Project on
"The Hidden Dangers of Calcium Carbide in Fruit Ripening"

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Chemical Tests:

Calcium carbide is banned for fruit ripening in India due to its harmful effects on human health. The Food Safety and Standards Authority of India (FSSAI) has alerted traders and food business operators to strictly comply with this prohibition, particularly during the mango season.

Why is calcium carbide banned?

- Releases acetylene gas containing toxic substances like arsenic and phosphorus
- Can cause serious health issues, including:

Health Risks:

- Dizziness
- Frequent thirst
- Irritation
- Weakness
- Difficulty in swallowing
- Vomiting
- Skin ulcers

May leave residues of arsenic and phosphorus on fruits

Regulations and Alternatives

The use of calcium carbide for ripening fruits is prohibited under Regulation 2.3.5 of the Food Safety and Standards (Prohibition and Restrictions on Sales) Regulations, 2011. As a safer alternative, FSSAI has permitted the use of ethylene gas for fruit ripening in India. Ethylene gas is a naturally occurring hormone in fruits that regulates the ripening process.[1]

Principle: Calcium carbide (CaC_2) reacts with moisture to produce acetylene gas (C_2H_2). The test detects the presence of acetylene gas, which indicates the use of calcium carbide. Mercuric Chloride reacts **with acetylene** forms a precipitate of **mercuric acetylide,** indicating the presence of acetylene (and thus calcium carbide).

Method: A sample of the fruit is placed in a sealed container or bag. After some time, the air inside the container is tested for acetylene gas using a chemical reaction.
Indication: If acetylene gas is detected, it may indicate the presence of calcium carbide residues on the fruit.

Protocol:

1. **Sample preparation:** Collect a sample from the fruit's surface using a swab or rinse with distilled water.
2. **Reagent preparation:** Prepare a 1% Mercuric chloride ($HgCl_2$) solution in distilled water.
3. **Test procedure:**
    a. Add a few drops of the Mercuric chloride solution to the sample.
    b. Observe the mixture for a white precipitate or turbidity, which indicates the presence of acetylene.
4. **Result interpretation:**
    a. A white precipitate or turbidity confirms the presence of acetylene, suggesting potential use of calcium carbide.
    b. A negative result (no precipitate or turbidity) does not necessarily rule out the use of calcium carbide, as the amount of acetylene may be below the detection limit.

Safety precautions:

- Handle silver nitrate with care, as it can cause skin and eye irritation.
- Wear protective gloves, goggles, and a lab coat.
- Dispose of waste properly.

Spectroscopic analysis

Principle: The **principle** for spectrophotometric analysis of calcium carbide typically involves an indirect method, where calcium carbide reacts with water to produce acetylene gas. The acetylene then reacts with a specific reagent to form a colored complex or compound. The concentration of calcium carbide is determined by measuring the absorbance of the colored complex using a spectrophotometer.
The principle of this analysis is based on the reaction of calcium carbide with water to produce acetylene gas, which then reacts with a specific reagent (e.g., palladium(II) chloride or copper(I) acetate) to form a colored complex. The intensity of the color is directly proportional to the concentration of calcium carbide in the sample.
The principle for spectrophotometric analysis of calcium carbide typically involves an indirect method, where calcium carbide reacts with water to produce acetylene gas. The acetylene then reacts with a specific reagent to form a colored complex or compound. The concentration of calcium carbide is determined by measuring the absorbance of the colored complex using a spectrophotometer.

Key steps:

1. Reaction of calcium carbide with water: $CaC_2 + 2H2O \rightarrow Ca(OH)_2 + C_2H_2$
2. Reaction of acetylene with reagent: C_2H_2 + Copper(I) acetate (Reagent) → Colored complex
3. Spectrophotometric measurement: Measure the absorbance of the colored complex.
4. Copper (I) ions react with acetylene gas to form a π-complex **copper (I) acetylide complex)**, where the copper ion coordinates with the triple bond of acetylene.

5. Complex formation: Copper (I) acetate reacts with acetylene to form a colored complex.

Protocol:

1. **Sample preparation:**
    a. Homogenize the food sample.
    b. Add a known amount of water to the sample to react with calcium carbide and produce acetylene gas.
2. **Sample preparation:** Method: A sample of the fruit is placed in a sealed container or bag. After some time, the air inside the container is tested for acetylene gas using a gas detector or a chemical reaction.
3. **Acetylene gas collection:** Collect the acetylene gas produced in a **Dreschel bottle**.
4. **Reaction with reagent:**
    a. Add a specific reagent; copper (I) acetate, to the collected acetylene gas.
    b. Allow the reaction to proceed for a specified time.
5. **Spectrophotometric measurement:** Measure the absorbance of the resulting colored complex using a spectrophotometer at a specific wavelength 420 – 460 nm.
6. **Calibration curve:** Prepare a calibration curve by measuring the absorbance of known concentrations of calcium carbide or acetylene.
7. **Quantification:** Calculate the concentration of calcium carbide in the food sample using the calibration curve.

Instrument settings:
- Wavelength: Set the spectrophotometer to the specific wavelength corresponding to the maximum absorbance of the colored complex.

Quality control:
- Blank measurement: Measure the absorbance of a blank sample (reagent only) to account for any background absorbance.
- Standard measurement: Measure the absorbance of a known standard solution to verify the accuracy of the calibration curve.

Method:

1. Reaction with water: Calcium carbide reacts with water to produce acetylene gas.
2. Acetylene detection: The acetylene gas can be detected using various reagents, such as:
- **Ilosvay's reagent:** A solution of copper(I) chloride and hydroxylamine hydrochloride, which forms a red-colored complex with acetylene.
3. Spectrophotometric measurement: The absorbance of the colored complex is measured using a spectrophotometer at a specific wavelength (e.g., 525 nm for the copper-acetylene complex).

How to look for warning signs in Mango

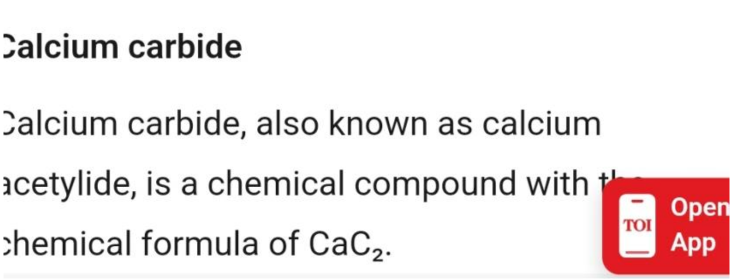
Mango should more or less feel firm, not squishy (unless it’s overripe)
Look for black dots on the skin of the mango
It should look uniform throughout. One part should not look different from another part.

Fruits ripened with calcium carbide may appear more vibrant or glossy.

Possible Visual Differences
1. Color: Fruits ripened with calcium carbide may have an unnatural, uniform color.
2. Texture: Calcium carbide-ripened fruits may be softer or have a different texture than naturally ripened fruits.
3. Appearance: Fruits ripened with calcium carbide may appear more vibrant or glossy.

Limitations
1. Variability: Natural ripening processes can vary depending on factors like fruit variety, climate, and handling.
2. Masking: Some fruits may be treated with additional chemicals to enhance appearance.

Health Risks
1. Toxicity: Calcium carbide contains arsenic and phosphorus, which are toxic to humans.
2. Respiratory Issues: Inhaling calcium carbide dust can cause respiratory problems.
3. Gastrointestinal Problems: Consuming fruits ripened with calcium carbide may lead to stomach pain, vomiting, and diarrhea.



Calcium carbide

Calcium carbide, also known as calcium acetylide, is a chemical compound with the chemical formula of CaC_2.

3:26 89%

Also look for black dots on the skin of the mango, and avoid buying one if you spot some.

Do the pressure test: Your mango should more or less, feel firm, and not squishy (unless it is overripe) An unripe mango feeling squishy is not a good sign.

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Water test: Fill a jar of water and dunk the mango in it. If it sinks, it is usually good to go. If it does not, it will float. This is because the use of Calcium carbide reduces the quantity of pulp in the mango, making it lighter and hence, it might float, and not sink.

Luke Coutinho further says that all of us should do this test at home to check the authenticity of mango, and added that we should not fear the humble mango, rather should watch out for a

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Look for uniformity in the skin: The mango should look uniform all throughout. If one part looks different from the other, then it could be a warning sign.

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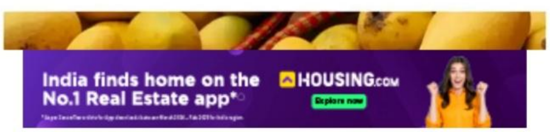

Calcium carbide (CaC_2) ripening in fruits: Health risks, non-destructive detection, quality control, and regulatory frameworks

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