

# Potatoes, French Fries

Revised 2018

## Storage Conditions

|                                | Raw Potatoes for French Fries | Frozen French Fries   |                   |
|--------------------------------|-------------------------------|-----------------------|-------------------|
|                                |                               | Small Cuts            | Larger Cuts       |
| Temperature                    | 45 to 50°F (7.2 to 10 °C)     | 0°F (-17.8 °C)        | 0°F (-17.8 °C)    |
| Storage Period                 | 1 to 10 months*               | 12 months**           | 18 to 24 months** |
| Relative Humidity or Packaging | 90 to 95%                     | Vapor-proof packaging |                   |

\*Sprout suppressors are required for raw potatoes to achieve listed storage periods.

\*\*Commercial processors prefer to store only 6 to 9 months.

## Introduction

Frozen potato products claim a growing percentage of the world's potato production. Almost 85% of U.S. frozen processed potatoes are marketed as frozen French fries. The remaining 15%, mostly byproducts of French fry processing, are processed into hash browns, so-called 'tater tots' and similar 'pre-formed' products. These are made mainly of French fry trimmings and are formed into various products on what is known as the 'patty line'.

### Storage of Raw Potatoes for French Fries

Raw potato storage is designed to minimize tuber respiration and its byproducts and prevent greening, sprouting, dehydration, and decay. Storage is also intended to minimize reducing sugar concentrations in order to favor light-colored fries by keeping the storage temperature at or above 45°F (7.2°C) because lower temperatures favor conversion of starch to soluble sugars that will turn brown during cooking.

Respiration involves oxidation of carbohydrates (starch and sugars) or other storage compounds to produce carbon dioxide, water, chemical energy and heat. Skillful storage involves supplying sufficient oxygen to maintain the rate of respiration required to fuel minimal metabolism while removing the respiratory products (carbon dioxide, water, and heat), any of which can reduce tuber quality and/or cause serious decay.

Potatoes form chlorophyll and turn green only when exposed to light. Therefore, greening is controlled by keeping storages dark as much as possible. Greening is usually accompanied by increasing levels of glycoalkaloids, mostly solanine, which can be poisonous at high concentrations or when consumed in large amounts. Practically speaking, glycoalkaloids are not a serious consideration at even supernormal levels of potato consumption. Many other crops such as

tomatoes and lima beans also contain toxic alkaloids that could be harmful if consumed to great excess.

Most processing potatoes are stored in bulk piles in common or ambient storages that lack refrigeration and depend solely on skillful movement of ambient air for controlling temperature and humidity. A small percentage of the crop is held in refrigerated facilities for late processing into the following summer.

Common storage relies on common sense and attention to detail. Success is also highly affected by the condition of the crop going into storage. The utmost care should be taken to place only clean, healthy, mature tubers of the correct moisture content and temperature into well-prepared storage facilities. Varieties differ in storability. Russet Burbank stores better than all other leading processing varieties.

During the first 2 weeks of storage, potatoes are typically held at about 55°F (12.8°C) and high (90 to 95%) relative humidity (RH) to favor suberizing or wound-healing. Following the healing period, temperatures are slowly dropped (0.5°F or 0.3°C per day) until the final holding temperature is reached. Because both sugar concentrations and chip color increase with declining storage temperatures, most potatoes for frozen French fry processing are stored relatively warm at approximately 45 to 50°F (7.2 to 10.0°C), depending on the variety. Some varieties can be stored slightly cooler without sugar buildup and subsequent darkening of fries while others should be stored slightly warmer.

Success with common or ambient storages depends on air movement for cooling and maintaining tuber health. Most modern structures are designed to uniformly and consistently deliver up to 20 ft<sup>3</sup>/min (0.6 m<sup>3</sup>/min) per ton of potatoes from the bottom upward through the top of the pile (8 to 20 ft or 2.4 to 6.1 m); many older structures have much less ventilating capacity. Good air movement is especially important early in the season for removing field heat and/or excess moisture. The presence of disease or field frost also calls for high rates of air movement to cool and dry the potatoes. Potato tubers with free moisture on the surface are very prone to decay development.

Air can be moved either in ventilation (air in/air out) or recirculation (movement only within the storage) mode. Storages are cooled by ventilating; that is, moving in cool outside air (mostly at night) and simultaneously exhausting warm storage air. Care must be taken to avoid chilling or freezing potatoes near ventilation inlets. For that reason, external and internal air is typically mixed in a proportioning chamber or 'plenum' to provide the proper temperature prior to contact with tubers. Because air movement can remove tuber moisture, especially early, before wounds have healed and skins have fully thickened, 90 to 95% RH is maintained throughout the storage season unless the crop is threatened by excess moisture or disease. Severe disease, such as late blight followed by bacterial decay, can completely destroy the crop unless extreme measures are taken. Therefore, every attempt should be made to cool and dry potato crops at risk from decay. High RH is also not recommended for poorly insulated storages prone to condensation on roof and walls.

After tubers have reached the final storage temperature, fans may be operated only intermittently in either circulation or ventilation mode. After the final storage temperature is reached, ventilation

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may be needed only to provide adequate oxygen, prevent excess carbon dioxide accumulation, and equalize temperatures throughout the storage.

Most modern potato storages are fully instrumented and automated. However, facilities should be inspected daily to assure that all is well, and that the crop is sound. Odors suggesting decay and/or ammonia should be immediately investigated. Infrared heat-detecting devices are useful in locating 'hotspots' caused by the high metabolic rate of disease organisms. Diseased areas can sometimes be corrected by operating fans continuously, reducing RH as much as possible, and forcing more air through the affected area(s) by diverting flow from other sections. Obviously, severely blighted or otherwise compromised potatoes should never be placed in long-term storage.

## **Frozen Storage of French Fries**

Potato products that have been processed and partially fried ('oil blanched'), commonly called 'Par-fries', can be held long-term in a frozen state. Enzyme systems are destroyed during par-frying, and the tissues therefore remain basically stable until thawed. Smaller cuts can be stored up to 12 months and larger cuts up to 18 or 24 months at about 0°F (-17.8°C) without serious loss of quality due to dehydration. However, processors prefer to store only 6 to 9 months. Par-fries should remain frozen, preferably at about 0°F (-17.8°C), until shortly before final cooking and consumption.

Due to the extremely low temperatures involved, humidity is not a critical factor in storage of par-fries. Par-fries eventually lose moisture and quality even when frozen and cannot be stored indefinitely.

Frozen fries are almost as fragile as eggs and should be handled accordingly. Damaged boxes almost certainly indicate a high percentage of broken fries. According to the U.S. Potato Board, dropping boxes twice from a height of 3 ft (0.9 m) decreases the proportion of fries over 2 inches long (5.1 cm) from about 40% to 20%. Standard boxes or cases of frozen fries should not be stacked unaided in storage at more than eight high or 110 inches (2.8 m). Higher stacks tend to crush boxes near the bottom and cause breakage of fries.

Boxes should never be piled directly on the floor or flush against walls or ceilings for extended periods. They should be carefully stacked on pallets to promote air circulation beneath. Further, a gap of at least 2 inches (5.1 cm) should be maintained between boxes and walls or ceilings, not only to avoid transfer of heat from the outside, but also to promote good air movement.

## **Transportation**

Par-fries should be held at about 0°F (-17.8°C) and kept frozen until shortly before final cooking and consumption. Therefore, every attempt should be made to use reliable refrigeration facilities at all stages of storage and transport. Par-fries that have been thawed and re-frozen develop musty, stale flavor and odors and have poor texture and darker color when fried.

As noted above, par-fries are typically packaged in plastic bags of various sizes and placed in cardboard boxes holding up to 50 lbs (about 22.7 kg) each. Cardboard boxes are stacked on pallets

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and wrapped for stability before being placed in trucks or shipping containers. Processors prefer that total transportation and storage time combined not exceed 6 to 9 months for maximum quality.

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