NUTS
• hazel nuts,
• almonds
• pistachios nuts
• cashew nuts,

-----

Similar process for sunflowerseed, peanut, leblebi etc.
The huge number of different nuts and types;
(hazel nuts, peanuts, cashew nuts, pistachios and nuts)
• as whole nuts
• chopped,
• with and without their shells,
• roasted,
• peeled,
• salted,
• blanched,
• flour
• paste.
Introduction:

In general,

- Tree Nuts contain about 50% lipids (oil) by weight
- which are susceptible to oxidation reactions in the presence of oxygen and light.
- Lipid oxidation causes unacceptable off-flavors and off-odors, reducing product
  shelf life.
- The rates of oxidation increase after roasting and/or during storage (long)
- Proper storage and handling pre and post process will help maximize quality.
- Acidity and peroxide value (rancid taste) critical
- Aflatoxin is critical
Raw nuts handling/Storage:

• Cool (<10°C or <50°F) and dry (<65% relative humidity) are the optimal storage conditions for nuts.
• A storage temperature below 10°C will minimize respiration and reduce the rate of deteriorative reactions.
• A relative humidity range from 55–60% in the storage environment will maintain the nuts at 5–6% moisture content.
• MAP (CO2, N2 packaging), Cooling, vacuum packaging, oxygen level control etc. critical for storage and packaging.
• T, RH, Acidity, Peroxide, m.c., aflatoxin, salmonella are critical.
Overall: Basics nuts processing

1-Cleaning
2- Color sorting
3-Salting (optional)/roasting
4-Chopping
5-Packaging

Additional:
- Paste
- Peeled (sking removing)
(*) Cleaning and transport:

- A large number of solutions for separating undesirable elements and pneumatic or mechanical conveyors is available.
  - a) Pre-sieving (to separate coarse/big size dirty materials)
  - b) Metal separation (magnet)
  - c) Aspiration with fine sieving (dust, stem, small particles removed)
  - d) Stone separator (to remove stone)

- Washing (unusual)/not used widely/due to damage the kernel
(*) Cracking (cracking Shell of nut)/deshelling

- **Pistachio nuts/Almond:**
  - First calibration in size
  - Small amount tempering (1-2% m.c. increased for flexibility and prevent breaking ok inside kernel)
  - Rotary type steel-roll/corrugated twin cracker

**Hazelnuts:**
- First calibration in size
- Stone mills cracking for each calibration
Genel yerleşim planı ekipman listesi
1. Kabuklu findik girişı
2. Kabuklu findik giriş elevatörü
3. Ana kabuklu findik ambarı
4. Kabuklu findik ayrırm eleği besleme elevatörü
5. Kabuklu findik ayrırm eleği ve findik aktarım ambarı
6. Kabuklu findik eleme grupu ve elek altı ambarları
7. Kabuklu findik seçim masası
8. Kabuklu findik aktarım konveyoru
9. İnce findik seçilmiş ambarı besleme elevatörü
10. İnce findik seçilmiş ambarı
11. Taş besleme elevatörü
12. Findik kırın taşları
13. Taş çıkışı toz eleği
14. Taş çıkışı kabuk ayrırm vantilatörü
15. Sallama elek
16. Geri dönüşüm elevatörü
17. Buruşuk vantilatörü
18. Kabuk elevatörü
19. Buruşuk eleği besleme elevatörü
20. Buruşuk eleği ve elek altı ambarı
21. İç findik ayrırm eleği besleme elevatörü
22. İç findik ayrırm eleği ve elek altı aktarım ambarı
23. İç findik elek grupu ve elek altı ambarı
24. İç findik aktarım konveyoru
25. İç findik seçim bandı besleme elevatörü
26. İç findik seçim konveyörleri
27. İç findik vagon ambarı
28. Elektrik panosu
29. Kabuk depo
(*) Optical sorting:
• Improving food safety and quality by removing foreign materials and rotting or harmful nuts.
• Sorting according to size and shape for optimum processing methods.
• Removing blanched nuts that are discolored or where the skin has not been removed.
• Reducing aflatoxins through efficient removal of affected nuts.
(*) Salting

Adding and resting with salt solution for a certain time to allow salt absorption.
(*) Roasting:

• Roasting is one of low or high or continuous or batch processing is used, the most important methods for processing nuts.
• Low or high or continuous or batch processing is used,
• Batch-operated roasters for demanding roasting qualities
• Continuous dryers and roasters for high capacity of up to 25,000 kg/h.
• Unique air circulation systems for excellent and consistent product quality, color and moisture content.
• T profile: initially low (at high m.c.) than increased (at m.c.) during roasting. (120 C \(\Rightarrow\) 200 C «depend on product») to prevent case hardening (to remove moisture in kernel). [It is vice versa of drying profile]
• During roasting, moisture evaporates from the nuts, resulting in a crunchy texture.
• Also, a complex reaction between sugars and amino acids or proteins takes place, known as non-enzymatic browning or the Maillard reaction.
• Non-enzymatic browning of nuts leads to the formation of brown or colored compounds that modify the skin color and also generate a golden or dark brown color within the kernel.
• During non-enzymatic browning many different volatile or non-volatile reaction compounds are formed.
• More than 300 flavor compounds that are generated during non-enzymatic browning and contribute to typical roast flavor have been described for nuts and other tree nuts.
Batch-Rotary type roaster
- Constant temperature
- Rotated
- No salt found on surface
- Supply shining/polishing on surface for Hard Shell product

Continous type belt roaster
- Continous
- Different (low to high) roasting temp.
- High capacity
- Kernel (skin) or hard shell nuts
Details for roasting (!!!):

• Hot air (dry) roasting is a thermal process suitable for nuts.
• Roasting changes the flavor profile of the nuts and results in a brown color and a crunchy texture.
• Light-, medium-, or dark-roasted products are achieved with specific temperature-time roasting treatments.
• Flavor composition and intensity depend on the roasting conditions.
• Hot air roasting temperatures used for nuts in typically range from ~130 to 154°C (~265 to 310°F).
• Nuts are rich in unsaturated fatty acids, but the high degree of unsaturation makes almond oil susceptible to oxidation during processing and storage.
• Oxidative reactions degrade the quality of roasted nuts and limit their shelf life.
• The use of lower hot air roasting temperatures helps to preserve the almond microstructure and maximizes shelf life.
• Hot air roasting for nuts can be optimized by applying a two-step roasting process.
  • he first step uses an intermediate temperature to stabilize the nut microstructure, and the second step uses a higher temperature to generate the desired flavor and color.
1. Introduction
Nuts contain about 50% lipids (oil) by weight (USDA, 2013), which are susceptible to oxidation reactions in the presence of oxygen and light. Lipid oxidation causes unacceptable off-flavors and off-odors, reducing product shelf life. The rates of oxidation increase after roasting. Proper storage and handling pre and post process will help maximize quality.

2. Raw nuts handling/Storage
Cool (<10°C or <50°F) and dry (<65% relative humidity) are the optimal storage conditions for nuts. A storage temperature below 10°C will minimize respiration and reduce the rate of deteriorative reactions. A relative humidity range from 55–60% in the storage environment will maintain the nuts at 5–6% moisture content.

3. Hot air roasting
3.1. Overview of nuts texture, color, and flavor changes
During roasting, moisture evaporates from the nuts, resulting in a crunchy texture. Also, a complex reaction between sugars and amino acids or proteins takes place, known as non-enzymatic browning or the Maillard reaction. Non-enzymatic browning of nuts leads to the formation of brown or colored compounds that modify the skin color and also generate a golden or dark brown color within the kernel. During non-enzymatic browning many different volatile or non-volatile reaction compounds are formed. More than 300 flavor compounds that are generated during non-enzymatic browning and contribute to typical roast flavor have been described for nuts and other tree nuts (Perren, 1995; Perren and Escher, 2007).

The kinetics of roast flavor development depend largely on temperature, nut moisture content, and time.
3.2. Heat transfer during roasting
Hot air roasting is a convective heat transfer process. During hot air roasting, the nut temperature rises continuously as a function of heat transfer and the temperature of the nuts rises to far above 100°C (212°F). As the nut temperature approaches 130°C (266°F), the rate of temperature increase slows as moisture evaporation accelerates. Almond moisture content decreases to 2% or less during roasting.

3.3. Influences of roasting temperature
Effects on almond weight loss, moisture content, and color;
The temperature during hot air roasting influences the rate of change in weight loss, moisture content, and color (lightness, L*). There is a strong correlation between weight loss and change in moisture content upon roasting because weight loss is largely caused by moisture evaporation (Figure 1).
Effects on microstructure:
nuts are seeds and store energy (primarily in the form of lipids) needed for germination. Nuts have a highly compartmentalized microstructure that protects lipids from environmental oxygen and oxidation. The lipids in nuts are present as intracellular oil droplets stored in small globular structures called oleosomes, approximately 1 to 2 μm in diameter, which are protected by a monolayer membrane (Figure 2) (Perren, 1995; Young et al., 2004). The oleosomes are separated from each other by a membrane network that forms a honeycomb structure. The subcellular organization in raw nuts protects the oil from oxygen access so there is less substrate available for oxidation.
During roasting, however, the oleosomes burst, the membrane network is destroyed, and the volume of extracellular pores enlarges (Figure 3). The loss of compartmentation and the accompanying increase in porosity accelerate oxygen transfer and oxidation. These changes in almond microstructure are mainly influenced by the product temperature during roasting and to a lesser extent by roasting time.

To dry roast nuts, hot air temperatures should be as low as possible to preserve the native microstructure and to maximize shelf life (Perren and Escher, 2013). Another strategy designed to improve shelf life includes the use of a two-step hot air roasting process, as discussed in 3.4 below.
3.4. Industrial roasting systems

To achieve high quality roasted nuts, a roasting process must meet the following requirements:
• Heat treatment must be uniform.
• Heat treatment must provide consistent quality in color, flavor, and texture.
• Roasting equipment must transfer only minimal mechanical energy to the nuts to preserve integrity and appearance.

The development of roasting equipment and processes has been driven mainly by technical innovation. A wide range of hot air roasting systems is available, including continuous roasters (single belt convection roasters, vertical continuous roasters, continuous drum roasters, etc.) and batch roasters (semi-fluidizing batch roaster, drum roasters, ball roasters, etc.).

Continuous roasters are usually limited in terms of roasting temperatures and times, but may be preferable if variations in product and roasting degree are of minor importance. Batch roasters are very versatile and are often able to achieve a wide range of roasting degrees and product qualities. With modern control systems, batch processes can be run in a quasi-continuous manner, eliminating the operational differences between batch and continuous systems.
Uniform heat transfer
Roasting requires a sufficiently high energy transfer rate. To avoid temperature differences that lead to color differences among the nuts, it is essential to either mix the nuts, as in rotary drum or ball roasters, or to distribute the energy uniformly through the nuts. However, mechanical action in rotary roasters may impair the surface structure of nuts, causing release of oil.

Cooling
Cooling must be considered part of the roasting process. A rapid air-cooling process is essential to stop the roasting reactions after processing is complete. The roasted product must be cooled to below 25–30°C (77–86°F) to limit oxidation during storage. The product should not be packed and sealed if the product temperature is above 30°C (86°F) because moisture may condense on the inner surface of the package.
Two-step hot air roasting process

Hot air roasting for nuts and other tree nuts can be optimized by applying a two-step roasting process. The first step uses an intermediate temperature to stabilize the nut microstructure, and the second step uses a higher temperature to generate the desired flavor and color. In the two-step roasting process, microstructure degradation during roasting is reduced, which in turn leads to increased oxidative stability.

The two-step roasting process is achieved with a semi-fluidizing hot air batch roaster and has been successfully commercialized and installed worldwide. More than 100,000 tons of nuts can be processed per year with this two-step roasting system. Improved oxidative stability by the two-step roasting process compared to traditional industrial hot air roasting processes has been clearly demonstrated for nuts, hazelnuts, and peanuts in many industrial scale trials comparing different nut types and varieties, roasting processes, and roasting degrees. In all trials investigated, nuts roasted with the two-step process exhibited superior shelf stability compared to nuts roasted with a traditional hot air process.
4. Downstream processing and packaging

Shelf life expectations for roasted nut products should be considered in downstream processing. Because oxidation starts immediately after roasting, roasted nuts are unstable goods and so any further processing should be done as quickly as possible.

Mechanical treatment and transport systems are additional issues for roasted nuts. Due to low moisture content, roasted nuts are susceptible to mechanical damage, leading to damaged surface structures and oil leakage. Therefore, only minimal downstream processing that affects appearance and surface integrity should be applied.

For chocolate production and dicing applications, the roasted nuts must first reach a suitable temperature. For applications using ground roasted nuts, the oxidative stability of the oil is the predominant concern. Microstructure degradation is not an issue because the cellular structure is completely disintegrated, the oil is the continuous phase, and the surface exposed to air is reduced.

To maximize the shelf life of roasted nut products, proper packaging must be selected. Packaging materials must be non-transparent, and modified atmosphere or vacuum packaging may be used to decrease potential oxidation reactions during storage. In addition, storage at reduced temperatures is ideal to protect lipids and flavors, but products must be protected from condensation when removed from cold warehouses.
(*)Peeling

1) Peeling for Hazel nuts:

Kernel with skin → Roasting → Rubber disc peeler → aspiration to sep. skin → color sorting
2) Peeling for Pistachio nuts and almonds:

Boiling/blanching in water → Rubber type roll peeler → aspiration to remove skin → drying
(*) Size reduction and grinding (Chopping/flour/grit):

• – Size reduction and grinding nuts into small particles, creating flour or pastes.
• – High degree of food safety through appropriate design.
• – Very fine ground pastes with fineness of less than 20 μm possible.
(*) Paste/Puree operation

Roasting/heating → Peeling → Pre-grinding → Milling → Paste → Additive adding and mixing (optional)
(*) Apron/Selecting table

Bottle neck
Last control
Green belt color is preferred
Young ladies
Speed and lighting → important
Hygiene (hair and E.coli problem)
(*)Packaging

Shell particle control (apron/color sorter) (last control)

Packaging (MAP, Vacuum etc)/Rancidity/lipid oxidation

[ALWAYS LAST STEP!!!]

X-Ray detector (to remove stone, glass, plastic, metal etc.) or only metal detector
HAZELNUT
Hazelnut

1. Hazelnut harvest
2. Drying in farm
3. Removing cover/husk
4. Hazelnut inshell
5. Cleaning (destoning-metal sep.)
6. Calibration
7. Cracking with stone mill acc. to calibration
8. Separation shell
9. Natural kernel

- Roasting
- Peeling with rubber disc
- Roasting kernel
- Sliced
  - flour
  - paste
## Raw Kernels

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<tr>
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<tr>
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<tr>
<td>SHRIVELLED             : Max. 4 %</td>
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</tr>
<tr>
<td>TOUCHED                : Max. 7 %</td>
<td></td>
</tr>
<tr>
<td>BROKEN                 : Max. 1 %</td>
<td></td>
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<tr>
<td>MOISTURE               : Max. 6 %</td>
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<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>FREE FATTY ACID        : Max. 1 %</td>
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</tr>
<tr>
<td>PEROXIDE VALUE         : Max. 5 Meg/Kg</td>
<td></td>
</tr>
<tr>
<td>AFLATOXIN : B1         : Max.2 ppb Total: Max. 4 ppb</td>
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## Roasted Blanched Whole

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<td>Over Size</td>
<td>Max. 5 %</td>
</tr>
<tr>
<td>Under Size</td>
<td>Max. 5 %</td>
</tr>
<tr>
<td><strong>ROTTEN</strong></td>
<td>Max. 1 %</td>
</tr>
<tr>
<td><strong>SHRIVELLED</strong></td>
<td>Max. 2 %</td>
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<tr>
<td><strong>TOUCHED</strong></td>
<td>Max. 8 %</td>
</tr>
<tr>
<td><strong>BROKEN</strong></td>
<td>Max. 2 %</td>
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<td><strong>FOREIGN MATTER</strong></td>
<td>Max. 5 shell pieces per tone Target : Zero Free of stone, wood, glass etc.</td>
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<tr>
<td><strong>SKIN CONTENT</strong></td>
<td>5 % to 20 % (According to buyers need)</td>
</tr>
<tr>
<td><strong>MOISTURE</strong></td>
<td>Max. 2.8 %</td>
</tr>
</tbody>
</table>

## CHEMICAL SPECIFICATION

| FREE FATTY ACID         | Max. 1 %  |
| PROXIDE VALUE           | Max. 5 Meg/Kg |
| AFLATOXIN : B1          | Max. 2 ppb Total: Max. 4 ppb |

## MICROBIOLOGICAL LIMITS

| T.P.C             | Max. 2000 ( C.F.U /g ) |
| COLIFORM          | Max. 10 ( C.F.U /g )  |
| MOULD             | Max. 50 ( C.F.U /g )  |
| YEAST             | Max. 50 ( C.F.U /g )  |
| E. COLI           | Negative ( C.F.U /g ) |
| STAPH. AUREUS     | Negative (C.F.U. /g)  |
| SALMONELLA        | Negative ( C.F.U / 25 g ) |
**Roasted Chopped/Diced**

**ROASTED CHOPPED/DICED**

**PHYSICAL SPECIFICATION**

<table>
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<td>Over Size</td>
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**SKIN CONTENT**

5 % to 20 % (According to buyers need)

**MOISTURE**

<table>
<thead>
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<th>Roasted</th>
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<tbody>
<tr>
<td>Blanched</td>
<td>Min. 3.2 %</td>
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</table>

**CHEMICAL SPECIFICATION**

| FREE FATTY ACID | Max. 1 % |
| PROXIDE VALUE   | Max. 5 Meg/Kg |
| AFLATOXIN : B1  | Max. 2 ppb Total: Max. 4 ppb |

**MICROBIOLOGICAL LIMITS**

<p>| T.P.C          | Max. 2000 ( C.F.U /g ) |
| COLIFORM       | Max. 10 ( C.F.U /g ) |
| MOULD          | Max. 50 ( C.F.U /g ) |
| YEAST          | Max. 50 ( C.F.U /g ) |
| E. COLI        | Negative ( C.F.U /g ) |
| STAPH. AUREUS  | Negative (C.F.U /g ) |
| SALMONELLA     | Negative ( C.F.U / 25 g ) |</p>
<table>
<thead>
<tr>
<th>Natural Chopped</th>
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<tbody>
<tr>
<td>Natural Chopped</td>
</tr>
<tr>
<td>NATURAL CHOPPED</td>
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**PHYSICAL SPECIFICATION**

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<td>Over Size</td>
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<td>Under Size</td>
<td>Max. 5 %</td>
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<table>
<thead>
<tr>
<th>MOISTURE</th>
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<tbody>
<tr>
<td>Max. 5 %</td>
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**CHEMICAL SPECIFICATION**

<table>
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<tr>
<td>AFLATOXIN : B1</td>
<td>Max.2 ppb Total: Max. 4 ppb</td>
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</table>
### Roasted Meal and Blanched (Powder)

#### ROASTED BLANCHED MEAL

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<tbody>
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<td>Max. 2.8</td>
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<tr>
<td>Blanched</td>
<td>Min. 3.2 %</td>
</tr>
</tbody>
</table>

#### CHEMICAL SPECIFICATION

| FREE FATTY ACID | Max. 1 % |
| PROXIDE VALUE   | Max. 5 Meg/Kg |
| AFLATOXIN : B1  | Max. 2 ppb Total: Max. 4 ppb |

#### MICROBIOLOGICAL LIMITS

| T.P.C            | Max. 2000 ( C.F.U /g ) |
| COLIFORM        | Max. 10 ( C.F.U /g ) |
| MOULD           | Max. 50 ( C.F.U /g ) |
| YEAST           | Max. 50 ( C.F.U /g ) |
| E. COLI         | Negative ( C.F.U /g ) |
| STAPH. AUREUS    | Negative (C.F.U. /g ) |
| SALMONELLA      | Negative ( C.F.U / 25 g ) |
PISTACHIO NUTS

ANTEP FISTİĞİ
As paste
In chocolate industry
Sauce industry
Ice cream
As roasted-sauced nut
GENERAL PROCESS

DIFFERENCES BETWEEN
ANTEP AND AMERICAN/IRANIAN/ITALIAN ETC.

PISTACHIO NUTS PROCESSING
Dry pistachio (%8-10 m.c.)

Fresh pistachio (%30-35 m.c.)

Unhulled and empty

Risk:
- Water m.o. Risk
- Pistachio soil m.o. risk
- m.o. Growth during soaking

Prof. Dr. Mustafa BAYRAM   @ProfDrMusbay   GAUN-Food
Eng. Dept.    FE 401 Lecture Notes
Separation and Classification

SPLIT / UNSPLIT SEPARATION

ACOUSTIC AND NEEDLE SEPARATORS

Akustik sınıflandırıcı (acoustic sorter)

hopper

microphone

PC computer

Hava valfl

Fistikların çarptığı metalden plaka

Red edilenler

Kabul edilenler

Split

Unsplit

Prof. Dr. Mustafa BAYRAM   @ProfDrMusbay   GAUN-Food Eng.
Dept.  FE 401 Lecture Notes
USAGE OF SPLIT AND UNSPLIT

UNSPLIT:
- Can be split by machine or hand (risk!!!)
- Can be used for kernel (paste/chopped/sauce)
- OR RE-SPLIT

SPLIT:
- Salted and roasted
PROCESS DETAILS  
(Next 3 Slavts)  

• ANTEP  

• AMERICAN
ANTEP METHOD

Harvesting
Drying with hull
Storage
Soaking
Dehulling
Drying
Storage
Separation (Splitting and unsplitting)

Split Pistachio nuts
Salting
Roasting
Cooling
Sorting-Control
Packaging

Hull

Unspit Pistachio nuts
Sieving
Peeling (optional)
Drying
Cutting (optional)
Sorting-Control
Packaging
Şekil 1. Baklavalık Antep Fıstıklı Üretim Akış Şeması (kernel pistachio)

- Yeşil yumuşak kabuku, meyve içi genellikle az gelişmiştir.
- Tane ve çöp ayırımı
- Kabukla tane ayırımı
- Kalan kabağın temizlenmesi
- Suyla dolu-boş ayırımı
- %8-10 nem
- Büyüklüğine göre elek ile sırmilandırma
- Fıstığın içinin çıkarılması
- Kabuk ve iç fıstığı sırmilandırma
- Kabuk ve iç fıstığı ayırma
- Son ayırma işçiler tarafından

Şekil 2. Kavrulmuş Antep Fıstıklı Yapımı Üretim Akış Şeması (Roasted pistachio nut)

- Kılarmızı yumuşak kabuku
- Tane ve çöp ayırımı
- Tane fıstıkların makinada kabağının soylanması
- Kabukla tane ayırımı
- Kalan kabağın temizlenmesi
- Suyla dolu-boş ayırımı
- %8-10 nem
- Büyüklüğine göre elek ile sırmilandırma
- Tanerlerin tek tek çiçeklerle çıkarılmıştır
- Tuz ve su ile yaklaşık 12-16 saat bekleme
- İçinde kalan fazla tuzun çıkarılması
- Soğutma tünelerinde 5 dakika

21-Feb-16
General risk

CONVEYORS FOR ALL SYSTEM (no rest/no deposit)

MOISTURE CONTENT controls

PERSONAL

AFLATOXIN

WATER CONTAMINATION

HAIR-STONE-METAL

INSECT (especially for kernel “chocolate”)

Open processing

Salmonella?

BIRD M.C.
OTHERS

A. **Toothache relief** - Resin used in Europe and N. America.

B. **Hardening of gums** - Mastic (chewed substance) used to prevent periodontal disease.

C. **Pistacia mutica** - "Turk terebinth" Gum used to make chewing gum in Iran.

D. **Blood clotting agent** - Gum used in Europe and the Middle East.

E. **Husks** - used in India for dying or tanning; made into marmalade in Iran; used as fertilizer in many areas.

F. **Folk medicine** - Pistachios have been reported as a remedy for: Scirrhus and sclerosis of the liver, abdominal ailments, abscess, bruises and sores, chest ailments, circulation problems, and other problems. Powdered pistachio root in oil is used for children's cough in Algeria. Leaves were used to enhance fertility in Lebanon, and Arabs consider the nuts an aphrodisiac.

G. **Wood** - is good for carving, cabinetry, and firewood.
Cashew Processing
Walnut AND Chestnut Processing

Walnut & Chestnut
- Cleaning
- Screening
- de-husker/dehuller
- air separator.
- drum washer.
- Drying
- Deshelling
- screening
- inspecting and size grading section.
AFLATOXIN AND MICROORGANISM PROBLEMS
AFLATOXIN AND PISTACHIO

Risk period:
Last harvesting period
  Raining
  Damage on the hull
  Dust
  Sun drying
  RH: 85 %
  T: 25-35°C
  High m.c. On dried product

Time for aflatoxin growth: 1-5 days
Dark and humit storage areas
Bad drying
Accumulation in conveyors
Bad tempering-soaking
Long term resting
Due to low consumption daily, Pistachio is low risky than main foods
ANALYSIS

- TLC
- ELISA
- HPLC
- Rapid kits

● Problems:
  ● Solid particle → Sampling "homogeneous sample"
  ● Wet sample preparation ***(better)
JUST EAT