, coloring sweetening and increases the aroma compounds so that the fruits become ready to eat. The ripening process is influenced by different factors such as Temperature, Humidity, Ethylene production and exposure period to these environmental conditions. An increase in the temperature significantly increases the rate of respiration and total carotenoids in pulp. Increased ripening temperature up to 30 °C also increases ethylene production in fruit (Lalel 2004) [5].

Ethylene is a natural plant hormone that regulates the fruit ripening process (Jobling 2000) [4]. Exposure of unripe fruit to a lower dose of ethylene is sufficient to stimulate the natural ripening process until the fruit itself starts producing ethylene in large quantities. These days' artificial fruit ripening has become a common practice (Siddiqui and Dhua 2009) [6].

Hence, Srinivaspur and Kolar taluk were selected for the study. Hence, Low cost ripening chamber has been demonstrated to farmers to ripen and marketing of Mangoes.

Materials and Methods

Technology

The technology developed by IIHR, Bengaluru is used for demonstration to farmers.

Room Size and Capacity:

4 cubic mts (1.6 m× 1.4 m ×1.8 m) Low cost plastic Ripening chamber can accommodate 1 tons of Mangoes.

The Method

- Place the fruits in ventilated plastic crates and put them inside an airtight plastic chamber and exposed to liberated gas in air tight tents of known volume
- Take required (2 ml per every 1 cu m room size) quantity of ethereal into a container and place inside the room.
- Add required quantity (0.5 g per 2 ml of ethereal) of sodium hydroxide for releasing the ethylene gas from liquid ethereal and seal the tent airtight immediately.
- Open the tent after 24 hr of exposure and shift the crates to ambient temperature for completing the ripening process.

Note: The tent should be filled with fruits up to approximately 70-75% of the room size.

Mango fruits exposed to 100 ppm ethylene gas for 24 hr could ripen in 5 days as compared to the ripening in 12-15 days of the non-treated control fruits without adversely affecting quality. This is simple, easy to use and low cost method and does not require any sophisticated equipment. It can be used by commercial growers, traders and retailers as an alternative to banned calcium carbide method. Its best alternative to calcium carbide ripening which is carcinogenic.

Important: The tent room should be sealed immediately as soon as possible after adding caustic soda. Otherwise the liberated ethylene gas will escape from the room.

Intervention

This technology has been demonstrated as an Field level Demonstration (FLD) by Krishi Vigyan Kendra, Kolar at Rampura, Kolar Tq and Kadadenahalli, Srinivasapura Tq, during 2017-18, 2018-19, 2019-20 and 2020-21 respectively and also conducted several training programmes and field days to promote and spread the technology to farmers.

Fig 1: Capacity Development Programmes and demonstration of Low Cost Ripening Chamber

Results and Discussion

Impact

Normally farmers are practicing conventional ripening method like using paddy and Ragi straw. But this method takes minimum 12 to 15 days for ripening. By this method farmers are normally used for household consumption. By intervention of this technology to farmers can able to ripen more than 3-4 tons in 5-6 days same time farmers can able to sale ripened Mangoes at commercial level.

Horizontal Spread

Now these farmers are effectively utilized the technology for ripening of more quantity of Mangoes simultaneously nearly more than 15-20 farmers are utilizing the technology for ripening of Mangoes. These farmers are sale ripened Mangoes at Mango Mela, Lalbagh, Bengaluru and UAS Bengaluru Stall.

Research output

A trial was conducted to study the effect of the low cost ripening chamber on the ripening behavior and quality of mango Cv. Alphonso.

The pooled data presented in the Table 1 to 3 indicate that there was a significant difference observed between fruits ripened in low cost ripening chamber and control fruits with respect to TSS, Colour and organoleptic qualities of mango fruits cv. Alphanso. However, there was a significant difference for the period of ripening of mango fruits. The mango fruits kept in low cost ripening chamber ripened within 7 to 8 days earlier than control fruits. The cost of ripening is 0.89 paise per kg of fruits.

Hence, the low cost ripening chamber is suitable for early ripening of mango cv. Alphonso fruits and the technology is economically viable

The essential requirements of low cost ethylene ripening system are

A reasonably air tight condition during exposure to ethylene gas Flushing of recommended concentration of the ethylene gas Opening of the outlet to ensure better ventilation depending upon the exposure period Proper humidity level inside the chamber

Features of low cost ethylene ripening system

The low cost ripening chamber has been recommended by IIHR during the year 2018 for quality and early ripening of Mango fruits.

It is observed that the Mango cv. Alphonso fruits treated with 100 ppm ethylene gas in the ripening chamber ripened 6 to 7 days earlier than the conventional ripening method

Ripening chamber is easily collapsible and portable.

Cost of ripening chamber is ₹ 9850 only

Cost of ripening of mango fruits is ₹ 0.89 kg^{-1}.

Economics of the low cost ethylene ripening system

Cost of ripening chamber: 9850/-

Total: ₹ 9850

Recurring cost: which is recurring cost is for ripening of every 1000 kg fruits

Cost of ethylene gas cylinder (100 ppm): ₹ 250 per cylinder

Total: ₹ 250

Economic gains

The farmers will get additional cost minimum Rs. 25-30/- each per kg of ripened Mangoes by this method. Further, income obtained from their Mangoes Rs.45000-50000/-. Farmers obtained additional income of Rs. 85000-95000/- per acre additional income if they have ripened and sold by themselves.

Fig 2: Farmer is used for Ripening of Mango

Fig 3: Intervention of KVK Kolar to Good Post Harvest Methods to Ripening of Mangoes

Fig 4: Conducted Field day to promote the technology

Table 1: Critical inputs

Particulars	Cost (Rs.)
Low cost Plastic Ripening chamber	9850
Ethylene can (2 Nos)	700
Packaging materials	-
Field day	1250
Total	11200/-

Table 2: Effect of low cost ripening chamber on Ripening Time, Colour, TSS and Shelf Life of Mango Cv Alphanso

Year	Ripening Time (No. Days)		Colour		TSS (^{0}Brix)		Shelf life (days)	
	Conventional Ripening	Ripening chamber	Conventional Ripening	Ripening chamber	Conventional Ripening	Ripening chamber	Convention Ripening	Ripening chamber
2017-18	12	5	More Green Patches and small black spots	Light pale yellow colour and less green patches	14	18	7	12
	14	6	-	-	15	19	8	13
	16	5	-	-	14	21	7	12
Avg	14	5.33			14.33	19.33	7.33	12.33
2018-19	11	6	More Green Patches and small black spots	Light pale yellow colour and less green patches	15	17	8	11
	12	5	-	-	16	18	9	12
	11	7	-	-	15	20	8	13
Avg	11.33	6	-	-	15.33	18.33	8.33	12
2019-20	13	5	-	-	14	18	7	12
	14	6	-	-	16	18	5	11
	13	5	-	-	16	19	6	12
Avg	13.33	5.33	-	-	15.33	18.33	6.0	11.66
2020-21	14	6	-	-	15	21	8	13
	14	6	-	-	14	22	7	12
	15	7	-	-	16	20	6	12
Avg	14.33	6.33	-	-	15	21	7	12.33

Table 3: Economics of Low cost plastic ripening chamber

Year	Conventional ripening (t)	Amount	Low cost Plastic ripening chamber(t)	Amount
2017-18	1	1000×75=75000	1.5	1500×110=165000
Expenditure	1450		11800	
Additional income	90000			
2018-19	-	-	4	4000×100=400000
Gross income	400000			
Expenditure	65000			
Net Income	335000			
2019-20	-	-	6	6000×110=660000
Gross income	660000			
Expenditure	82000			
Net Income	578000			
2020-21	-	-	8.5	8500×100=850000
Gross income	850000			
Expenditure	98000			
Net Income	752000			

Fig 5: Demonstration of Good Horticultural practices in Mango and Intervention of Low cost plastic ripening Chamber

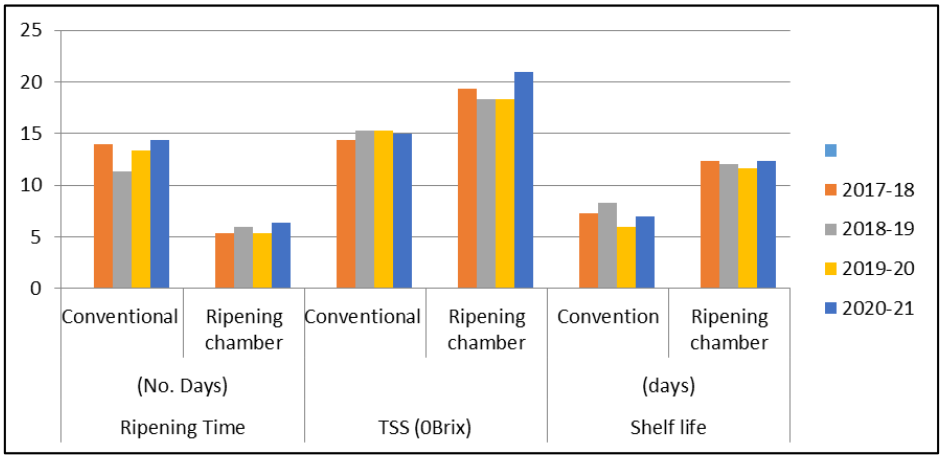

Fig 6: Comparison of Ripening time, TSS and Shelf life of conventional method and Low cost

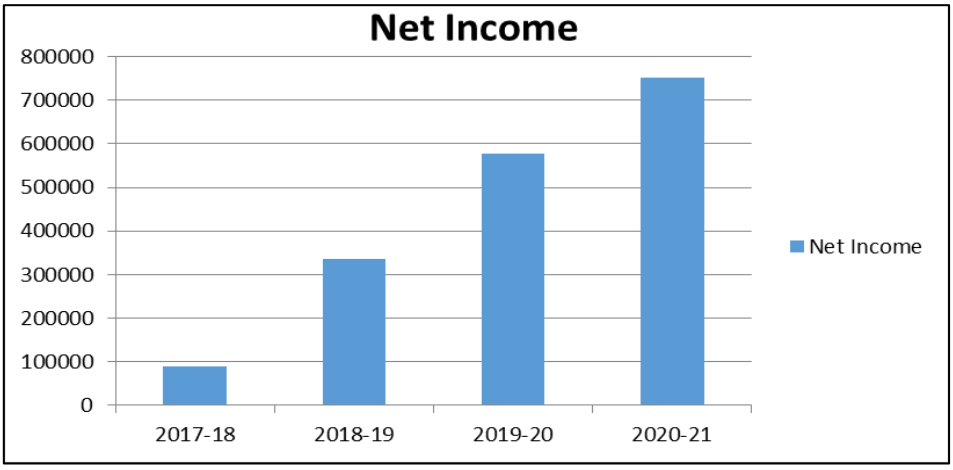

Fig 7: Economic analysis of the farmer by utilizing of Low cost Ripening chamber

This technology was demonstrated as Field Level Demonstration (FLD) to Mr Ashok, Rampua, Kolar tq in 2017-18, and 2018 -19 he was ripened the Mangoes by conventional method by 1 ton and demonstrated technology by 1.5 tons and 4 tons and he received net profit of Rs. 90,000/- and Rs. 3,35,000/- respectively (Table 3). In the conventional ripening method the ripening time (days), TSS (O Brix), shelf life and Colour were recorded as follows 14,14.33,7.33 and More Green Patches and small black spots respectively and meanwhile the demonstration technology values as follows like 5.33,19.33, 12.33 and Light pale yellow colour and less green patches (Table 2) respectively.

In the year 2019-20 and 2020-21 this technology was demonstrated to Mr. Venkatesh Gowda, Kadadevandhalli, Srnivasapura Tq. He was ripened the Mangoes by using the demonstrated technology by 6 ton and 8.5 tons respectively and he has received net profit of Rs. 5,78,000/- and Rs 7,52,000/- (Table 3) respectively. The demonstration

technology ripening time (days), Colour, TSS (O Brix), and shelf life were recorded as follows 13.33,15.33, 6.0 and More Green Patches and small black spots respectively and meanwhile the values as follows like 5.33,18.33,11.66 and Light pale yellow colour and less green patches (Table 2) respectively.

Sensory quality

Table 4: Sensory evaluation results on ripened mango

Time (Days)	Treated Mango	Untreated Mango
Visual color of pulp	1.6	2.1
Odour	1.8	2.3
Texture	1.3	1.9
Overall acceptability	1.3	2.3

The sensory evaluation (9 point Hedonic scale) of ripened mango (Table 3) was carried out by a panel of ten members (8 male and 2 female) in age ranging from 25-35 years. It showed that Ethylene gas ripened Mango had high score in comparison to conventional ripening of Mango.

The data on effect of ethylene gas exposure treatment in the ripening chamber as compared to conventional ripening on changes in sensory quality are presented in Table 3. The organoleptic rating of Mango Cv. Alphanso in terms of overall acceptability on 6th day in the ripening chamber as compared to conventional ripening is 13th day. The uniform and sustainable colour development of the fruit during ripening may be associated with faster degradation of chlorophyll and functional activity of ethylene as a degreening agent. Generally the distinct flavor development is function of adequate sugar acid blend coupled with suitable combination of other bio-chemicals and volatiles, which might have developed adequately during the ethylene, induced ripening of fruits.

Similar findings were recorded by Dhemre (2001) [2] in mango Cv. Kesar, Daware (2012) [3], Zagade and Relekar (2014) [7], Venkatram and Pandiarajan (2014) [8] in mango Cv. Alphonso.

Cost of ripening of Mango fruits

The cost of ripening of 1 kg Mango fruits was worked on per day basis. The cost of ripening chamber for 1000 kg fruits on per day interest and ethylene gas was considered for calculating the cost of ripening. The cost was found to be Rs 0.89 per kg.

It was found that mango Cv. Alphanso exposed to the ethylene gas in the ripening chamber treatment triggered the ripening process. It was also noticed that more the period of exposure to ethylene gas faster was the ripening process and showed the significant increasing trends in Ripening Time, Colour, TSS and Shelf Life of Mango Cv Alphanso.

It was observed that Mango fruits Cv. Alphanso ripened by exposing them to 100 ppm ethylene gas in ripening chamber for 24 hrs and storage at ambient condition recorded the maximum shelf life of 8 days and showed better results in respect of high overall acceptability.

Feed Back

1. Normally we are sold orchard to middle man for procuring Mango fruits
2. This year we have ripened mangoes by using low cost plastic ripening chamber. So income has increased

Way Forward

- Extension work in terms of On-farm demonstrations for transfer of technology
- Need to develop low cost mechanism to maintain the optimum temperature and humidity inside the chamber

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