

*Prunus dulcis* (Mill.) D.A. Webb  
Monograph



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## **Introduction:**

The Almond, almond tree, or *Prunus dulcis* if you will, is a nut from the family Rosacea. My initial interest in that nut sparked due to how supplemental it is and by that, I mean how many things it replaces. I don't love almonds by nature. They have been forced on me since I was a child. I have a parent who suffers from multiple health issues, it being easier for them to consume the healthier version of these, many, involving almonds. I wanted to research and really get to know what it was that made these nuts so wonderful, so healthy and so useful.

The following chapters will explore this species. The first chapter will investigate the origin, taxonomy, and environmental factors that affect the plant. Chapter two will focus on the biology of the plant, looking at its structure and reproductive structures and growth. The third chapter looks at how we can manage and propagate the fruit and the final chapter concludes with information about its uses.

# Chapter 1: Ecology

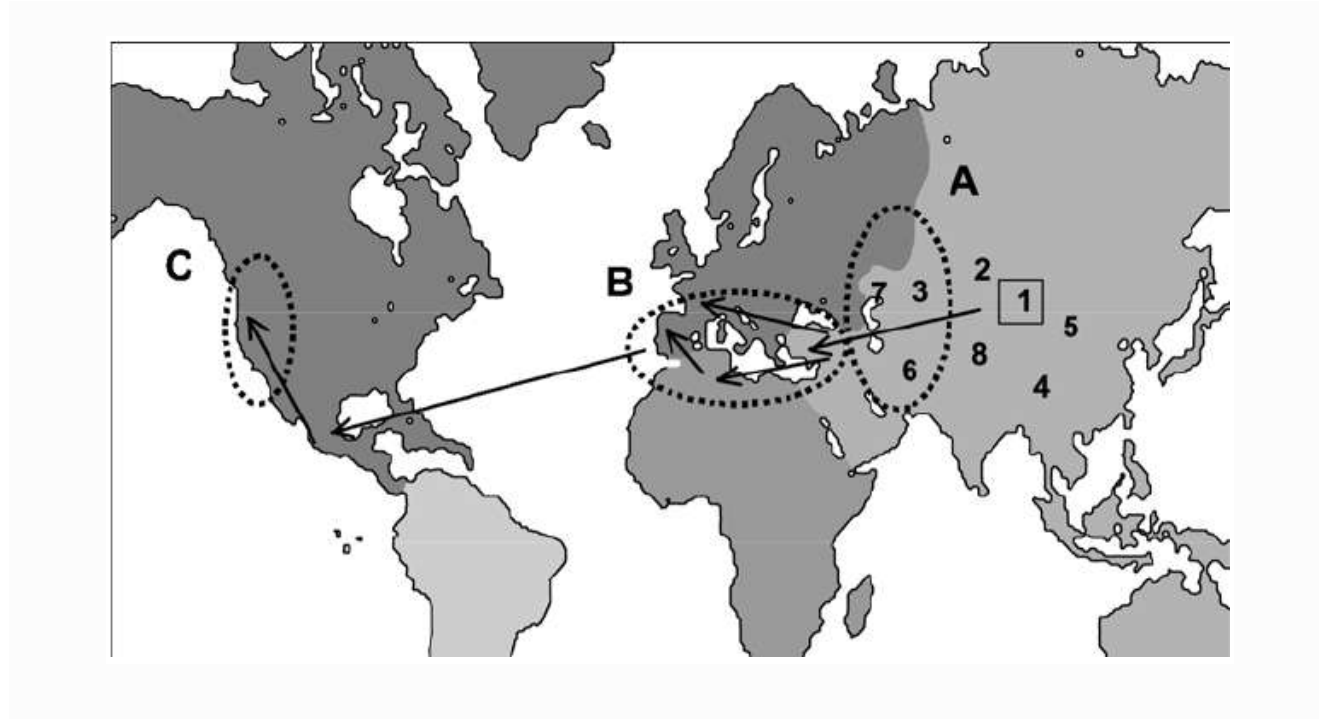
## 1.1 Origin:

Almonds have a long and illustrious history dating back thousands of years. Almonds grew wild in Western and Central Asia and were likely foraged by our forefathers until being domesticated circa 4000 BC, when they were grown and became a popular cuisine across Asia. From 600 to 900 AD, travelers traversing the 'Silk Road' between Asia and the Mediterranean benefited from the nutritional benefits of almonds, leaving uneaten kernels over Italy and Spain and spreading almond cultivation worldwide. The first almond groves were established in California in the mid-1700s, but the trees did not grow in the new soil, and it took another 100 years for an almond cross-breed to be developed that thrived in the hotter climate. Those throughout history valued almonds for their substantial nutritional qualities, and there is evidence of nomadic cultures grinding up almond kernels for use in high-energy, on-the-go snacks as long back as the 4th century BC - even King Tutankhamen was buried with almonds to sustain him in the afterlife. Aside from archaeological evidence, almonds are mentioned in historical writings such as the Bible, where both almond trees and almond fruit are mentioned. Almond blossom represents hope in the Bible, while almond fruit is characterized as "the best in the nation." For many years, the concept that almonds are a sign of richness, good fortune, and indulgence has persisted, passing down through the Romans and into many of our cultures today.

**Figure 1:**

*Map of world showing the origin for almond*

As seen in figure 1, most cultivations are grown along and around the equatorial line, where the trees will have tropical weather and high temperatures.



[ *Prunus dulcis* ( 1 )] and different relative *Prunus* species [ *P. bucharica* ( 2 ), *P. fenzliana* ( 3 ), *P. davidiana* ( 4 ), *P. persica* ( 5 ), *P. scoparia* ( 6 ), *P. webbii* ( 7 ), and *P. argentea* ( 8 )], the dissemination routes for the cultivated almond [ → ], and the three main areas for diversification and cultivation of almonds [Asiatic ( A ), Mediterranean ( B ), and Californian ( C )]

### 1.3 Taxonomy:

#### Taxonomic Hierarchy

Kingdom	Plantae – plantes, Planta, Vegetal, plants
Subkingdom	Viridiplantae - Green plants
Infrakingdom	Streptophyta - Land plants
Superdivision	Embryophyta
Division	Tracheophyta - Vascular plants, tracheophytes
Subdivision	Spermatophytina - Spermatophytes, seed plants, phanérogams
Class	Magnoliopsida
Superorder	Rosanae
Order	Rosales
Family	Rosaceae - roses
Genus	Prunus - Chokecherry, plum
Species	Prunus Dulcis, (Mill.) sweet almond, almond, almendro

(ITIS, 2014.)

#### 1.3.1 Related species:

Almonds fall into the subfamily Amygdaloideae along with the following

Amygdaloideae

- Stone fruits and relatives (genus Prunus)
  - Almond (Prunus Dulcis)
  - Apricot (Prunus Armeniaca)
  - Blackthorn (Prunus Spinosa)
  - Cherry (Many Prunus species)
  - Cherry Laurel ( Prunus caroliniana and P. laurocerasus)
  - Chokecherry ( Prunus Virginiana)
  - Nectarine ( Prunus Persica)

- Peach ( *Prunus Persica*)
- plum ( various *Prunus* species)

#### **1.4 Affinity:**

The species [Prunus fenzliana](#) may be the most likely wild ancestor of the almond, in part because it is native to [Armenia](#) and [western Azerbaijan](#), where it was apparently domesticated.

The rosaceae family is a major angiosperms (flowering plant) family. It's divided primarily into four subfamilies all primarily based on fruit type:

- Amygdaloideae (with drupes, fleshly stone fruits)
- Maloideae, with pomes (fruits in which the floral hypanthium becomes fleshy)
- Rosoideae, with acheness (dry fruits that do not open) or drupelets (small aggregated drupes)
- Spiraeoideae, with follicles (dry fruits that open on one side)

#### **1.5 Fossil record:**

Smith (2022) has produced an extensive investigation of fossilized *Prunus*, citing multiple authors and where they obtained specimens from. For example endocarps of *Prunus* (Rosaceae: Prunoideae) were found in Wutu, Shandong Province, China, from the Eocene period. The oldest records of *Prunus* however, were based on leaves from the Late Cretaceous of Wyoming, New Jersey and Nebraska, U.S.A. (Berry, 1916; Brown, 1933, as cited by Smith (2022) but their identification has not yet been confirmed.

Since the Eocene, abundant endocarps were reported from the Northern Hemisphere including both mold-casts as follows (Smith, 2022).

- (e.g., Reid & Reid, 1910, 1915
- Kirchheimer, 1936, 1942, 1957
- Miki, 1936, 1938
- Mädler 1939
- Szafer, 1961
- Tanai, 1961
- Dorofeev, 1963
- Mai, 1964, 1973, 1984, 1995
- Geissert, 1972



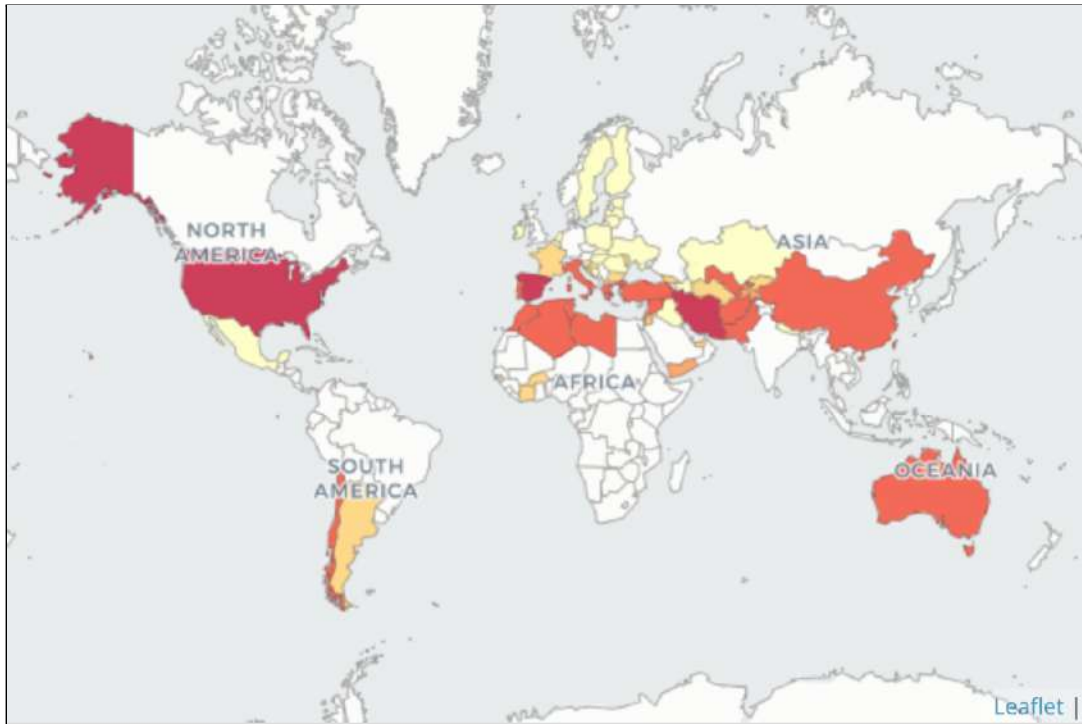
- Gregor, 1978) and some specimens with internal anatomical structure (CevallosFerriz & Stockey, 1991
- Manchester, 1994).

According to Smith (2022) Prunus-related fossil wood has been found in the Northern Hemisphere from the Eocene to Miocene periods (Wheeler & al., 1978; Guleria & al., 1983; Suzuki, 1984; Takahashi & Suzuki, 1988; Cevallos-Ferriz & Stockey, 1990; Wheeler & Manchester, 2002). To date, the wood of Prunus from Japan's Oligocene (Suzuki, 1984) is the first record of Prunus in Asia, while the earliest occurrence of endocarps in Asia was documented from Japan's Late Miocene (Tanai & Onoe, 1961). Prunus fossils were not discovered in Asia until the Oligocene.

## 1.6 Distribution:

**Figure 3**

*Distribution map of Almonds with shell 1994-2020*



Cultivated and wild almonds have adapted to difficult climates and developed a deep and widespread root system, allowing them to exploit a wide range of ecological niches in their native range in Central Asia, which stretches from the Takla Makan desert in western China to the Mediterranean (Kester et al. 1991; Ladizinsky 1999). Due to its low chilling requirement for early bloom, quick early shoot growth, and excellent tolerance to summer heat and dryness, almonds are well adapted to mild winter and dry, hot summer conditions. Because it is the first temperate tree crop to blossom, production is limited to places with few spring frosts. Because almond is self-sterile, it necessitates cross-pollination, which increases genetic variety and, as a result, adaptation to new conditions.

## 1.7 Elevation and Climate:

### Elevation

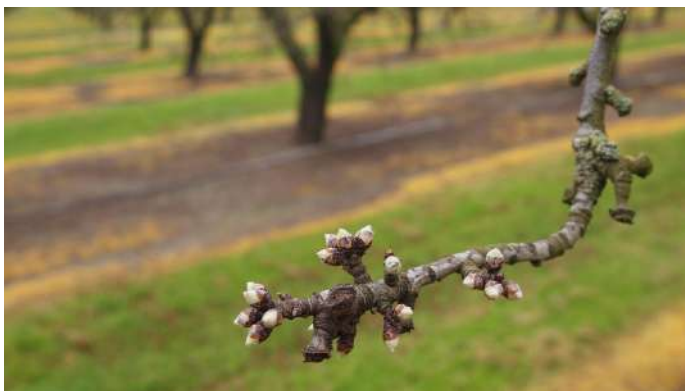
Optimal Elevation for *Prunus Dulcis* (Almond) Plants ranges from an altitude of 750 to 3200 meters above sea level (Corely, 2021).

## 1.8 Temperature:

Although Almond trees are best suited to grow in warm-dry weather (Mediterranean) and mild winters, the average rainfall needed is 75 to 110 cm. The ideal temperature range is between 59 and 86 degrees Fahrenheit, making warm locations optimal for cultivation.

### Figure 4, 5, 6,.

*Almond Orchard in California through different temperatures and environmental conditions.*





In California's chilly, damp winters, almond trees become dormant from November to January, losing their leaves and cooling off. Rainwater is stored in orchard soils for the coming growing season, and nutrients and energy are stored in the trees for the following crop. Buds start swelling on each tree's branches at the conclusion of dormancy, preparing for bloom.

### **1.9 Soil:**

As is common in most fruit trees, Almond trees prefer full sun and well-drained soil. The almond tree grows well in a wide range of soil types, from sandy loam to sandy clay, but it likes light, fertile, deep, and well-drained soils. Although the almond tree is drought hardy and may live for many years on dry soils, productivity is greatly decreased in such conditions. Low soil moisture at the conclusion of the growing season is less of a concern than it is at the start. Heavy or poorly drained soils should be avoided because they have been shown to reduce production and promote the spread of fungi. The pH of the soil is usually not a limiting factor, as the tree can thrive in a pH range of 5,5 to 8,5. Most experienced almond farmers, on the other hand, maintain a soil pH of 6.5 to 8.0.

### **Figure 8.**

*Types of soil suitable for Prunus dulcis*



## **1.10 Relation with insects & Pest and disease control:**

Almonds, or more typically the tree's leaves, are eaten by a variety of pests. Ants, particularly southern fire ants and pavement ants, are very fond of the tree's foliage. Although large colonies of these can ruin a nut harvest, they are rarely a major issue.

### **1.10.1 Beneficial:**

The honey bee is beneficial to the almond tree in order for it to cross pollinate.

### **1.10.2 Non-beneficial:**

Aphids and scales, tiny sap sucking critters that feed in colonies, create yellow leaf spots, leaf deformation, and blossom deformity. When either of these insects is present, the number of ants increases. This is because these insects produce Honeydew, which attracts ants as well as growing sooty mold. In exchange for the honeydew, the ants defend the scales and aphids from predatory insects. Tent caterpillars skeletonize foliage from April through June. Treating these pests on almond trees is as simple as handpicking and disposing of them when there are just a few of them on the tree. For bigger infestations, trim and remove extensively affected twigs and branches. In the case of a significant number of tent caterpillars, an insecticide may be required. The bodies of Leafroller larvae are green with black heads. They eat the buds of almond trees as they open. Leafroller populations are usually tiny and can be left alone, but if there is a big population, *Bacillus thuringiensis* can be useful.

Treatment:

For Aphids: Hard spray from the garden hose, prune out heavy areas of infestation, spread the tree with an insecticidal soap.

For tent caterpillars: Pick them out and dispose of them. High infestations might require insecticides.

For leafroller larvae: *Bacillus thuringiensis*

Borers: Pesticides

### **1.10.3 Diseases and pests:**

Pruning or weed whacker wounds are the prime source of infection for the fungal disease botryosphaeria canker also known as band canker. If the tree catches it, it'll have to be removed, stump and all.

**Figure 9.**

*Bacterial spot on Almond, a new disease of almond in California*



## Chapter 2: Biology

### 2.1 Chromosomes:

*Prunus dulcis* has two sets of 16 chromosomes

Genus	Prunus
Species	dulcis
Common Name	Almond
Abbreviation	P. dulcis
Ploidy	Diploid
Chromosome Number	2n=16
Genome Size	240 Mb
Genome Assemblies	2
GRIN Taxonomy	<a href="#">29890</a>

### 2.2 Life cycle and Phenology:

Figure 10.

Life cycle of *Prunus dulcis*

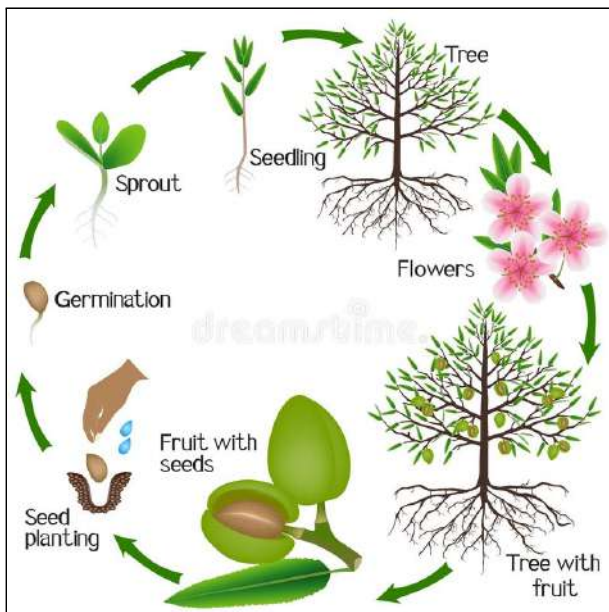
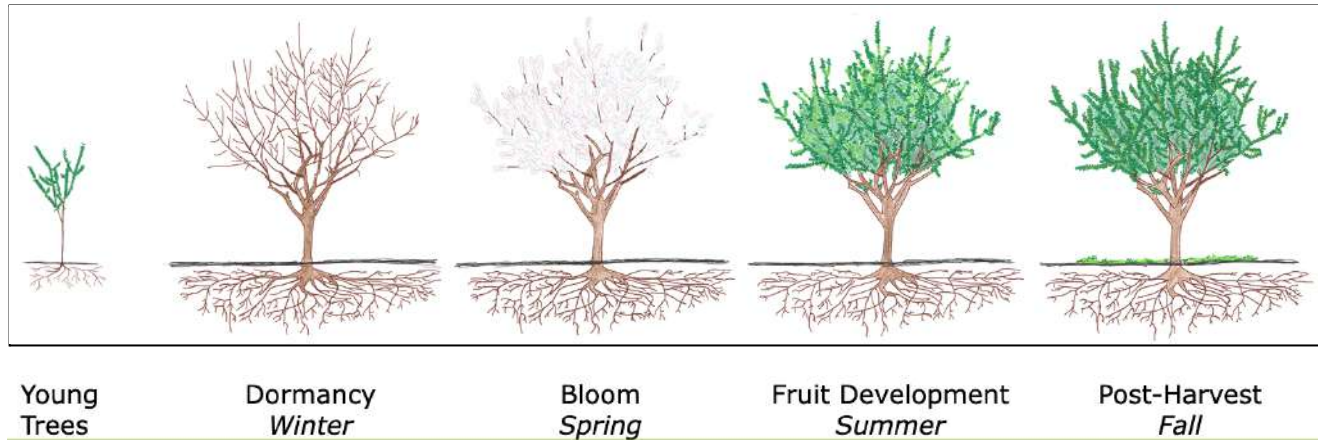




Figure 11

Almond tree phases through the seasons



### 2.3 Deciduousness:

The almond tree is a deciduous tree that bears fruit for five to six years after being planted. The flowers have five petals and are a lovely whit/pale pink color. Almond trees thrive in warm, dry summers and mild, wet winters, and tree buds require 300 to 600 hours of freezing below 7.2°C to break dormancy.

### 2.4 Reproduction and pollination:

Because most popular almond cultivars are not fertile by themselves, they require cross pollination in order to produce fruit. The almond tree requires only one granule of pollen from another compatible type at the correct time to yield one almond. The only insect that can help almond trees cross pollinate is the honeybee. Almond growers all around the world rely heavily on strong, healthy honeybee colonies to achieve the best possible cross pollination. A large population of honeybees (2-3 strong colonies per acre or 5-7 per hectare) is essential inside the almond orchard, so that a single bee can not only visit different flowers on the same tree, but also carry pollen to different varieties of trees, which are typically 20-30 feet (6-9 meters) away. In consequence, farmers use the technique of planting one row of pollinating trees for every three rows of the primary type. When one pollinating variety doesn't assure effective cross pollination because of asynchronous blooming, two

pollinating varieties are employed, one early flowering and the other late flowering, so that their flowering times overlap with the main variety's flowering time.

## **2.5 Anthesis:**

Almond trees typically blossom from late July to early September

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## Chapter 3: Propagation and management

### 3.1 Propagation:

One of the earliest domesticated [fruit trees](#), due to "the ability of the grower to raise attractive almonds from seed. Thus, in spite of the fact that this plant does not lend itself to propagation from suckers or from cuttings, it could have been domesticated even before the introduction of [grafting](#)"

### 3.2 Grafting:

Budding, also known as bud grafting, is a popular method for the propagation of almond trees. Buds from the growing almond tree are grafted onto the rootstock of a compatible tree in this method of tree grafting. Other almonds, as well as peaches, plums, and apricots, can be used as rootstock for budding almond trees.

### 3.3 Management:

Almond trees thrive in deep, well-draining loam, but they can also endure drought and thrive in poor soils. Because trees bloom early and are prone to harm from late frosts, they benefit from being planted in places protected from frost and wind. Trees usually bear nuts after 3 to 4 years, with the nut harvest growing after the blooming season in the fall.

### 3.4 Harvesting and storage:

#### 3.4.1 Harvesting

To harvest nuts (excluding chestnuts), use long wooden, fiberglass, or plastic (PVC) poles to knock or shake them from their tree. Rubber mallets or poles, available at agricultural supply stores, can be used to knock almonds from their trees. The inedible outer hull of nuts (also known as husk, shuck, or bur) must be removed as soon as possible after harvesting to allow the nuts to dry properly. The nut quality degrades the longer the hulls remain on the nuts after harvest. To reduce kernel moisture, dry nuts (excluding chestnuts) properly after harvesting and hulling. Molds and a foul flavor (rancidity) are more prone to form in undried or poorly dried nuts, and they have a shorter storage life.

### **3.4.2 Storage**

The length of time nuts can be stored is determined by the temperature and humidity in the storage area. In general, room temperature storage life is less than in a refrigerator or freezer, where nuts can last 1 to 2 years. To save weight and volume, nuts are frequently shelled before storing. Shelled nuts absorb moisture and external tastes quickly, thus proper packaging and handling are critical for ensuring the highest quality.

## Chapter 4: Importance

### 4.1 Markets:

Over the projection period, the global almond market is expected to develop at a CAGR of 4.47 percent, reaching a total market value of US \$12.073 billion by 2025, up from US\$9.286 billion in 2019.

Figure 13.1

Production quantities of almonds with shell

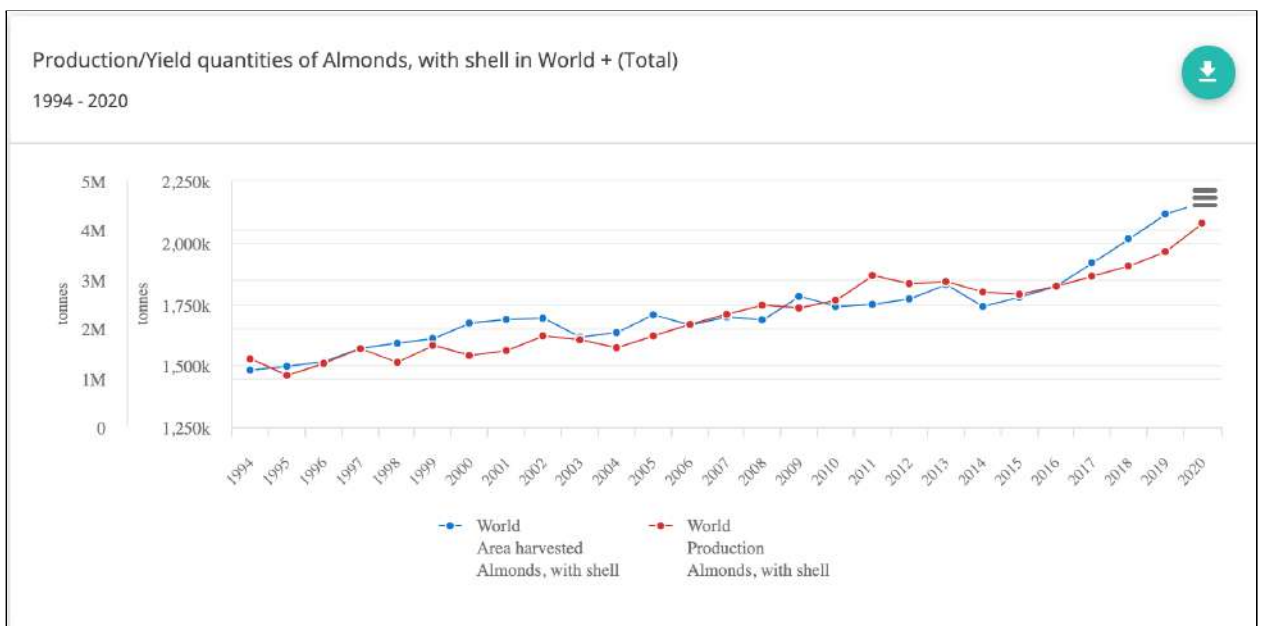
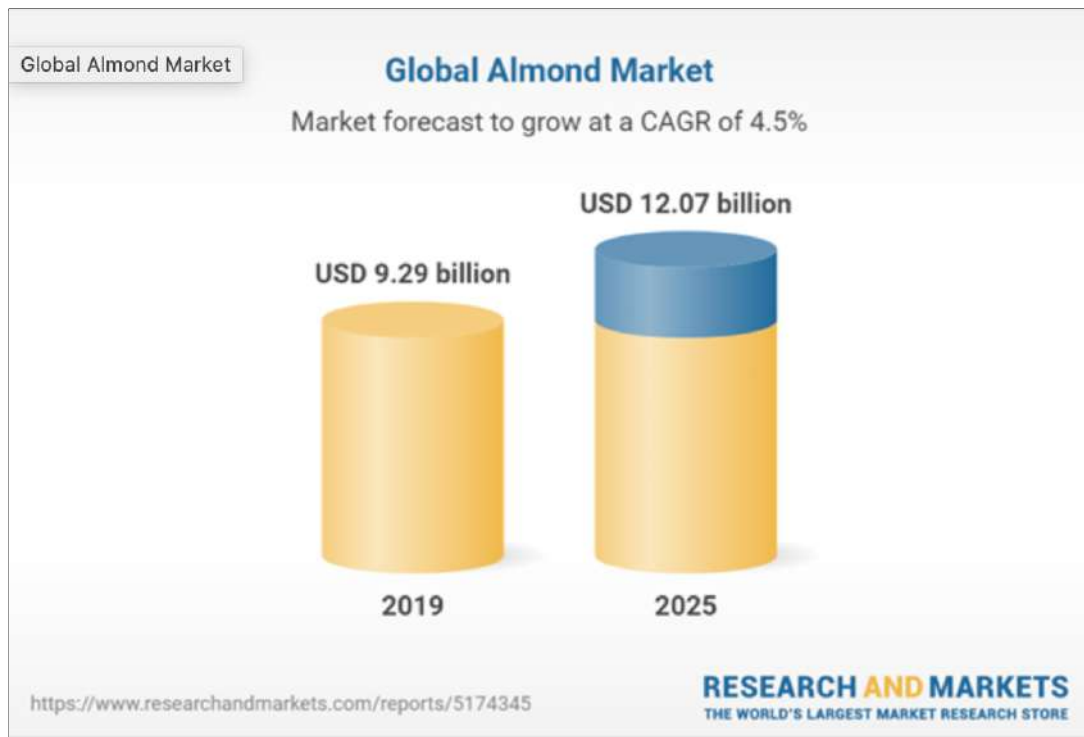


Figure 13.2

Global Almond Market



Wonderful Pistachios & Almonds LLC, South Valley Farms, Almond Ace, Agriland Farming Company Inc, Olam International, Harris Family Enterprises., Western Nut Company., BAPU Almonds, Chico Nut Company, TREEHOUSE ALMONDS, and RPAC, LLC are among the prominent/major key market players in the global almond market.

## 4.2 Composition:

Almonds are a rich source of oil, with 50% of kernel dry mass as fat (whole almond nutrition table). In relation to total dry mass of the kernel, almond oil contains 32% [monounsaturated oleic acid](#) (an [omega-9 fatty acid](#)), 13% [linoleic acid](#) (a [polyunsaturated omega-6 essential fatty acid](#)), and 10% [saturated fatty acid](#) (mainly as [palmitic acid](#), USDA link in table). [Linolenic acid](#), a polyunsaturated [omega-3](#) fat, is not present (table). Almond oil is a rich source of [vitamin E](#), providing 261% of the Daily Value per 100 ml (table).

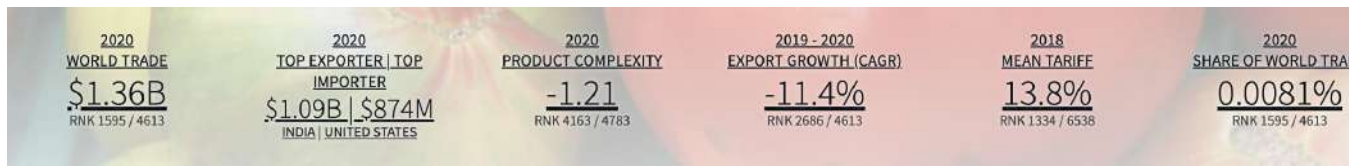
When almond oil is analyzed separately and expressed per 100 grams as a reference mass, the oil provides 3,700 kJ (884 kcal) of food energy, 8 grams of saturated fat (81% of which is palmitic acid), 70 grams of oleic acid, and 17 grams of linoleic acid (oil table).

Oleum amygdalae, the fixed oil, is prepared from either sweet or bitter almonds, and is a glyceryl oleate with a slight odor and a nutty taste. It is almost insoluble in [alcohol](#) but readily soluble

in [chloroform](#) or [ether](#). Almond oil is obtained from the dried [kernel](#) of almonds. Sweet almond oil is used as a carrier oil in aromatherapy and cosmetics while bitter almond oil, containing benzaldehyde, is used as a food flavoring and in perfume.

- 4% Water
- 22% Carbohydrates
- 21% Protein
- 50% fat
- Rich source (provides 20% or more of DV Daily Value of the B vitamins Riboflavin and niacin, vitamin E, minerals like Calcium, copper, iron, magnesium, manganese, phosphorus, zinc.

### 4.3 Use and trade:



(Figure 14.) Market statistics for Almonds

#### 4.3.1 Exports:

The largest exporters of fresh or dried almonds in shell in 2020 were the United States (\$1.09 billion), Australia (\$111 million), the United Arab Emirates (\$34.8 million), Spain (\$28.5 million), and Hong Kong (\$26.9 million).

#### 4.3.2 Imports:

India (\$874 million), China (\$182 million), Hong Kong (\$39.4 million), Spain (\$34.1 million), and Turkey (\$32.3 million) were the leading importers of almonds in shell, fresh or dried in 2020.

#### 4.3.3 Tariffs:

Almonds in shell, fresh or dried had an average duty of 13.8 percent in 2018, making it the 1334th lowest tariff in the HS6 product classification.

#### 4.4 Products:

(Figures 15, 16, 17, 18.) Products derived from Almonds



Figure 15:

Almond flour



Figure 16:

Almond butter



Figure 17

Almond Milk



Figure 18

### Almond Oil



## 4.5 Medicinal properties:

### 1. High in Nutrients

Almonds by themselves have plenty of Medicinal properties and contain an impressive nutrient profile. A 1 ounce (28 gram) serving of almonds contains the following:

- Fiber
- Protein
- Fat
- Vitamin E
- Manganese

- Magnesium
  - They also contain a fair amount of copper, vitamin B2 (riboflavin) and phosphorus.
2. Loaded with Antioxidants
    - a. Largely concentrated in the brown layer of skin
  3. High in Vitamin E
    - a. Vitamin E, is a family of fat-soluble antioxidants that build up in cell membranes of your body, protecting your cells from oxidative damage.
  4. Assistive with blood Sugar control
    - a. 25-38% of diabetic people (type-2) are deficient in magnesium which Almonds are high in. This supplement reduces blood sugar levels and improves the insulin function.
  5. Magnesium benefits blood Pressure levels
    - a. Deficiency in magnesium is linked to Heart Attacks
  6. Lower cholesterol levels
    - a. High levels of LDL lipoproteins in your blood (bad cholesterol), is a well know factor of heart disease. Almonds effectively lower LDL.
  7. Prevent Harmful Oxidation of LDL Cholesterol
    - a. They protect LDL from oxidation
  8. Eating Almonds reduces hunger, Lowering your overall calorie intake
    - a. Low in carbs and high in protein and fiber

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