Chestnuts should be treated more like apples than like tree nuts.

Optimal Temperature: -1 to 0°C (30 to 32°F); prompt cooling to 0°C (32°F) is strongly recommended to stop decay development and preserve quality.

Optimal Relative Humidity: 90 – 95%; packaging in microperforated plastic film is highly recommended to minimize water loss from fresh chestnuts.

Maturity Stages of Almonds and Walnuts

Almond

Walnut

Postharvest Handling Systems for Almond, Walnut and Pistachio Nuts

Tree Shaker for Almond Harvesting

Windrowing Almonds to Facilitate Collection
Windrowed Almonds

Collecting Almonds from Windrows

Sorting Almonds at the Hulling Facility

Quality Losses due to Improper on-farm Storage of almonds

Concealed damage of almonds due to high temperature and relative humidity

Tree Shaker for Harvesting Walnuts

Windrowed Walnuts
**Pick-up Machine for Walnuts**

**Kernel Darkening due to Exposure of Harvested Walnuts to the Sun**

**Walnut Kernel Color Chart**

- Price is inversely related to kernel color.

**Pistachio shell split is desirable while early hull split is not desirable because it increases potential for fungal infection.**

**Pistachio Nut Maturity Indexes**

- Ease of hull separation from shell
- Shell dehiscence (splitting)
- Change in shell color (green to ivory)
- Decrease in fruit removal force
- Kernel dry weight and fat content

**Tree Shake-Catch System for Pistachio Harvesting**

- Pistachio nuts require more careful handling due to their higher water content at harvest than other tree nuts.
Sorting Pistachio Nuts to Remove Defects

Separating Pistachio Nuts by Size

Pistachio Nut Hull Removal

Pistachio Staining

Visual Shell Staining Scores for Pistachio Nuts

Drying Methods

Sun drying
Ambient-air drying
Two-stage drying
1. Heated-air drying to about 12% moisture
2. Ambient-air drying to 5-6% moisture
Heated-air drying
Cross-flow Dryers Used for Pistachio Nuts

Drying temperature of pistachio nuts should not exceed 71 C (160 F) to avoid kernel separation from its shell.

<table>
<thead>
<tr>
<th>Temperature</th>
<th>Drying Time</th>
<th>% Shells that are too open</th>
</tr>
</thead>
<tbody>
<tr>
<td>F</td>
<td>C</td>
<td>(to 5-6% moisture)</td>
</tr>
<tr>
<td>140</td>
<td>60</td>
<td>14</td>
</tr>
<tr>
<td>160</td>
<td>71</td>
<td>10</td>
</tr>
<tr>
<td>180</td>
<td>82</td>
<td>7</td>
</tr>
<tr>
<td>200</td>
<td>93</td>
<td>5</td>
</tr>
</tbody>
</table>

Fatty acids composition of nuts influences their storage potential.

Storage Factors for Nuts and Dried Fruits and Vegetables

- Moisture content of the product
- Relative humidity of storage
- Storage temperature
- Oxygen concentration
- Effective insect control

Moisture Content vs Water Activity of Nuts and Dried Fruits and Vegetables

Relationship between pistachio and walnut moisture content (on a fresh weight basis) and ambient relative humidity at indicated temperatures.
Relationship between water activity and mold growth on dried fruits and nuts

Stored Products Insects cause Qualitative and Quantitative Losses

- Navel orangeworm
- Indian meal moth
- Dried fruit beetles
- Saw tooth grain beetle
- Merchant grain beetle
- Raisin moth
- Fruit fly

Insect Control Procedures for Nuts and Dried Fruits and Vegetables

- Fumigation (methyl bromide or phosphine)
- Irradiation at 750 Gy
- Freezing at -18 °C for longer than 2 days
- Use of heat treatments (50-55 °C)
- Exposure to 100% carbon dioxide for longer than 2 days
- Storage at temperatures below 5 °C reduces insect activity
- Storage in 0.5% oxygen (balance nitrogen) atmosphere reduces insect activity

Sensory Quality of Irradiated Almonds

<table>
<thead>
<tr>
<th>Irradiation dose (Kg)</th>
<th>0</th>
<th>1</th>
<th>3</th>
<th>5</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Color</td>
<td>9.0±0.0</td>
<td>9.0±0.3</td>
<td>9.0±0.6</td>
<td>9.0±0.2</td>
<td>9.0±0.0</td>
</tr>
<tr>
<td>Texture</td>
<td>8.7±0.4</td>
<td>8.6±0.3</td>
<td>8.6±0.1</td>
<td>8.5±0.5</td>
<td>8.4±0.2</td>
</tr>
<tr>
<td>Taste</td>
<td>8.4±0.1</td>
<td>8.4±0.1</td>
<td>7.4±0.0</td>
<td>6.9±0.0</td>
<td>1.7±0.2</td>
</tr>
<tr>
<td>Odor</td>
<td>8.3±0.1</td>
<td>8.3±0.1</td>
<td>7.8±0.2</td>
<td>7.4±0.2</td>
<td>7.4±0.4</td>
</tr>
</tbody>
</table>

Values are the mean of six determinations (n=6), ±S.D.
Scoring scale: 0-9 (9=extremely, 1=slightly) for color, taste, and odor.
Scoring scale: 0-9 (9=Very crisp, 1=very soft) for texture.
Means with different superscripts (*, **) in the same row are statistically different (p<0.05).

Note the reduction in quality in response to 1.5 Kg or higher irradiation doses.

Experimental Insect Control Treatments

- Fumigation with carbonyl sulfide, sulfuryl fluoride, or ethyl formate
- Insecticidal atmospheres (below 0.5% O₂ and/or 40-60% CO₂)
- Heat treatments (radiofrequency)
- Ultraviolet radiation
- Vacuum treatments

CONCLUSIONS: How to Maintain Quality and Reduce Losses of Dried Products

- Drying to reduce moisture content to below 8%
- Insect disinfestation and protection against reinfestation using insect-proof packages
- Storage temperature of 10 C (50 F) ; storage potential increases with lower temperatures
- Storage relative humidity in equilibrium with moisture content of the product to prevent moisture loss or gain
- Proper sanitation to minimize microbial contamination and avoid mycotoxin formation
- Protection from birds and rodents