The University of Texas at Austin
Department of Chemistry
College of Natural Sciences

Liquid Nitrogen Ice Cream

Performer's Version

Safety Hazards

- Personal Protective Equipment
    - Safety glasses
    - Cryo gloves
    - Chemical & flame retardant lab coat
- Physical Hazards
    - Contains refrigerated gas; may cause frostbite or cryogenic burns
    - Gas under pressure; may cause injury
- Chemical Hazards
    - May displace oxygen and cause rapid asphyxiation

Materials

Please refer to the table on the following page for quantities based on enrollment.

- Plastic mixing bowls
- Mixing spoons
- Liquid nitrogen
- Whole milk
- Granulated sugar
- Vanilla extract/Imitation Vanilla
- Xanthan Gum (optional)
- Syrups (Chocolate, Caramel, Strawberry)
- 5 oz. plastic cups
- Plastic spoons
- Napkins

Safety Data Sheet(s)

- Liquid nitrogen

Procedure

1. Fill each bowl approximately ¼ to ⅓ of the way with premade ice cream mixture. Don't fill the bowls too much – the nitrogen will bubble over!
2. Have the volunteers begin slowly stirring the mixture while nitrogen is slowly poured into each bowl.
    a. Note: Pour only a little at a time! The nitrogen can bubble over and splash. It will become immediately foggy and difficult to see the liquid level, so be patient and take your time.
3. When the ice cream has reached the desired consistency, scoop it into 5 oz. plastic cups and serve!

Pedagogy & Supplemental Information

Liquid nitrogen ice cream is a popular and dramatic chemistry demonstration that illustrates fundamental principles of phase changes, heat transfer, and colloid chemistry. Liquid nitrogen (LN_2) is nitrogen in its liquid state at –196ºC (77 K) and atmospheric pressure. When poured into a sweetened cream mixture, it causes the mixture to freeze rapidly, forming ice cream in under a minute – far faster than conventional methods.

The key chemical principle is heat transfer via conduction. As the liquid nitrogen comes into contact with the much warmer cream mixture (typically around 5 – 25ºC), it rapidly absorbs heat from the mixture and undergoes a phase change from liquid to gas. This transformation requires energy in the form of latent heat of vaporization—about 199 J/g for nitrogen—which is drawn from the mixture. The sudden and intense cooling freezes water molecules in the cream into ice crystals. Because freezing occurs so quickly, only very small ice crystals have time to form, resulting in a smoother texture compared to traditional slow-churned ice cream.

From a molecular standpoint, ice cream is a colloid, a heterogeneous mixture where fat droplets and air bubbles are dispersed in a continuous frozen water phase. The presence of emulsifiers, proteins, and sugars stabilizes this dispersion, preventing phase separation. As the mixture freezes, these molecules also influence the freezing point and ice crystal size. Rapid freezing with liquid nitrogen minimizes crystal growth and promotes uniform texture, while also trapping air, creating a creamy consistency.

Additionally, the expansion of nitrogen gas (which expands roughly 700-fold as it vaporizes) provides a visual cue and sensory experience, producing the characteristic fog. This fog is condensed water vapor, not nitrogen gas itself, and forms as cold gaseous nitrogen chills the surrounding air, causing ambient moisture to condense.

Real-world applications of this chemistry extend beyond frozen desserts. The rapid freezing principle is used in cryopreservation of biological samples, flash freezing in food processing, and materials science for quenching metals. The demonstration also introduces students to safe cryogen handling, thermodynamics, and the science behind food textures—making it a compelling intersection of chemistry, physics, and culinary science.