

## The Use of Liquid Nitrogen in Food: Health Risks and Safety Measures

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### SUMMARY

Liquid nitrogen is a common ingredient in the food industry for innovative culinary purposes, but it carries significant health risks such as frostbite, burns, internal injuries, and asphyxiation. To ensure safety, proper training, adherence to safety protocols, and awareness of regulatory guidelines are crucial. In addition to health risks, food safety concerns related to liquid nitrogen include chemical contamination and microbial growth, emphasizing the importance of continuous education on safety practices in food preparation.

### INTRODUCTION

Liquid nitrogen is increasingly being used in the food industry, especially in molecular gastronomy, because of its exceptionally low temperature of  $-196^{\circ}\text{C}$ . Liquid nitrogen is commonly used by chefs and food enthusiasts to produce unique textures, quick freezing effects, and visually appealing products like desserts called "dragon's breath," which emit a visible fog when consumed. Liquid nitrogen is popular because of its near-instantaneous freezing of substances, which enables creative cooking procedures that are unfeasible with more conventional processes (Molecular Recipes, 2023). However, serious safety and health risks are associated with these culinary inventions. When liquid nitrogen comes into contact with the skin or tissues, its intense cold can result in frostbite and severe burns. Consumption of liquid nitrogen can cause severe internal injuries, such as esophageal and stomach perforations (FDA, 2018). Moreover, asphyxiation can result from breathing nitrogen vapors because they replace oxygen in the air, especially in places with inadequate ventilation (CDC, 2019). Because of the risks associated with liquid nitrogen, people handling liquid nitrogen in food processing environments must follow strict safety procedures and receive extensive training (OSHA, 2020).

### Health Risks

**Cryogenic Burns and Frostbite Risks:** Direct contact with liquid nitrogen can cause frostbite and severe cryogenic burns, which can lead to necrosis and damage to cells. Even a brief exposure can result in serious harm that requires medical attention, so it is crucial to use the right protective gear, such as insulated gloves and face shields, to prevent such injuries (FDA, 2018). Furthermore, accidental consumption of liquid nitrogen can cause serious internal damage, such as stomach and esophageal perforations. Since the rapid expansion of nitrogen gas in the stomach can potentially result in gastric rupture, some patients who consume liquid nitrogen-chilled drinks experience internal injury that requires emergency surgery (NHS, 2018).

**Respiratory Hazards:** The evaporation of liquid nitrogen into nitrogen gas, which can replace oxygen in enclosed spaces and cause hypoxia, presents a hazard to asphyxiation. This risk is very high in poorly ventilated kitchens or laboratories. Proper ventilation and oxygen level monitoring are essential safety precautions because oxygen displacement can cause unconsciousness and death if not treated quickly (CDC, 2019). Nitrogen vapor inhalation can also irritate the respiratory system, resulting in symptoms such as coughing and breathing difficulties. Extended exposure to elevated nitrogen gas levels can worsen these symptoms and may lead to more serious respiratory problems (OSHA, 2020).

**Digestive System Damage:** Consuming food that has been treated with liquid nitrogen before allowing it to warm enough to reach a safe temperature might cause instant harm by freezing tissues in the oral cavity and gastrointestinal tract. Pain, tissue necrosis, and the need for surgery may have resulted from this.

**Acute and Chronic Health Effects:** Frostbite, respiratory distress, and asphyxiation are acute symptoms of liquid nitrogen exposure, indicating the need for immediate medical intervention to avoid long-term harm or death. Furthermore, prolonged exposure to nitrogen vapor in poorly ventilated locations, including chronic respiratory

disorders, can persist. Long-term exposure to low-oxygen environments can have serious detrimental effects on overall health (Vitharana et al., 2015).

**Explosion Hazard:** Pressure build-up is a major risk when utilizing liquid nitrogen because it can vaporize and expand 700 times its liquid volume when exposed to ambient temperatures. This expansion can cause hazardous pressure build-up and explosions if kept in a sealed container. Thus, to avoid these risks, liquid nitrogen must be stored in vented containers (Ramli & Wong, 2022).

### Food Safety Concerns

**Chemical Contamination:** Handling liquid nitrogen raises serious concerns regarding cross-contamination because surfaces and equipment may contaminate food. Consumer health may be at risk owing to chemical contamination resulting from improper washing and sanitation procedures. Furthermore, material migration is a crucial problem, as food contact materials (FCMs) can leak dangerous substances into food when exposed to high temperatures. Consumers are frequently ignorant of the risks associated with this migration, which can be particularly severe if the materials are not intended for cryogenic use (Moura et al., 2023).

**Microbial Growth:** The low temperature of liquid nitrogen can efficiently prevent microbial development; thus, it is important to consider temporary inhibition while utilizing it. After treatment, microbial growth can continue and cause foodborne diseases if improper handling occurs (Alexandra et al. 2023). However, the risk of contamination increases after the food returns to normal temperatures. Thus, it is imperative to uphold stringent sanitation and hygiene protocols, both before and after using liquid nitrogen. Preventing microbiological contamination requires thorough cleaning of all surfaces and equipment that come in contact with food and liquid nitrogen (Ramli & Wong, 2022).

### Regulatory Guidelines and Safety Practices

#### Proper Training and Equipment:

**Personal Protective Equipment (PPE):** To prevent splashes and direct contact, insulated gloves, face shields, and aprons must be worn. To prevent accidents, it is necessary to provide training on proper PPE use and handling procedures (FDA, 2018).

**Training Programs:** Comprehensive training programs that cover the characteristics of liquid nitrogen, possible risks, emergency protocols, and appropriate application methods are crucial. All workers handling liquid nitrogen are required to complete these courses (Ramli & Wong, 2022).

#### Ventilation and Environmental Controls:

##### Adequate Ventilation:

Appropriate ventilation systems are required to avoid nitrogen gas buildup, which can displace oxygen and present a suffocation risk.

In order to maintain acceptable oxygen levels, ventilation systems should be able to evacuate excess nitrogen gas (CDC, 2019).

##### Monitoring Devices:

Asphyxiation hazards can be reduced and oxygen depletion can be identified using oxygen level monitors in places where liquid nitrogen is handled. When the oxygen concentrations drop below safe levels, these devices are supposed to trigger an alarm (OSHA, 2020).

#### Emergency Procedures:

**Spill Response:** Risks can be reduced by establishing precise protocols for managing liquid nitrogen spills. This includes isolating the impacted area, ensuring sufficient ventilation, and cleaning up spills using the appropriate absorbent materials (Healthline, 2020).

**First Aid Measures:** All personnel should be knowledgeable about first-aid procedures for frostbite and cryogenic burns. An injured person should be immediately removed from the cold source, the affected area should be progressively warmed, and medical attention is essential (NHS, 2018).

### CONCLUSION

The utilization of liquid nitrogen in culinary applications offers unique and exciting possibilities but is associated with significant health risks and safety concerns. Proper handling, rigorous safety protocols, and

adequate training are essential for mitigating these risks. By adhering to regulatory guidelines and promoting continuous education on safety practices, the use of liquid nitrogen in food preparation can provide a safe and enjoyable experience.

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