

# Popcorn

Revised 2018

## Thermal Properties

	Air-popped	Oil-popped
Moisture, %	4.10	2.80
Protein, %	12.00	9.00
Fat, %	4.20	28.10
Carbohydrate, %	77.90	57.20
Fiber, %	15.10	10.00
Ash, %	1.80	2.90
Specific Heat Above Freezing	0.49 Btu/lb*°F or 2.04 kJ/(kg*K)	0.48 Btu/lb*°F or 1.99 kJ/(kg*K)
Specific Heat Below Freezing	--	--
Latent Heat of Fusion	6 Btu/lb or 14 kJ/kg	4 Btu/lb or 9 kJ/kg

## Storage Conditions

Temperature	32 to 40 °F (0 to 4.4 °C)
Relative Humidity	80% to moisten 70% to maintain 60% to dry
Storage Period	4 - 6 months

Moisture content is the critical factor in maintaining maximum popping volume in popcorn. Popcorn will yield the highest popping volume when the kernel moisture content is near 13.7%. Higher or lower kernel moisture will result in decreased popping volume. Fortunately the moisture content of popcorn in storage can be regulated by controlling the relative humidity of the air. Popcorn within a range of 12-16% moisture can be brought to the optimum (13.7-14%) by storing in open containers, either paper or cloth sacks, for approximately 10 days at a relative humidity of 70% and a temperature of 70 °F (21 °C). For large sacks, i.e., 25-lbs. and up, and extremely wet or dry popcorn, more days will be required for all kernels to reach equilibrium at the optimum moisture content.

The following conclusions are derived from a WFLO-sponsored project at Iowa State University on the "Cold Storage of Popcorn."

1. Popping volume of popcorn, when kernels are stored at optimum moisture content, is neither improved nor injured when grain is stored at temperatures as low as -10 °F (-23 °C) for prolonged periods (120 days) of time.

2. Popcorn stored in **polyethylene bags or other types of lined bags** to prevent moisture loss can be stored for long periods of time (4 to 6 months) at temperatures of 32 to 40 °F (0 to 4.4 °C) without a significant change in popping volume. Storage at 70 °F (21 °C) for 60 days with this type of container resulted in some loss in moisture, but only a slight loss in popping volume.

3. Popcorn stored in **cloth bags without liners** for 120 days at 32 °F (0 °C) or lower lost only a slight amount of moisture. Popping volumes were slightly lower when stored at 32°F (0 °C) than at below freezing temperatures. Popcorn stored in cloth bags at 45 to 70 °F (7 to 21 °C) without humidity control were subject to drastic and unfavorable changes in moisture content and in popping volume.

Drying conditions prior to storage or extreme moisture changes during storage can adversely affect popping volume. Equalization of moisture gradients within the kernel may result in large tensile stresses in the endosperm causing endosperm fracture. Studies conducted at the University of Kentucky Agricultural Engineering Department on endosperm fracture in popcorn have indicated:

1) Stress cracks in kernel endosperm developed during storage (12 to 36 hours after drying) rather than during the heating or rapid cooling phase of the drying process.

2) Only small differences in expansion volumes existed between the single crack (one fracture plane in a kernel) and multiple crack (several fracture planes in one kernel) samples.

3) Generally, the presence of stress cracks in kernels lowered popping expansion volume by less than 10%.

4) The number and severity of stress cracks appeared to be related to the temperature and relative humidity of the drying air.

(a) Few cracks developed in kernels in storage after high humidity drying (61% RH) when drying air temperatures were 80 to 120 °F (27 to 49 °C).

(b) A much greater number of stress cracks developed in kernels in storage after drying with low humidity (26%RH) and 100-120°F (38-49 °C) air temperatures.

## Insect Control

Insect control is also an important consideration in the storage of popcorn. Processors cannot be certain that popcorn thoroughly fumigated at time of shipment will not become infested with insects in transit or in the consumer's unrefrigerated warehouse. Refrigerated storage of popcorn can assist with insect control. Killing insects in food commodities by means of low temperatures is

generally accomplished with temperatures of 0°F (-18 °C) for 24 hours; or temperatures of between 10 and 15°F (-12.2 to -9.4 °C) for 5 days. Once insects have been controlled with time and temperature freezing, protecting the commodities from further insect attack by storing them at low temperatures of 50°F (10 °C or below) are established methods of insect control. These methods offer several advantages over control with insecticides: (1) the commodity is not contaminated with foreign or poisonous residues; (2) it does not acquire an off-flavor or abnormal odor; (3) operators are not endangered; (4) there is no fire hazard.

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