

ARTIFICIAL RIPENING OF FRUITS



Presented by

Tamilselvan . T

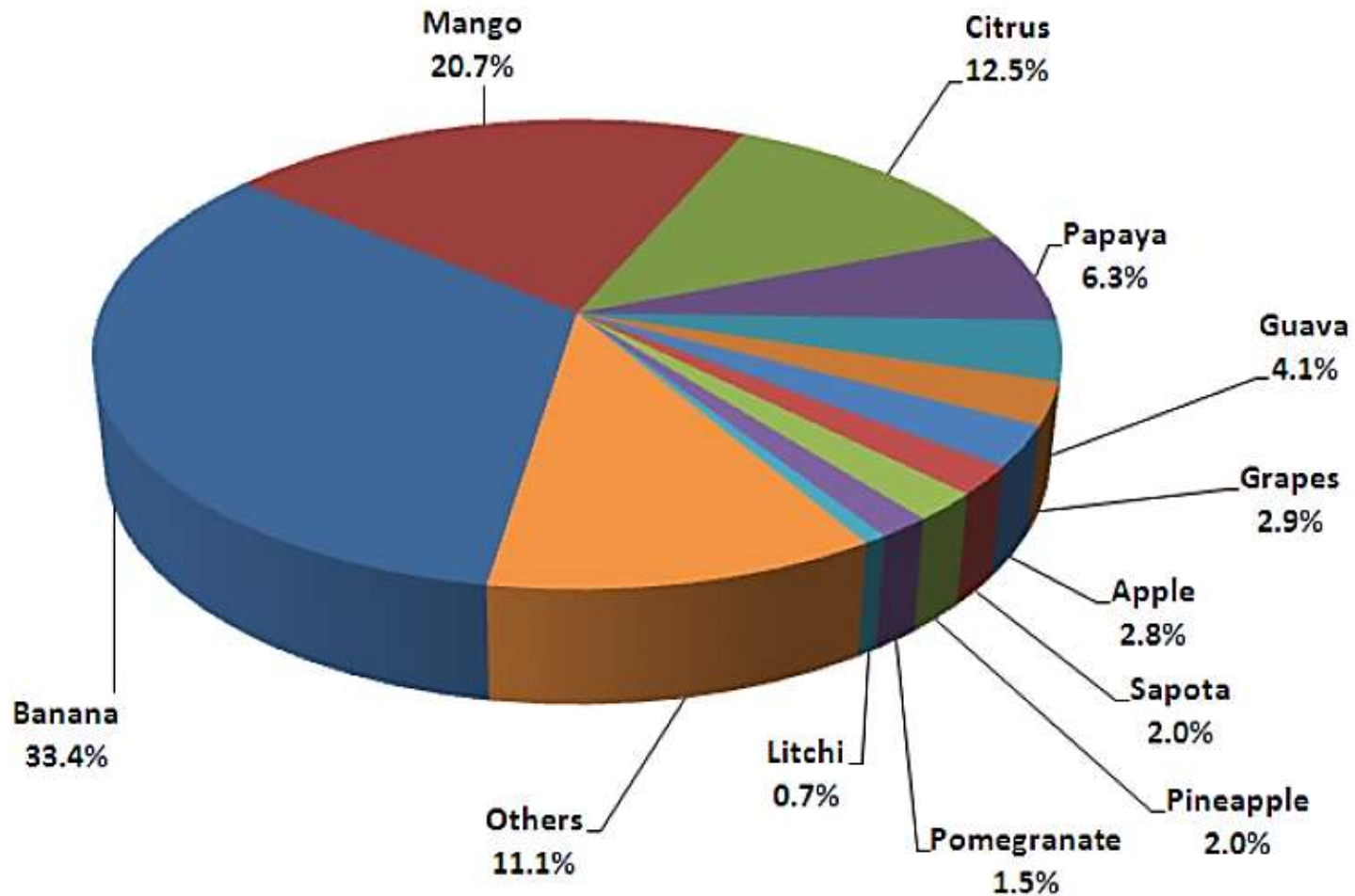
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Current status of India in Fruit Production

- India's diverse climate ensures availability of all varieties of fruits.
 - India ranks **Second** in fruit production in the world after China.
 - The area of cultivation of fruits 6.110 million hectares.
 - India produced 86.602 million metric tonnes of fruits in 2014-2015.
 - In 2015 -16 India exported fruits of worth of Rs. 3,524.50 crores.
 - **Mangoes, Walnuts, Grapes, Bananas , Pomegranates** are largely exported.
- (*According to APEDA.gov.in*)

Production share of fruits in India (2013-14)



Ripening

Ripening of fruit is a natural process which makes the fruit less green, soft and sweeter . (or)

Ripening is the physiological process by which fruits attain their desirable Flavor, Quality, Color, Palatable nature and other textural properties.

Composition changes:

1. Acid content high in unripe fruit but reduced during ripening.
2. Starch are converted to sugars by Amylases.
3. Hard pectin converted to soft one by Pectinase.

There are two types of fruits based on ripening:

1. Climacteric fruits.
2. Non- climacteric fruits.

Climacteric fruits:

Fruits that continue to ripen after harvest.

- ✓ These fruits emits ethylene during ripening along with increased respiration rate. So harvested **hard and green**.
- ✓ These fruits cannot withstand rigorous transport and handling.

Ex : Mango, Banana, Apple, Kiwi, Plum, Pear, Sapota,
Guava.

Non - Climacteric fruit :

Fruits once harvested do not ripen further.

- ✓ These fruits produce very small amount of ethylene and do not respond to ethylene treatment.
- ✓ There is no characteristic increased rate of respiration.
- ✓ So, these fruits are harvested once they are fully ripened.

Ex : Orange, Grapes, Watermelon, Pomegranate,
Strawberry, Litchi, Blackberry.,

ARTIFICIAL RIPENING

It is the process by which ripening is controlled and product may be achieved as per requirement by controlling the different parameters. *(Bhattarai et al.,2005)*

- It is done to achieve faster and more uniform ripening.
- Generally 80% fruits are ripened artificially through ripening agents. *(Dhembare, 2013).*
- The cosmetic quality of artificially ripened fruits will increase but organoleptic qualities, nutrition value and shelf life are depreciated when fruits are subjected to treatment without considering maturity status.

Artificial ripeners

The chemicals or agents which are used to ripen fruits artificially.

- ✓ These are used during **Pre-harvest, Post-harvest, Transportation, Storage** by farmers, transporters and traders.
- ✓ These induce color changes and accelerate ripening.
- ✓ Ripped fruits are not suitable to carry and distribute. So, farmers pick unripe fruits which are hard and green and ripen it using chemicals.

Some of most commonly used artificial ripeners are,

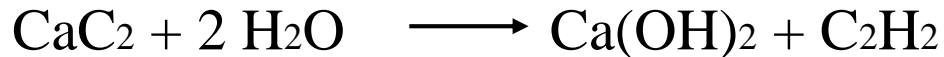
- ✓ *Calcium carbide*
- ✓ *Acetylene gas*
- ✓ *Ethephon*
- ✓ *Ethylene*
- ✓ *Ethylene glycol.*



Calcium carbide (CaC₂)

It is a chemical compound used in the production of acetylene and calcium cyanamide and also in gas welding.

- ✓ It reacts with water or moisture to produce acetylene gas (Carbide gas) which act as ripening agent produce similar effect of ethylene.



- ✓ Acetylene is not effective as ethylene.
- ✓ Fruits develop good peel color with CaC₂ the intensity of color developed proportional to concentration of CaC₂ used .

- ✓ More raw/ immature the fruit, higher CaC_2 is required to ripen it.
- ✓ Carbide ripened fruit produce uniform skin color.
- ✓ Actually CaC_2 only changes the skin color and fruit remains raw inside.
- ✓ Carbide contains traces of **Arsenic and Phosphorous hydride** which are carcinogenic compounds. Because of cheap availability of CaC_2 in local markets illegally it is used for ripening process.
(1 kg - Rs.100 – ripen 200 kg of fruits)

In local it is popularly known as ‘**Masala**’.

Ex: Mango, Banana, Apples, Papaya, Sapota are ripened using carbide.

Health effects :

- ❖ Early symptoms of Arsenic or Phosphorous poisoning include vomiting , diarrhoea with or without blood, burning sensation of chest and abdomen, thirst, weakness, difficulty in swallowing, irritation or burning in the eyes and skin, permanent eye damage, ulcers on skin, sore throat, cough and shortness of breath.
- ❖ Higher exposure may cause a build-up of fluid in the lungs.

- ❖ Carbide ripened fruit consumption erodes the mucosal tissues in the stomach and disrupts intestinal functions.
- ❖ It is carcinogenic and also may cause neurological problems.

Rules against Carbide use:

- ✓ In India, Artificial ripening is banned under PFA act ,1954.
- ✓ The use of carbide gas for ripening is prohibited under Rules 44A of Prevention of Food Adulteration Rules, 1955.

Those convicted under this act could face for imprisonment for three years and a fine of Rs.1000.

- ✓ According to Food Safety and Standards Act, 2006 the selling of unsafe food is punishable.
- ✓ The food safety and standards regulation, 2011 explicitly prohibits the selling of fruits which are artificially ripened by carbide gas.

In India, Ethylene like compounds are quite expensive so traders are using low cost calcium carbide.

In developed countries , fruits are ripened commercially in ripening chambers having low health hazards.

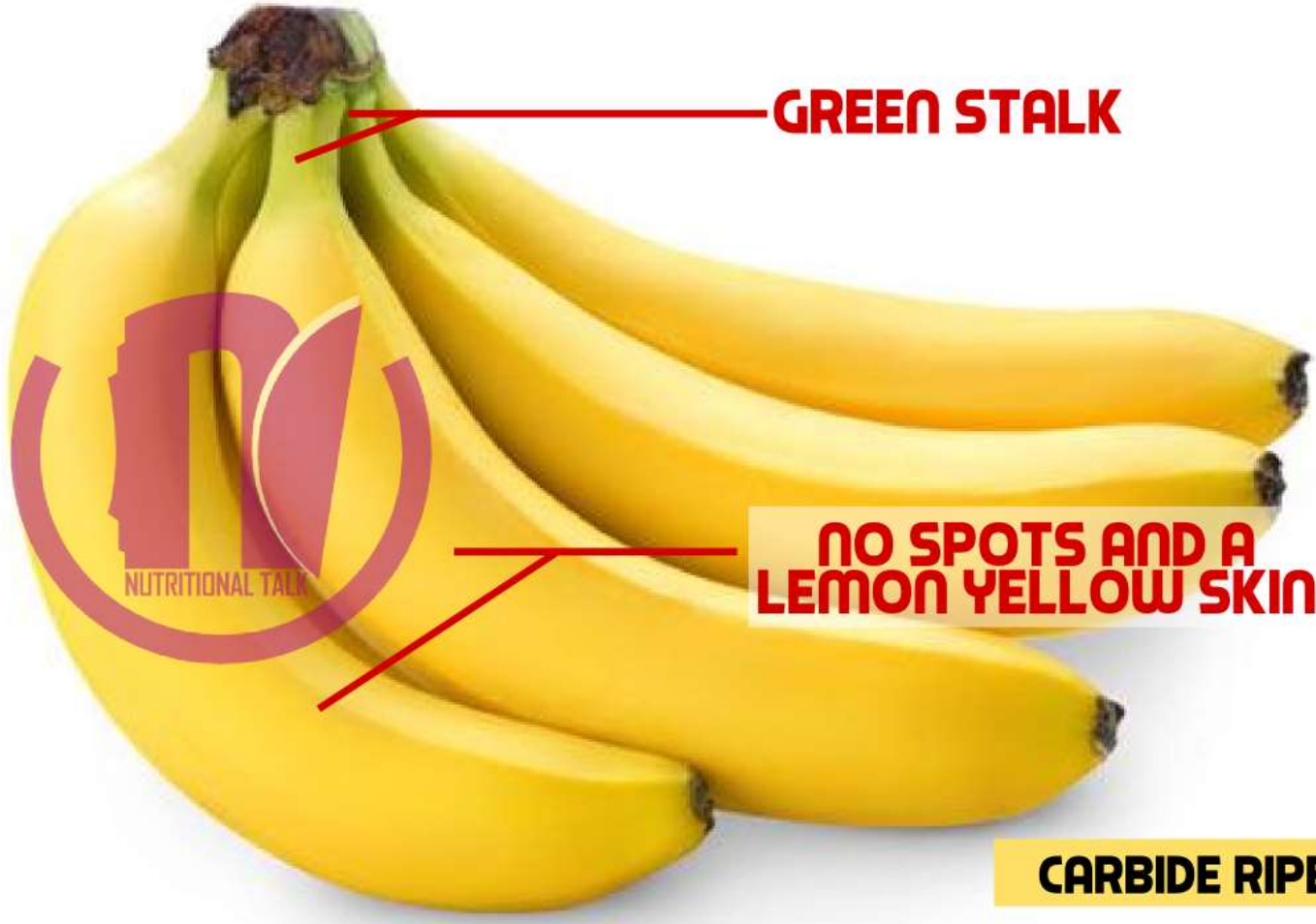
Countries using Calcium carbide for Ripening

Fruit species	Countries
Banana	India, Australia, Egypt, South Africa, Philippines, U.S.A, Taiwan, Sudan
Mango	India, Malaysia, Brazil, Senegal, Coast Rica, Philippines.
Citrus	Australia, Philippines, South Africa
Plums	South Africa
Peaches	South Africa



Identification of Calcium Carbide Ripened Fruits

Quality parameters	Fruit ripened using Calcium carbide	Naturally ripened fruit
Weight per fruit	Fair	Good
Texture	Not very attractive but uniformly colored	Attractive but not uniformly colored
Aroma	Mildly good	Good
Firmness	Fair	Fair
Taste	In-core sour, mildly pleasant	Sweet, Longer.
Shelf-Life	Shorter, Black Blotches appear on the skin in 2 or 3 days.	Longer

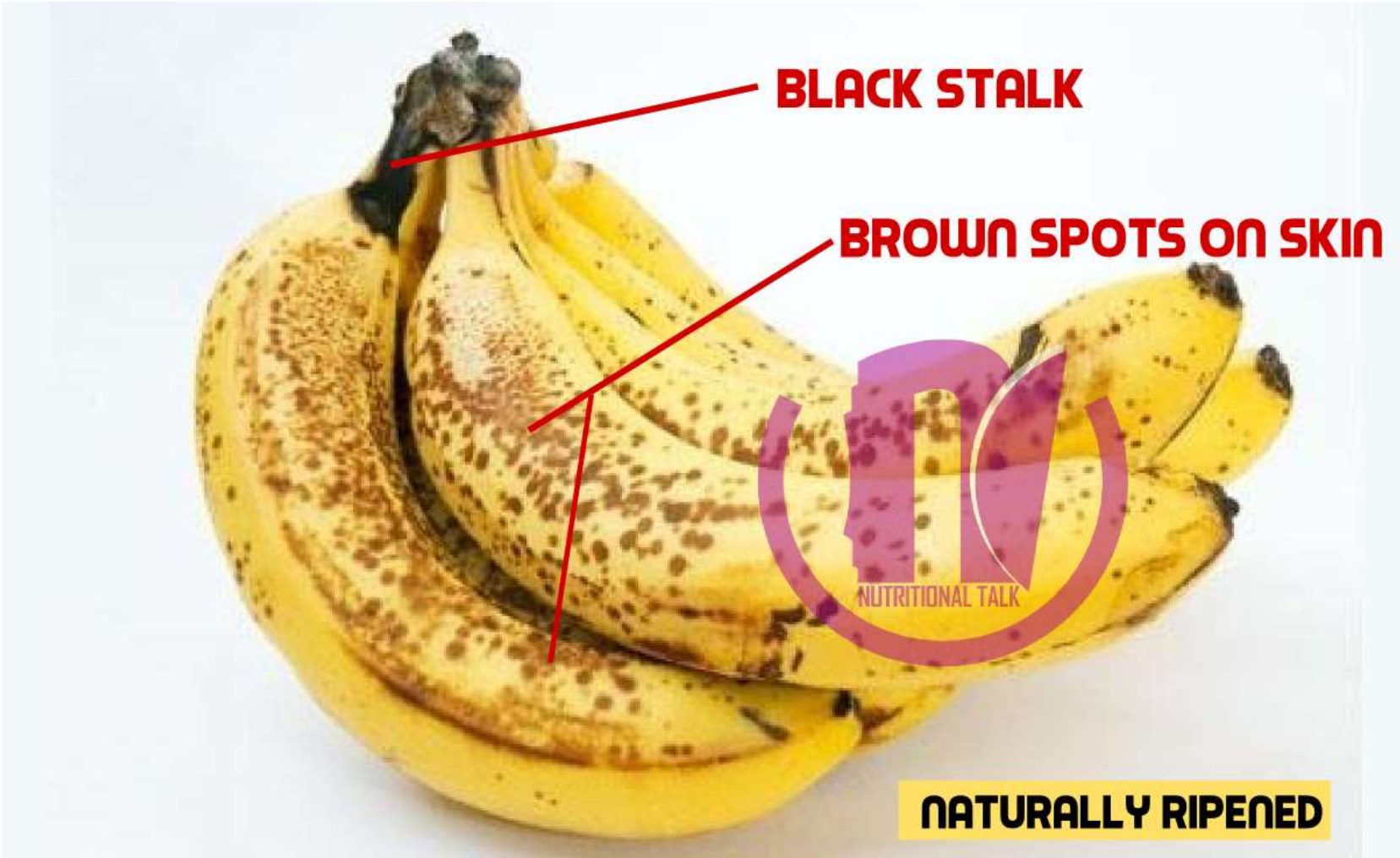


GREEN STALK

**NO SPOTS AND A
LEMON YELLOW SKIN**

CARBIDE RIPENED





BLACK STALK

BROWN SPOTS ON SKIN



NATURALLY RIPENED

Ethephon / Ethrel

2 – chloroethyl phosphonic acid ($C_2H_6ClO_3P$) is the chemical formula.

- ✓ It is a commercially available plant growth regulator which is a source of ethylene similar to that produced during ripening process.
- ✓ The government of India has allowed the use of ethephon for ripening of fruits as it is less harmful.
- ✓ Fruits ripened with ethrel have more acceptability and more shelf-life than fruits ripened with CaC_2 .

Ex : Mango, Papaya, Banana are usually ripened .

- ✓ The procedure is slightly difficult , the fruit sellers have to either dip the solution of this mixture or pass fumes of this chemicals.
- ✓ In TamilNadu, a solution has been developed for ripening.

A mixture of water (5l) , Ethephon 39% (10 ml), NaOH (2g) kept in a bucket close to mangoes heaped in air-tight container would release ethylene gas, which naturally facilitate ripening of fruits without any harmful effects.

Ethephon is sold under commercial names as
Floral, Cepa.



Health effects :

- ✓ It produces organophosphate signs of toxicity including salivation, lacrimation, incoordination, muscle twitching.
- ✓ The most sensitive indicator to ethephon is the inhibition of red blood cells and cholinesterase inhibition.
- ✓ Respiratory depression, tightness in chest, fluid in lungs, dark vision.
- ✓ In severe cases : seizures, incontinence , respiratory depression , loss of consciousness.

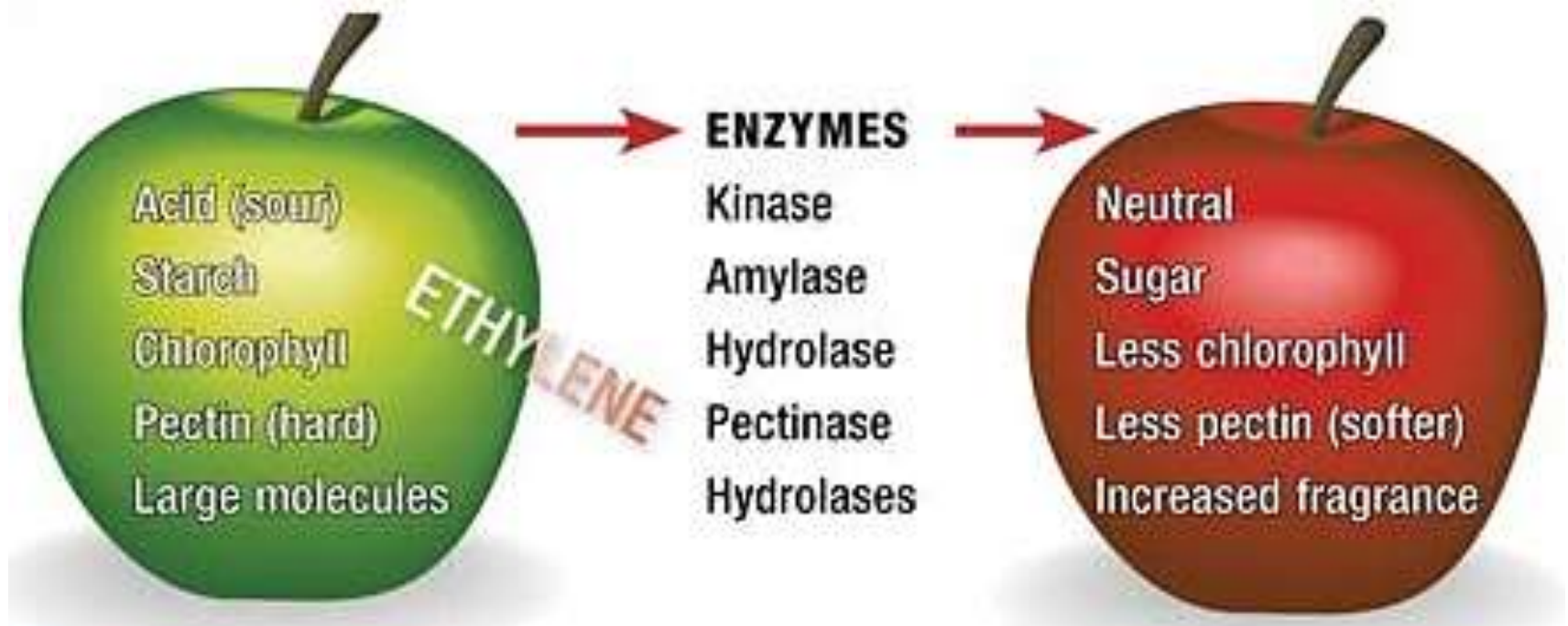
Ethylene (C₂H₄)

Ethylene is a daughter of ethyl (C₂H₅).

- ✓ It is a natural plant growth regulator.
- ✓ It acts as stimulating or regulating enzyme for the ripening of fruit.
- ✓ It is a gaseous hormone naturally produced in fruit.
- ✓ Commercially, it is very expensive . So traders use other chemicals.
- ✓ The concentration of ethylene required for the ripening initiation of commodities mostly in range of 0.1 to 1 ppm.

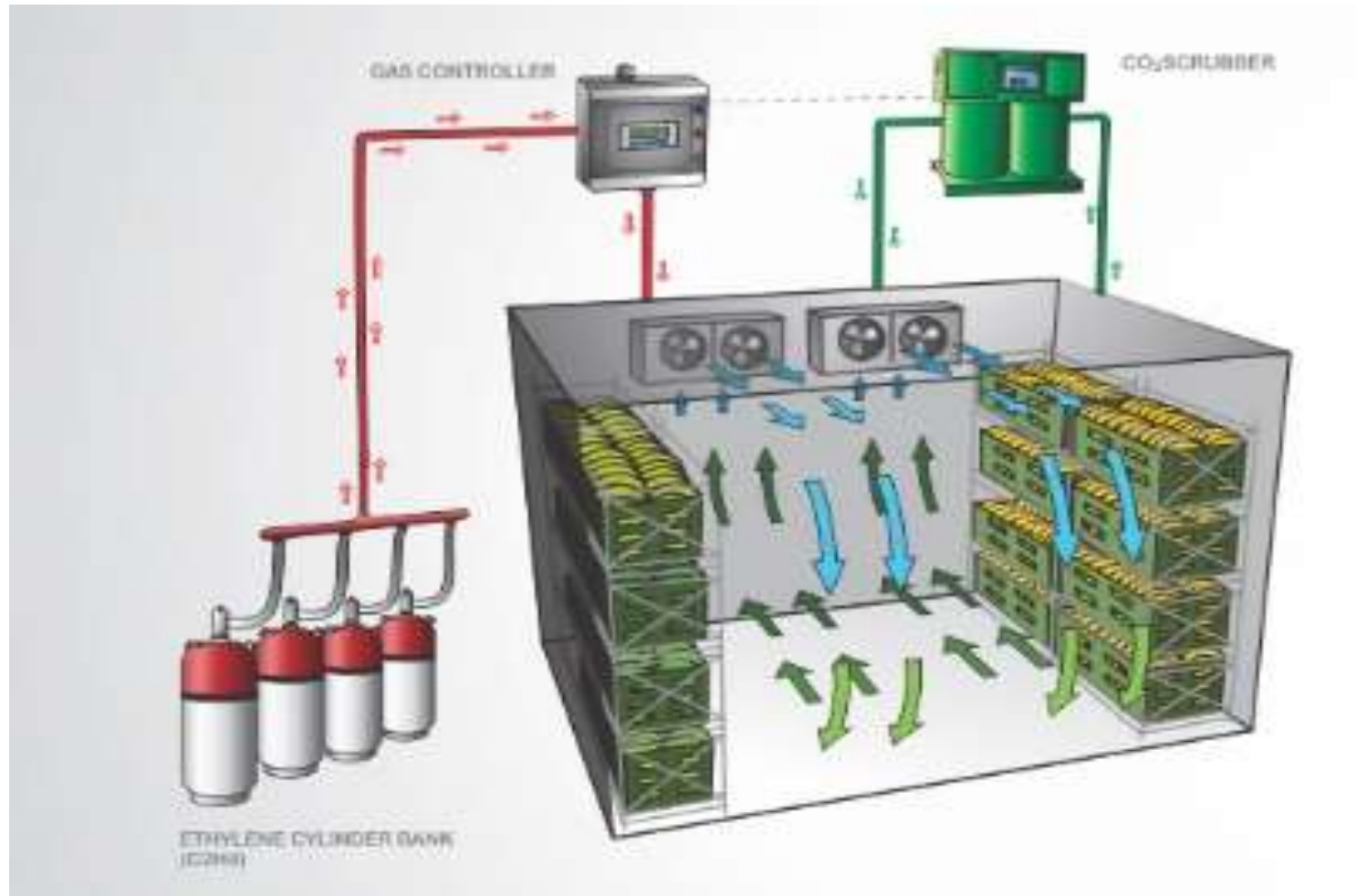
- ✓ The time of exposure to initiate ripening may vary but for climacteric fruits exposure for 24 hrs. is usually sufficient.
- ✓ The **only safe and worldwide accepted method** is using ethylene.
- ✓ Ethylene being a natural hormone, does not pose any health hazard for consumers of fruits.
- ✓ It is generally recognized as safe (GRAS) by FDA.
- ✓ It is used as a de-greening agent in citrus, bananas.
- ✓ As fruits ripe they release more and more ethylene that fastens ripening process.

- ✓ Climacteric fruits produce large amounts of ethylene .
- ✓ For artificial ripening , ethylene is spread using catalytic generators in a closed room under controlled temperature and RH.





Ripening chamber



Source of Ethylene :

1. Explosion proof ethylene mixture.
2. Ethylene generator.
3. Ethephon
4. Use of ripe fruit
5. Calcium carbide.

Health effects :

- ✓ If inhaled highly, it causes drowsiness, unconsciousness.

Ministry of Agriculture has clarified that the fruits are exposed to ethylene gas in low concentration of 10-100 ppm exogenously to trigger fruit ripening is safe.

Overall :

Ethylene increase the rate of respiration, chlorophyll degradation, carotene synthesis, conversion of starch to sugar and increase the activity of cell-wall degrading enzymes.

The exact role of ethylene in ripening of non-climacteric fruit is unknown.

Optimum ripening condition for different fruits.

Parameters	Value
Temperature	18 to 25 Degree Celsius
RH	90 to 95 %
Ethylene concentration	10 to 100 ppm
Duration of treatment	24 to 72 hrs. depending on fruit kind and Maturity stage
Air circulation	Sufficient to ensure uniform distribution of ethylene, high amount reduces effectiveness of ethylene.
Carbon dioxide	Less than 1% .

Aspects	Calcium carbide	Ethylene-based
Legal	Banned. Punishable under law.	WHO, FDA approved Internationally preferred.
Health	Hazardous and Carcinogenic, Affecting all vital organs	Completely safe and Natural
Quality of produce	Dry skin, Less/ Bad aroma, Possible Green patches	Uniform appearance, soft skin, Natural Aroma
Weight Loss	More (13%)	Less (7%)
Transport losses	Comparatively more	Less, Transport Friendly.
Shelf-Life	Less (5 Days), More prone to Rot (12%)	More (10%), Less prone to rot(3%)
Market demand	Decreasing	Increasing with Growing awareness
Ripening costs	Approx. Rs. 8.50/ kg	Approx. Rs.5 (40% lesser) More Economical.

Ethylene glycol

chemical formula - $C_2H_6O_2$.

- ✓ Ethylene glycol chemical structure contains the gas ethylene.
- ✓ Ethylene reacts with hydrogen peroxide to produce agent ethylene glycol.
- ✓ It is very much more inexpensive than the gas ethylene.
- ✓ Another aspect is the cheapness it can be diluted with water.
- ✓ The main disadvantage of ethylene glycol is if swallowed, it is **poisonous**.
- ✓ The swallowing of liberal amounts cause Kidney failure.
- ✓ It can use to ripe fruits in colder climatic environments.

Regulations to prevent Artificial ripening

- Food adulteration and illegal activities has become rampant due to inefficiency in Government regulated quality assurance practices. So strict rules have to be taken by GOI.
- Restrictions should be strictly imposed regarding the procurement and selling of such banned compounds to use for this purpose.

Ex: Carbide imported from china, South Africa and Taiwan.

- The fruit traders need to be aware of the danger and imbued with a sense of moral responsibility to the society.

- Vigilance at wholesale market should be strengthened to stop the practice.
- The consumer rights groups should raise the issue on the use of this banned chemical agents like carbide.
- Effective and better methods should be developed to prevent direct contact of ripening substances with the fruits.
- New compounds which are environmentally safe and not harmful for human health must be discovered and tested.

Preventive measures to be taken by consumers

- ✓ One should not select homogeneously ripened fruits with eye catching brightened colors.
- ✓ Keep in mind that naturally ripened fruits are not uniformly ripened . (These have patches of green and yellow)
- ✓ Washing and Peeling procedures before eating the fruit could help in minimizing the risks of artificial agents.
- ✓ Washing the fruit under running water for few minutes may help in reducing the chemical contents, if any adhering to the fruits.

- ✓ While eating mangoes and apples it is better to cut the fruit into pieces, rather than consuming directly.
- ✓ Select fruits without spots or lesions and any abnormality.
- ✓ Fruits come to market in off season or before due period is not advisable to buy.
- ✓ Do not buy and consume cut fruits from open or wholesale market.
- ✓ Suspected samples may be tested in lab for phosphorous and arsenic residue on the surface of fruits.

RESEARCH ARTICLES

Comparative study to evaluate the effect of Calcium carbide as an artificial ripening agent on shelf life, Physio chemical properties, Iron containment and quality of Peach. (Mahmood Talat et.al., 2013)

Aim : The synthetic ripening of fruits harmfully affects the quality of fruit. In order to recognize the effects of calcium carbide as an ARA on shelf life health, related physical properties of peach fruit were evaluated.

Conclusion: This study revealed that ARF's have less aroma, are less attractive , less weight per fruit, mild pleasant taste, less shelf life, Less total solids, un-dissolved solids and approximately equal value of dissolved solids and less moisture compared to NRF's.

On comparison of NRF and ARF it greatly affects the physiochemical, Nutritional, Antioxidant property. ARF gives the least amount of antioxidants, nutrients and less amount of digestible iron while NRF have a high antioxidant activity. The ARF are fatal for human consumption.

Published on European Academic research, Vol I, Issue 5, August 2013.

Studies on Physio-chemical changes during artificial ripening of banana var. 'Robusta'. (Kulkarni et.al.,2011)

Aim: To analyze the physio-chemical changes in Banana using ethrel at Different concentrations from 250 to 1000 ppm.

Conclusion :

The fruits treated with 500 ppm of ethrel shows induced uniform ripening without impairing the taste and flavor of banana. Untreated control fruits remained shriveled, green and failed to ripen evenly even after 8 days of storage. Fruits treated with 500 ppm ripened well in 6 days at 20 degree celsius.

The speed of ripening increases with increase in concentration. Fruit treated with 1000 ppm shows over ripening but control fruits shows slight change in firmness of fruit where as 1000 and 500 ppm treated fruits shows high firmness change. Ethephon treated fruit shows higher increase in sugar content compared to control.

On 6 day the ethrel treated shows excellent organoleptic characteristics in color, flavor, taste and overall characteristics of fruit. while control remained unripe after 6 days. **They recommended ethrel as an alternative to calcium carbide.**

Published on Journal of Food science and technology, December 2011, Vol 48, issue 6, pp 730-734.

Application of apple as ripening agent for Banana .

(Singal suman et.al., 2011)

Aim:

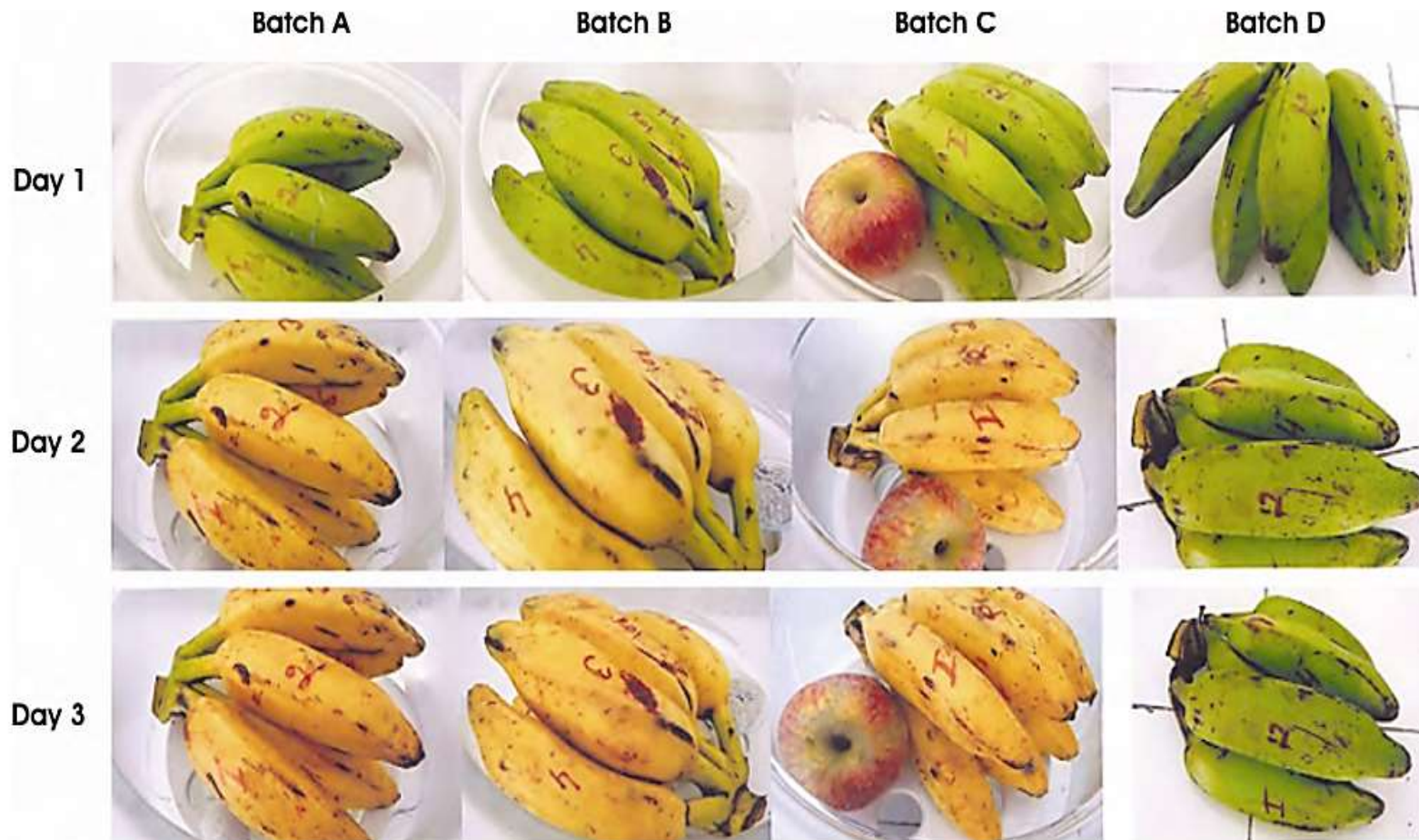
The study aimed at investigating potential of apple as a ripening agent as an alternative to the artificial ripening agent CaC_2 , which is carcinogenic in nature.

The four bunch of unripe bananas labeled A,B,C and D were exposed to same temperature of 15-25 celsius and 85% RH. A and B were 1 and 2 g of CaC_2 , batch C was apple used and D was natural ripened.

Conclusion:

Batch A and B took 5 and 4 days for full ripening. Batch C took 3 days for ripening. Batch D took 10 days for full ripening.

They concluded that apple can be exploited as a natural, safe and faster ripening agent to facilitate ripening of fruits.



Published on Indian journal of Natural products and Resources , march 2012,
Vol 3(1), pp 61-64.

Effects of Ethylene Glycol as a Fruit ripening agent.

(Goonatilake Ruchitha, 2008)

Aim :

To find out if the agent ethylene glycol, when diluted, can ripen various fruits faster than the regular ripening rate of fruits in colder climatic conditions.

Procedure :

The EG is mixed with water using one part of EG (20%) to Four parts of water (80%). The fruits bananas, lemons, apples and Nectarines were used. The temp. is 8 degree celsius.

Conclusions:

EG reduce at least a quarter of time it usually takes fruits to ripen. The EG treated fruits ripened at much faster rate than Regular fruits.

Fruits	EG treated fruits days taken to ripe	Control fruits days taken fruit to ripe
Banana	5	8
Mangoes	7	11
Nectarines	7	10
Lemons	8	9

Published on Global Journal Of Biotechnology & Biochemistry, 2008, 3(1): 08-13.

Conclusion

Fruits are being treated with artificial ripeners to ripen them faster. Considering its hazardous effects, the use of ripeners like calcium carbide, ethephon must **be strictly monitored and controlled**. It is not solely the responsibility of the Government: the people must also become aware and avoid consuming contaminated fruits.

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Thank
You

