CALIFORNIA ALMONDS

Since ancient times, almonds have been prized for their delicious taste, crunchy texture and, increasingly, for their nutritional value.

California is the world's largest producer of almonds. With its ideal growing conditions, including a mild climate (hot, dry summers and cool, rainy winters), rich soil and abundant sunshine, this area produces about 80% of the global almond supply, exporting to more than 100 countries. To ensure a consistent, high-quality, wholesome product year-round, state-of-the-art equipment and specialized techniques for growing, harvesting, processing and packaging are used.

The California almond industry respects the environment and keeps consumer health in mind, with food safety and quality assurance programs in the orchard and in processing and packaging.

California almonds are highly versatile and available in numerous varieties and forms suitable for diverse product applications. The Almond Board of California's Technical Kit can help determine the most suitable variety, size, form and grade of almond for your needs.

ALMOND BOARD OF CALIFORNIA

- The Almond Board of California was established in 1950 under the Agricultural Marketing Act to administer a grower-enacted Federal Marketing Order under the supervision of the U.S. Department of Agriculture (USDA).
- The Almond Board's mission is to expand global consumption of California almonds through leadership in strategic market development, innovative research and the accelerated adoption of industry best practices.
- Efforts focus on supporting grower research and building global demand, consumption and usage of almonds by funding a variety of generic activities that benefit the industry as a whole.
- The Almond Board is funded by an annual assessment on the marketable kernel pound weight of almonds.
- Program activities include such critical functions as domestic and international marketing; nutrition, production and environmental research; food quality and safety initiatives; monitoring trade and market access issues; and analysis and dissemination of industry statistics. Almond Board does not establish commodity prices.

ALMOND SEASONS

Like nectarines, peaches and plums, the almond is classified botanically as a fruit. Almonds are either sweet (*Amygdalus communis* L. var. dulcis) or bitter (*Amygdalus communis* L. var. amara), but only sweet varieties are grown in California.

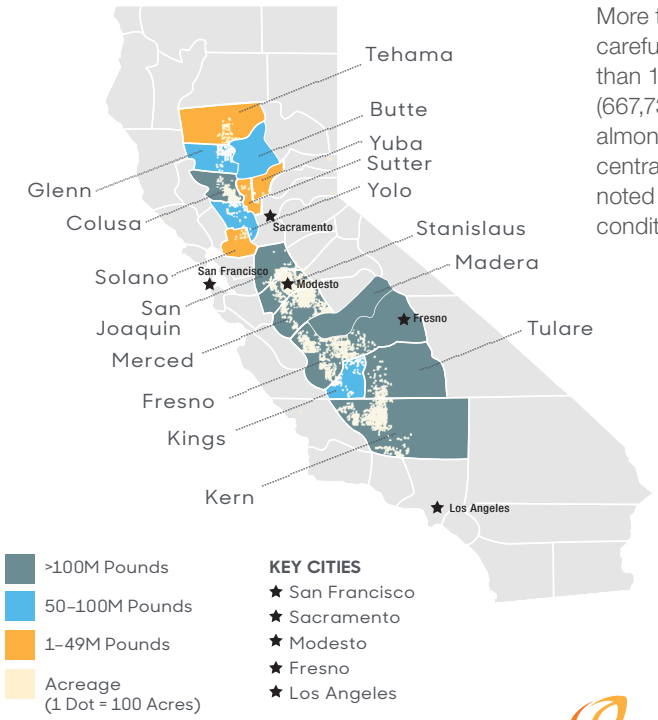
Almonds grow on trees that bloom from mid-February through March. Almond trees are not naturally self-fertile, so bees are required to cross-pollinate. For the trees to produce, at least two different almond varieties are planted in alternating rows. A number of varieties are being conventionally bred that are self-fertile, requiring fewer bees.

Almonds develop in a shell that is surrounded by a hull (analogous to the fleshy part of a peach). Over the summer, as the nuts mature, the hull dries and splits open, revealing a shell that encases the nut. The nuts dry naturally in this shell before they are harvested.

Between mid-August and October, almonds are harvested by mechanical tree shakers, which knock the almonds, still in their hulls, to the ground. The nuts are then gathered and delivered for processing, where the next stage of cleaning and grading occurs. Finally, they are sold to millions of people around the world.

OVERVIEW OF THE CALIFORNIA ALMOND INDUSTRY

AVERAGE PRODUCTION BY COUNTY (2021/2022)



More than 7,600 growers carefully tend more than 1,650,000 acres (667,731 hectares)[1] of almonds throughout central California, a region noted for its ideal growing conditions.

1. 2022 California Almond Acreage Report, 2022.

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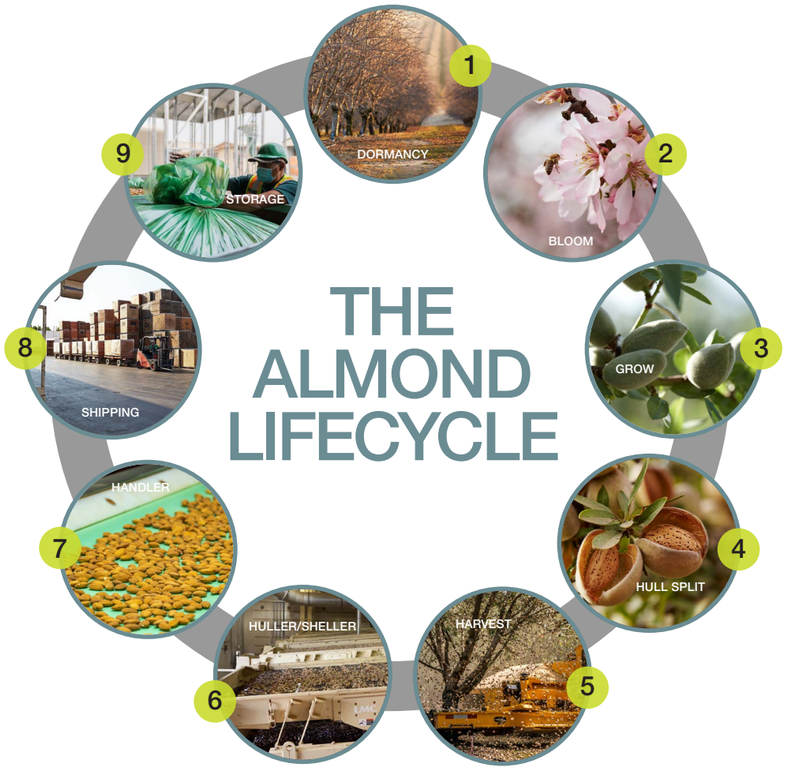
ALMOND TREES GENERALLY PRODUCE FOR 25 YEARS, YIELDING THEIR FIRST CROP THREE YEARS AFTER PLANTING. OVER THIS LIFESPAN, ALMOND TREES ANNUALLY CYCLE THROUGH MULTIPLE STAGES—ALL CRUCIAL TO THE DEVELOPMENT OF THIS VALUED NUT.

CALIFORNIA IS ONE OF THE FEW PLACES ON EARTH WITH A MEDITERRANEAN CLIMATE characterized by mild winters, a defined rainy season and hot, dry summers—perfect for growing almonds. As a result, California almond acreage has grown over time and represents **approximately 80%** of the world's almond supply[1]. Almonds are California's #1 agricultural export.



THE ALMOND LIFECYCLE

THE CALIFORNIA ALMOND COMMUNITY

7,600 ALMOND GROWERS AND **100** PROCESSORS[3]

as well as many others, from vendors and beekeepers to brokers and buyers.

- GENERATES MORE THAN 110,000 JOBS ACROSS CALIFORNIA[4]
- HAS A FARM GATE VALUE* OF MORE THAN $5 BILLION[5]
- CONTRIBUTES MORE THAN $19.6B GROSS REVENUE ACROSS ALL SECTORS IN CALIFORNIA, ADDING ABOUT $9.2B TO THE STATE'S TOTAL ECONOMY[3]

1. Almond Board of California. 2022 Almond Almanac. 2022. 2. USDA-ERS. Land Use, Land Cover and Pollinator Health: A Review and Trend Analysis. July 2017. 3. United States Department of Agriculture. 2017 Census of Agriculture, Table 37. 4. University of California Agricultural Issues Center. Contributions of the California Almond Industry to the California Economy. August 2020. 5. USDA, NASS. *Latest data available at time of publication.

1 DORMANCY: NOVEMBER–JANUARY
Almond trees lose their leaves and "rest" during California's cool, wet winters. Orchard soils store up rainwater for the upcoming growing season, and the trees store nutrients and energy for next year's crop. During this time, growers shake and knock any remaining unharvested nuts from the trees to minimize orchard pests. Toward the end of dormancy, buds begin swelling on each tree's branches in preparation for bloom.

2 BLOOM AND POLLINATION: FEBRUARY–MARCH
Almond tree buds burst into beautiful white and light-pink blooms. Most almond trees are not self-pollinating, so orchards are grown with multiple almond varieties, and beekeepers bring hives of honey bees to orchards to pollinate the blossoms. Every almond you eat is a result of pollination, and every honey bee that visits an almond orchard gets its first natural food source of the year there, supporting it with a healthy start[2] as it moves on to pollinate other crops across the nation.

3 GROWING: MARCH–JUNE
Almond kernels mature and grow to full size, with the shell hardening around them—and further protected by a fuzzy outer hull. Once the spring rains stop and the weather heats up, farmers begin irrigating their orchards to support the growing crop, taking great care to ensure each drop of water is used responsibly and efficiently. During this time, green almonds can be harvested for various culinary uses.

4 HULL SPLIT: JULY
Almond hulls split open, exposing the almond shell and allowing it and the kernel inside to dry. Shortly before harvest, the hulls dry and open completely.

5 HARVEST: AUGUST–OCTOBER
Mechanical tree "shakers" harvest the crop by vigorously shaking the tree, so almonds fall to the ground. Protected by their outer hulls and shells, the almonds then dry naturally in the warm California sun for 7–10 days before being swept into rows by a "sweeper" machine. After that, a harvester or "pickup" machine drives over the rows, vacuuming the nuts up into a cart that brings them to the edge of the orchard for transport to the next stop on their journey.

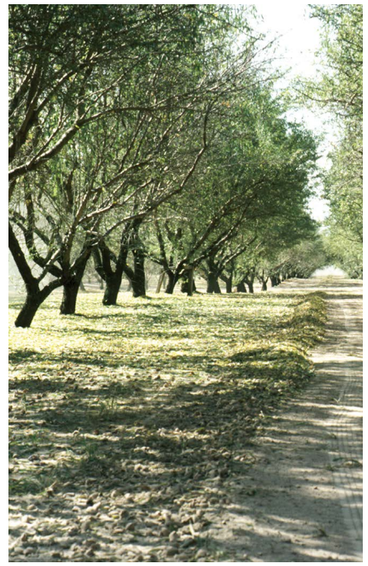
6 HULLER/SHELLER: Almonds arriving from the orchard are typically stockpiled and carefully monitored and/or fumigated to avoid insect damage while the almonds await processing. Almonds are sent through machinery at a huller/sheller to remove outer hulls, shells and any remaining debris such as sticks and rocks. Almond farmers take a zero-waste approach, ensuring the coproducts—hulls, shells and woody tree material—are put to good use. The trees store carbon and have traditionally been sent to cogeneration facilities to convert wood into electricity at the end of their lives. The shells become livestock bedding, and the hulls are used as dairy feed. With changing markets for these coproducts, the California almond community is spurring innovation for higher value and more sustainable uses. Current research is exploring using almond hull and shell components as a growing medium for mushroom cultivation, feed sources for poultry and aquaculture, soil amendments and strengthening post-consumer recycled plastics.

7 HANDLER/PROCESSOR: Once almonds arrive at a handler, they are further screened and sorted to remove defects, and they are also fumigated. The almonds are then sized and graded according to parameters outlined by the USDA. USDA grades establish tolerances for various quality factors and kernel characteristics. The California almond industry can supply almonds to customers' unique specifications, both in terms of sizes and grades, based on the intended application. Almonds are stored at the handler facility under cool, dry conditions. Prior to shipping, the almonds may be pasteurized based on the customer and market.

8 SHIPPING: After being sized and graded, the almonds are packed, stored and prepared for shipping. Depending on customer specifications and the shipping destination's regulations, almonds may be further sorted or tested to ensure compliance. The almonds are trucked to a port, loaded on a ship and sent to over 100 countries around the world. The U.S. remains the #1 global destination for California almonds; top export destinations include India, Spain, China/Hong Kong, United Arab Emirates, Germany, Netherlands, Japan, Italy, Turkey and South Korea.

9 STORAGE: Almonds are relatively low-moisture, high-oil-containing nuts with a long shelf life when properly handled and stored. California almonds are commonly shipped in 25- or 50-pound cartons, 1-ton fiber bins or 1-ton "super totes." The following recommended conditions will optimize the shelf life of almonds:

- Store under cool and dry conditions (<15°C/59°F and <60% relative humidity).
- Maintain almond moisture within 3 to 5.5% for optimal stability.
- Use packages with good barrier properties against water and air transmission, and prevent infestation to maximize shelf life.
- Avoid exposure to light and avoid storing adjacent to materials with extraneous odors.



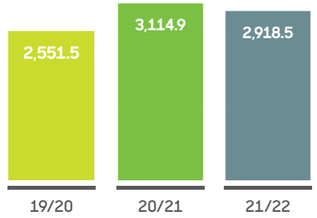
KEY MEASUREMENT AND REPORTING DATES

USDA National Agricultural Statistics Service (NASS) conducts annual surveys that provide the almond industry with data needed to make informed business decisions.

MAY: The **SUBJECTIVE FORECAST** provides an initial estimate of the crop based on a survey of growers.

JULY: The **OBJECTIVE FORECAST** is based on actual almond counts and uses a statistically rigorous methodology to determine yield.

CROP YEAR PRODUCTION IN MILLIONS OF POUNDS



PASTEURIZATION
USDA regulations require that California almonds marketed in the U.S., Canada and Mexico be subjected to a treatment to reduce pathogens and ensure a safe, nutritious food. Several types of validated pasteurization processes appropriate for conventional and organic production effectively eliminate potential contamination in almonds without diminishing the quality, nutritional value or sensory characteristics. These include: Oil Roasting, Dry Roasting, Blanching, Steam, Moist Heat and Propylene Oxide (PPO). New technologies are being identified which expand the treatment options that can be utilized.

THE ALMOND JOURNEY: FROM TREE TO TABLE

FROM THE FARM: California almond growers tend to their trees' needs year-round to produce a quality, nutritious nut.

DID YOU KNOW? Even after almonds are harvested each fall, they must still make multiple stops after leaving the farm to ensure their quality and safety before being sold to consumers.

- Nearly 70% of California almond farms are 100 acres or less.
- Of the roughly 7,600 almond farms in California, 91% are family farms, owned and operated by third- and fourth-generation farmers.

1

HULLER/SHELLER: After being harvested, almonds are brought to the huller/sheller. Hullers/shellers can either be grower-owned, handler-owned or independent.

- At the huller/sheller, almonds are sent through machinery that removes outer hulls, shells and any remaining orchard debris such as sticks and rocks.

DID YOU KNOW? California almonds introduced for commerce in North America are required to be pasteurized either by the handler or the customer to ensure a safe, nutritious food. All process systems used to pasteurize almonds must be validated by an Almond Board-approved process authority.

HANDLER*: There are approximately 100 handlers in California who prepare and distribute almonds.

- Almonds are screened and sorted, then sized and graded according to parameters outlined by the USDA. Almonds are stored and packaged at the handler facility under cool, dry conditions.
- Handlers may also process almonds into the over 14 different forms used in food and beverage applications.

2

3

4

SHIPPING: Almonds are either trucked to destinations in the U.S., which is the #1 global destination for California almonds, or they are taken to a port, loaded on a ship and sent to over 100 countries around the world.

5

RETAILERS AND MANUFACTURERS: Retailers sell almonds and almond forms to consumers. Manufacturers use almonds to make food products across major categories such as confectionery, snack, bakery, bars and dairy.

BROKERS, TRADERS, RE-PACKERS OR CUSTOM PROCESSORS: Specific transactions can be arranged by brokers or traders, or the almonds can be further tailored by re-packers or custom processors to accommodate requests for almonds in a full array of formats, varieties, quality grades, granulations and more.

CUSTOMER: Consumers can purchase almonds and products with almond ingredients through traditional retailers, online via e-commerce or through foodservice.

6

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* A handler is any operation in California that handles almonds during the crop year, using them commercially of own production or to sell, consign, transport, ship or put almonds grown into any channel of trade for human consumption worldwide.

 USDA Doc. #2023IR0065

STANDARDS & GRADES

USDA grades are voluntary standards, used to define the maximum level of defects for a particular grade.

The California almond industry can supply almonds to customers' unique specifications, both in terms of sizes and grades, based on the intended applications.

Depending on the ultimate use, different grades may be more relevant than others. Other terms like "Supreme" are also used in the industry when referring to particular grades. Be sure to speak with your supplier about your specifications.

WEIGHT CONVERSION
1 U.S. TON = 0.907 METRIC TON
1 METRIC TON = 2,204.6 POUNDS
1 POUND = 453.6 GRAMS
10 OZ. = 283.5 GRAMS

UNDERSTANDING USDA GRADES

Different grades reflect minimum standards and specify the maximum level of defects per grade as shown in the chart above. The higher the almond grade, the tighter the tolerance.

CALCULATION OF GRADING PERCENTAGES (EXAMPLE)

$$\%\ [\text{DISSIMILAR KERNELS}] = \frac{\text{WEIGHT OF [DISSIMILAR KERNELS] (G)} \times 100}{\text{WEIGHT OF TOTAL SAMPLE (G)}}$$

USDA GRADES OF SHELLED ALMONDS

USDA GRADES	WHOLE KERNELS	MINIMUM DIAMETER (IN INCHES)	DISSIMILAR	DOUBLES	CHIP & SCRATCH	FOREIGN MATERIAL	PARTICLES & DUST	SPLIT & BROKEN	OTHER DEFECTS	SERIOUS DEFECTS	UNDER SIZE
U.S. FANCY	–	–	5%	3%	5%	0.05%	0.1%	1%	2%	1%	–
U.S. EXTRA NO. 1	–	–	5%	5%	5%	0.05%	0.1%	1%	4%	1.5%	–
U.S. NO. 1 (SUPREME)*	–	–	5%	15%	10%	0.05%	0.1%	1%	5%	1.5%	–
U.S. SELECT SHELLER RUN (SSR)	–	–	5%	15%	20%	0.1%	0.1%	5%	3%	2%	–
U.S. STANDARD SHELLER RUN (STD)	–	–	5%	25%	35%	0.2%	0.1%	15%	3%	2%	–
U.S. NO. 1 WHOLE & BROKEN	30%	20/64 UOS†	5%	35%	x	0.2%	0.1%	x	5%	3%	5%
U.S. NO. 1 PIECES	x	8/64	x	x	x	0.2%	1%	x	5%	3%	5%

*U.S. No. 1 is commonly referred to by industry as Supreme. However, Supreme is not a USDA grade.
†UOS = Unless Otherwise Specified.

x No limit established. | Also included in "Other Defects." | Includes max. 2% under 20/64". | Includes max. 5% under 20/64". % also included in "Chip & Scratch."

OUTGOING SAMPLE SIZE

LOT SIZE		SAMPLE SIZE	
POUNDS (LBS.)	METRIC TONS (MT) APPROXIMATE	GRAMS DRAWN*	GRAMS ANALYZED*
<10,000 LBS.	<4.5 MT	2,000	1,000
10,000 LBS. - 44,000 LBS.	4.5 MT - 20 MT	4,000	2,000
44,001 LBS. - 70,000 LBS.	21 MT - 31.8 MT	6,000	3,000

* Add 2,000 grams and analyze 1,000 grams for each additional 30,000 lbs. (13.6 MT) or less for lots over 70,000 lbs. (31.8 MT)

UNDERSTANDING USDA INSHELL GRADES

U.S. NO. 1
Similar varietal characteristics. Free from loose, extraneous and foreign material.

Shells are clean, fairly bright, fairly uniform in color and free from damage caused by discoloration, adhering hulls, broken shells or other means. Kernels are well dried and free from decay, rancidity, damage caused by insects, mold, gum, skin discoloration, shriveling, brown spots or other means.

LOOSE FOREIGN MATERIAL
2%, including 1% passing through a 24/64" screen (this is also by weight).

INTERNAL DEFECTS
10%, including 5% serious damage.

EXTERNAL (SHELL) DEFECTS
10%. Internal Defects - Gum, skin discoloration, brown spots, shriveling; Internal Serious Defects - Decay, rancidity, damage caused by insects, mold, serious shrivel damage; External (Shell) Defects - Dull and discoloration (Stain), adhering hull, badly broken shells.

U.S. NO. 1 MIXED
U.S. No. 1 grade, except that two or more varieties are mixed.

U.S. NO. 2
Consists of almonds in the shell that meet the requirements of U.S. No. 1 grade, except that an additional tolerance of 20% shall be allowed for almonds with shells damaged by discoloration.

U.S. NO. 2 MIXED
Consists of almonds in the shell that meet the requirements of U.S. No. 2 grade, except that two or more varieties of almonds are mixed.

SIZE
Unless otherwise specified, 28/64" in thickness.

Note: Inshell almonds are sometimes shelled at destination, or sold with their shells into retail channels.

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UNDERSTANDING USDA SHELLED GRADES

Although these are voluntary USDA grades, buyers can discuss specific needs by working with their suppliers.

U.S. FANCY
The highest grade—typically appropriate for products where the visual appeal of the almond is critical to the application.

U.S. EXTRA NO. 1
Similar to U.S. Fancy—ideal for food applications where the appearance of the almond is very important.

U.S. NO. 1
Sometimes referred to as Supreme, and often used for whole almond applications or for further processing like blanching and roasting.

U.S. SELECT SHELLER RUN
Mid-quality grade—good choice for applications where the almonds with minimal sorting/processing can be incorporated with other ingredients; for example, inside a confectionery product a higher level of chipped and scratched kernels is accepted. Also appropriate for further processing, such as blanching, grinding, roasting, dicing and slicing.

U.S. STANDARD SHELLER RUN
Good grade for further processing, such as blanching, dicing, grinding or paste, particularly where a higher level of split and broken kernels is not a concern.

USDA GRADING PARAMETERS

The following is the breakdown of parameters that affect the grading for almonds, regardless of the variety or size.

DISSIMILAR
Different varieties of almonds in one load. Used for whole almond applications or for further processing, such as blanching and roasting. Limits of Dissimilar are set for only six grades (Whole, Whole and Broken).

DOUBLES
Two kernels developing in one shell. One side of a double kernel is flat or concave. Limits of Doubles are set for only six grades (Whole, Whole and Broken) and are not considered a quality parameter for Pieces. Whole and Broken grade has a limit of whole kernels at a minimal 30%. Pieces grade has a limit of 8/64" minimum diameter.

CHIP & SCRATCH
Loss of kernel skin as a result of mechanical processing. • Limits of Chip and Scratch are set for only five whole grades.
• An aggregate area of chipped and scratched greater than 6.4mm in diameter is scored as Chip and Scratch for Extra No. 1 or lower grades, and the chipped and scratched areas smaller than 6.4mm in diameter are not scorable for these grades.
• For U.S. Fancy, chipped and scratched area greater than 1/8" (3.2mm) in diameter is scored as Chip and Scratch.
• Double kernels with Chip and Scratch are scored as Doubles.

FOREIGN MATERIAL
Pieces of shell, hulls, rocks, sticks or other foreign matter that will not pass through a round-opening screen measuring 8/64" (3.2mm) in diameter.

PARTICLES & DUST
Fragments of almond kernels or other material that will pass through a round-opening screen measuring 8/64" (3.2mm) in diameter.

SPLIT & BROKEN
Seven-eighths or less of complete whole kernels that will not pass through a round-opening screen measuring 8/64" (3.2mm) in diameter. Scores of Split and Broken for Fancy, Extra No. 1 and No. 1 are counted as a part of Other Defects. Score of Split and Broken for Standard Sheller Run is also counted as a part of Chip and Scratch. Score of Split and Broken for Standard Sheller Run allows a maximum of 5% pieces smaller than 20/64". Score of Split and Broken for Select Sheller Run allows a maximum of 2% pieces smaller than 20/64". Split and Broken is not scored for grades of Whole and Broken, and Pieces and double kernels with split and broken are scored as Split and Broken.

OTHER DEFECTS
Any defect that materially detracts from the appearance of the individual kernel or the edible or shipping quality of the almonds. The defects include edible kernels and pieces scored as Split and Broken, Shrivels, Gummy, Discoloration, Brown Spot, Kernels with Embedded Shells, and Pliable Kernels.

SERIOUS DEFECTS
Any defect that makes a kernel or piece of kernel unsuitable for consumption. Serious Defects refer to any inedible kernels or pieces damaged by insect, mold, decay, rancidity, etc., and these scores are counted as a part of Other Defects for all seven grades.

 USDA Doc. #2023IR0065

CALIFORNIA ALMOND HANDLING AND STORAGE

California almonds are low-moisture, high-oil-containing nuts with a long shelf life when properly handled. Almond quality and shelf life can be influenced by three general factors: the product characteristics, the environment during distribution and storage, and the packaging. The most important aspect to preserving the incredible quality of California almonds is maintaining controlled conditions. Elevated temperatures and moisture can significantly reduce quality and shelf life. For that reason, almonds are normally stored in cool, dry conditions, held in bins, silos or other bulk containers. It is good practice to avoid exposure to direct sunlight, which can darken the surface of the nut.

Processing can also affect the shelf life of almonds. In general, cutting (dicing, slivering, slicing, grinding) and blanching increase the exposed surface area and begin the oxidative process, which can reduce shelf life.

Exposure of almonds to higher temperatures during oil roasting or dry roasting requires appropriate packaging to protect from oxygen.

FOOD SAFETY PRACTICES OVERVIEW

COMMON PACKING FOR CONTAINER SHIPMENT

PRODUCT	NATURAL ALMONDS	CUT ALMONDS	ROASTED ALMONDS	INSHELL ALMONDS
VOLUME	25 LBS (11.3 KG) 50 LBS (22.7 KG) 2,200 LBS (1 MT)	25 LBS (11.3 KG) 1,000 LBS (454 KG) 1,500 LBS (681 KG)	25 LBS (11.3 KG) 50 LBS (22.7 KG)	50 LBS (22.7KG)
PACKAGING	Cardboard cartons, boxes, fiber bins or tote bags	Cartons with plastic liner, fiber bulk bin with plastic liner	Cartons with vacuum-packed foil bags	Poly-bag sacks

RESPONSIBLE PARTY	SAFETY CONTROL PROGRAM	
GROWERS; HULLERS/SHELLERS	Good Agricultural Practice (GAP)	Series of practices to address potential hazards, such as pathogens, contaminants and pest management materials during production and harvest
	Stockpile Management	Practices to monitor and maintain quality of stockpiles
HULLERS/SHELLERS; HANDLERS	Sanitation Standard Operating Procedures (SSOP)	Procedures to ensure a clean and sanitary environment in the processing facility
	Good Manufacturing Practice (GMP)	Procedures to process, pack, store and distribute almonds under sanitary conditions
HANDLERS	Hazard Analysis Critical Control Points (HACCP) / FDA Preventive Controls	HACCP principles, which provide a systematic approach to identify, assess and control the risk of biological, chemical and physical hazards
	Pasteurization	Practices designed to identify and eliminate potential sources of contamination to protect product against recontamination in processing and storage areas
	Pathogen Environment Monitoring (PEM)	Guidelines to monitor and control environmental contaminants and protect against post-process recontamination of microorganisms in the processing and storage areas
	Incoming Almond Inspection	Inspection by USDA-licensed inspectors to identify inedible content in almond receipts
	Inedible Disposal	Mandatory disposal of inedible based on incoming inspection
	Pre-export Check (PEC)	Voluntary testing of product in the U.S. for aflatoxin prior to export to the EU

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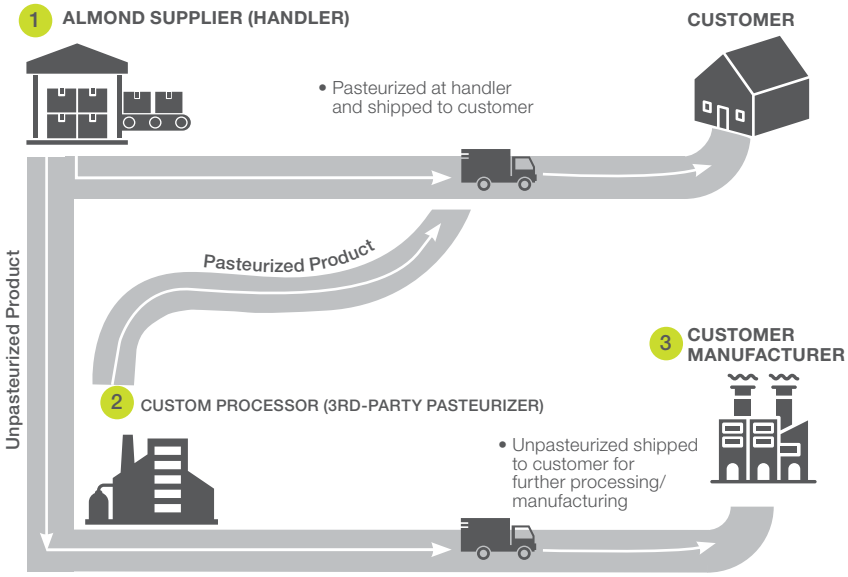
ALMOND PASTEURIZATION

Raw agricultural commodities including almonds and other nuts can be contaminated by microbial pathogens that are found in the environment and may be transmitted through the soil, water or other means. Although growers and handlers do their part to implement practices to minimize risk, definitive controls such as pasteurization are available.

Pasteurization is a treatment process to control potential pathogens that may be present including *Salmonella* bacteria. A minimum 4-log reduction of *Salmonella* bacteria on almonds has been acknowledged by U.S. Food and Drug Administration as an appropriate standard for ensuring food safety. There are many treatment options available, including steam, moist heat, steam under vacuum and propylene oxide, which all maintain the "raw characteristics" of almonds. In addition, other options exist including blanching, oil roasting and dry roasting.

WHO APPLIES PASTEURIZATION?

Depending on specific needs and applications, pasteurization may be conducted by the almond handler, by a third-party custom processor or by the customer.



Testing unpasteurized product for pathogens

Testing of unpasteurized almonds for the presence of *Salmonella* is not recommended by food safety experts as a means of assuring food safety. Rather than relying on a *Salmonella* negative certificate of analysis as an indicator of food safety, an appropriate pathogen reduction step should be applied by the almond supplier, a custom processor or the end user manufacturer depending on specific needs. California almond shipments that have not been pasteurized are labeled as "unpasteurized."

Microbiological References (unpasteurized almonds)[1]

AEROBIC PLATE COUNT	<50,000 cfu/g
YEAST AND MOLDS	<10,000 cfu/g
COLIFORMS	<200 cfu/g

1. Typical values for reference purposes only.

BITTER VERSUS SWEET ALMONDS

All almond trees grown in commercial orchards in California produce "sweet" varieties of almonds. The sweet or bitter flavor of an almond variety depends on the genetics of the parent tree in the orchard. A "sweet" almond tree produces sweet almonds. Amygdalin is the compound that provides "almond flavor." Sweet almonds contain lower levels of amygdalin, while bitter almonds contain much higher levels. Enzyme action breaks amygdalin down to release hydrogen cyanide as well as glucose and benzaldehyde. The low level of amygdalin in sweet almonds, when consumed, releases a sufficient sensation of benzaldehyde (amaretto-like) flavor without any concern of overexposure to hydrogen cyanide. Benzaldehyde, which is nontoxic, is extracted from bitter almonds and is an important flavoring substance also known as "oil of almond" or almond essence.

California almond varieties contain various levels of amygdalin that can only be partially converted to or detected as hydrogen cyanide (HCN). Analysis of almond varieties has shown average HCN ranges from 0.8-6.0 ppm and maximum values of 10.8 ppm. These values are less than the EU regulatory limit of 35 ppm.

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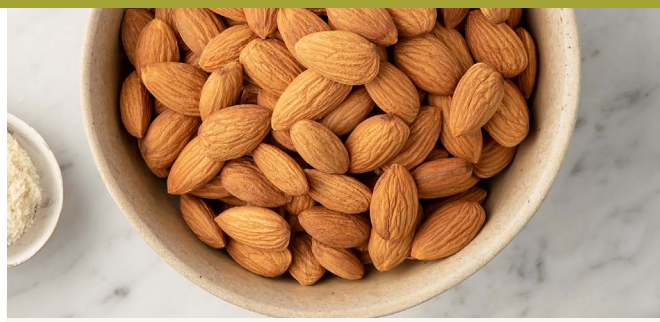
ALMOND QUALITY PRESERVATION AND SHELF LIFE



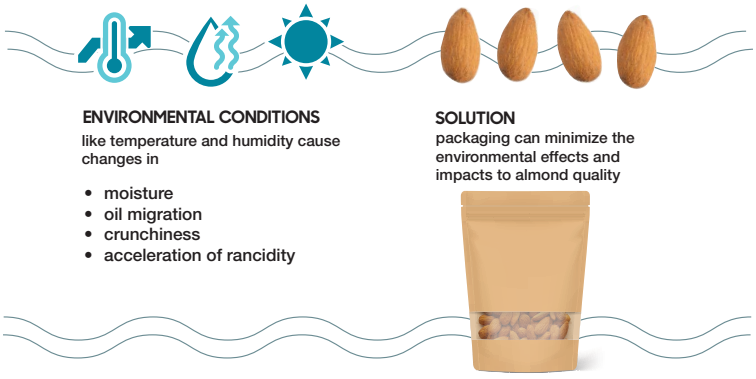
SHELF LIFE POTENTIAL

Unique physical and chemical properties provide great shelf life potential for almonds

Almonds are low-moisture (typically <6% moisture), high-oil-containing nuts with a long shelf life when properly handled.

- Almonds dried or processed to a moisture content of less than 6% undergo minimal biological (bacteria and mold growth) and chemical (browning) activities.
- Almonds have a good fatty acid profile: low in saturated and high in unsaturated fatty acids (S:M:P = 8:66:26). Oleic acid is the dominant fatty acid (monounsaturated: M) and is less prone to oxidation than linoleic acid (polyunsaturated: P).
- Almond kernels have a honeycomb-like cellular structure, and oil droplets are held within subcellular cavities, which protects the oil from oxidation.
- Both the high level of vitamin E in kernel flesh and the flavonoids in kernel skins provide additional protection against oxidation of almond oil.

The shelf life of almonds is influenced by factors such as almond properties, storage temperature, humidity and packaging



Almond quality and shelf life can be influenced by three general factors: the product characteristics, the environment during distribution and storage, and the package. Because these factors interact in many ways, shelf life guidance for almonds should specify the product, storage conditions and packaging.

Almonds can pick up or lose moisture depending on their initial moisture content and the relative humidity (RH) of the surrounding environment. When almonds pick up moisture (absorption), they may lose some of their crunch, mold may start to grow and lipid oxidation increases. Moisture loss (desorption) may lead to some desirable changes, such as more crunch, but at very low moisture lipid oxidation also increases.

Protecting almonds in packaging with good barrier properties limits the interactions between kernels, environmental humidity and oxygen, and will lead to an increased shelf life.

QUALITY IMPACT FACTORS

Texture deterioration and rancidity development

Texture deterioration due to elevated moisture content can be evaluated by measuring:

- Moisture
- Water activity
- Texture parameters

Rancidity development due to oil oxidation can be evaluated by measuring:

- Free fatty acids (FFA)
- Peroxide value (PV)
- Conjugated diene (CD)
- Hexanal and other off-flavor volatiles

SHELF LIFE DETERMINATION RELIES ON BOTH ANALYTICAL TESTING AND SENSORY EVALUATION

No single chemical indicator or sensory attribute should lead to sample rejection.

Note: FFA and PV values may fluctuate based on storage time and conditions—lower levels don't always reflect good quality and may be due to later stages of oil oxidation when both free fatty acids and peroxides are further decomposed. The values should be evaluated in conjunction with product storage history.

Kernel acceptability or rejection by consumers is complex, although texture deterioration and off-flavor rancid notes are two major factors.

- For raw kernels, flavor is the greatest contributor to acceptability, followed by texture changes.
- For roasted kernels, rancidity development and texture changes are significant predictors of overall acceptability.

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TEXTURE DETERIORATION BEGINS WITH INCREASED MOISTURE

Almond moisture levels increase at elevated humidity, leading to texture deterioration and release of free fatty acids that initiate oil oxidation, resulting in rancidity development. High temperatures accelerate textural and chemical changes.

- An online model is available to predict the effects of environmental relative humidity (RH) on almond moisture content and the impact on texture.

MOISTURE MANAGEMENT

Initial moisture and RH of the surrounding environment can affect texture, microbial stability and the shelf life of almonds.

Two simple solutions to stop moisture migration are:

- Moisture-barrier packaging
- Reducing the humidity of the environment in which the almonds are stored

Ideal moisture levels for almonds exist in an environment of 20-55% RH. Studies at the University of California Davis have found:

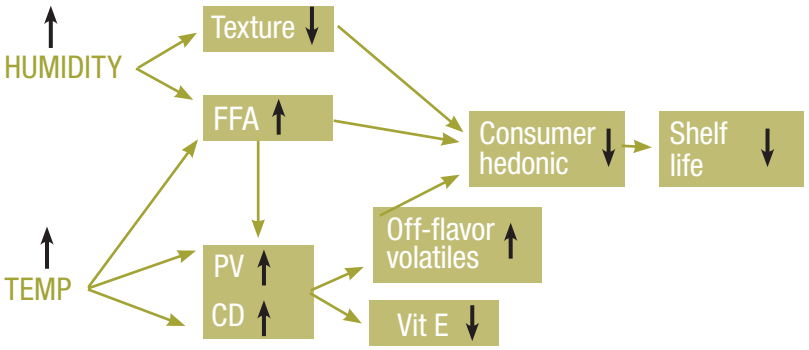
- Whole almond kernels, whether pasteurized or unpasteurized, behave similarly when exposed to different levels of RH, either taking in or giving up moisture.*
- Roasted and blanched almonds respond to environmental RH differently than whole almond kernels.*

Scan code to use the online moisture and texture model

*Taitano, L.Z. and R.P. Singh. 2012. Moisture adsorption and thermodynamic properties of California-grown almonds (varieties: Nonpareil and Monterey). International Journal of Food Studies 1: 61–75.

RANCIDITY DEVELOPMENT INITIATED BY ELEVATED MOISTURE AND ACCELERATED BY HIGH TEMPERATURE

DYNAMIC CHANGES OF CHEMICAL INDICATORS FOR LIPID OXIDATION



Lipid oxidation is a complex series of undesirable reactions that cause the breakdown of fats and oils. In oil-containing foods like almonds, oxidation reactions lead to a loss of quality as the nuts develop "rancid" flavors and odors.

- Oxidation can be measured by testing for the presence or accumulation of one or more of the primary and secondary breakdown products (e.g., peroxides, off-flavor volatiles).
- High storage temperatures, increased moisture, light and some metals (e.g., iron) may promote lipid oxidation in almonds and reduce shelf life.
- Processing also makes almonds more susceptible to oxidation; blanching and cutting increase the surface area exposed to oxygen, and roasting changes the almond microstructure, which allows more oil within the cells to be exposed to oxygen.

STORAGE RECOMMENDATIONS

- Store under cool and dry conditions (<15°C/59°F and <60% relative humidity).
- Maintain almond moisture at 6% or less.
- Avoid exposure to strong odors as almonds can absorb odors of other materials if exposed for prolonged periods.
- Protect from insects and pests.
- To protect roasted products from oxygen exposure, it is recommended to use packaging with oxygen barrier properties paired with vacuum or nitrogen flush packaging methods.
- If kept under cold storage conditions (<5°C/41°F and <60% relative humidity), whole natural almonds can be stored for about two years with no significant loss in quality.

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CROP PROTECTION

California almond growers use a variety of tools and methods to reduce potential damage by pests, while protecting surrounding ecosystems and communities. The result of these grower practices is a safe, high-quality product for consumers and customers around the world. The almond industry has been a leader in funding considerable research that has led to an industry-wide reduction in the use of pesticides and more emphasis on alternative integrated pest management (IPM) practices. The California almond industry has been recognized for awards multiple times for its IPM initiatives by both the U.S. Environmental Protection Agency (EPA) as well as the California Department of Pesticide Regulation (CDPR).

Almonds.com

INTEGRATED PEST MANAGEMENT

IPM focuses on preventive practices first to minimize the opportunities for pests to reach damaging levels. The next step is monitoring for pests and their symptoms as the basis for deciding if and when to use additional chemical or biological control tools. Pest management tools may include mating disruption, cultural or biological controls, beneficial insects and the use of pesticides, when necessary. Newer, more targeted chemicals and biological pesticide options allow almond growers to plan an IPM program that protects not only this year's crop, but also the long-term life of the orchard and surrounding environment. These pest management efforts also help to reduce food waste and optimize resources.

PESTICIDE APPROVAL

Since crop conditions vary every season and across production areas, having a variety of approved tools and methods ensures growers can utilize the most efficient, effective and economical practices. The only pesticides marketed and used by growers in the United States have been evaluated thoroughly by EPA to ensure that they meet federal safety standards to protect human health and the environment. The compounds that meet the requirements are granted a license, or "registration," that permits their sale and use according to specific directions and requirements stated on the product label. Maximum residue limits (MRLs) are established for the pesticides and for the specific crops on which they may be used.

The entire pesticide label must also be approved by the EPA, which provides clear directions for effective use while minimizing exposure to workers and the environment. It is a violation of federal law to use a pesticide in a manner inconsistent with its labeling.

Registrations are reviewed by the EPA at least once every 15 years to account for any new data and in consideration of current safety standards. This process ensures that approved compounds continue to meet the rigorous safety standards established under the law.

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CALIFORNIA GOES BEYOND FEDERAL LAW

For crops grown in California, all pesticides used must also be registered by the California Department of Pesticide Regulation (CDPR). The CDPR maintains a strict system that encompasses product evaluation, product registration, environmental monitoring, residue testing and local use enforcement.

Beyond registration with EPA, pesticide manufacturers who want to distribute their products in California must submit that same data to CDPR for evaluation. CDPR determines whether the chemicals can be safely used—or not used—given the specific and sometimes unique growing and environmental conditions found in California. While this process is similar to the EPA, CDPR may require additional specific data, for example, on worker exposure and environmental effects. Approved pesticides are also subject to periodic reevaluation by CDPR to determine if there have been any changes in the conditions of use or in risks.

Since all U.S. almond production is in California, any compound used on almonds will have undergone this rigorous dual evaluation prior to approval.

FURTHER PROTECTION THROUGH LICENSING, MONITORING AND ENFORCEMENT

Safe, environmentally sound and effective use of pesticides in California is ensured through regulations that require that (1) only licensed professionals can recommend and apply pesticides, and (2) growers and/or their employees who apply pesticides are properly trained and certified. The CDPR oversees licensing and certification of dealers, pest control advisers, pest control businesses and applicators. CDPR delegates both education and oversight responsibilities of pesticide applications to the county Agricultural Commissioners. Their staff have the authority to enter any property at any time, to assess if pesticides are being applied correctly.

Since 1990, the CDPR has required “100% use reporting.” All growers must report every pesticide application they make to the county Ag Commissioners’ office in which they farm. The report must include the name of the product, the amount applied, the size of the treated area, and the date and location of the application. The CDPR compiles these pesticide use reports; the aggregated results are available online at www.cdpr.ca.gov. Application information is not available for individual farms.

Taken together, the use of pesticides by California growers is highly regulated and monitored to protect the health and welfare of growers, workers, the community, the environment and ultimately the consumer.

California’s pesticide use report program is recognized as the most comprehensive in the world.

ALMOND BOARD OF CALIFORNIA PROGRAMS

The Almond Board funds research and works across ag extension, crop advisors and regulators to facilitate adoption of IPM practices. Education and outreach initiatives are focused on ensuring growers have the latest information and tools available to them. The Almond Board annually reviews pesticide use data and pulls samples from every handling facility statewide for pesticide and heavy metals screens. The pesticide survey covers more than 500 compounds, even though there are only about 160 compounds approved for use on almonds. In addition, specialty analyses are done for new compounds or those not covered by the screen.

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VARIETIES & SIZES

There are more than 50 almond varieties grown in California with 12 of those representing 95% of production. All of the varieties grown in California are sweet almond varieties. Almond varieties have traditionally been categorized according to several broad classifications for marketing purposes, based on distinguishing characteristics such as size, shape and "blanchability." The majority of almond production in California falls into the following three major classifications: Nonpareil, California and Mission. It is important to understand that some varieties may fall under more than one classification because they have the size or shape characteristics of one type (such as Mission) but are also blanchable (a characteristic of the California classification). All California almond varieties have been developed using traditional breeding methods; **genetically modified almond varieties are not planted or available in California.**

Inshell almonds are broken down into two types: hard shell and soft shell. When deciding on soft-shell almonds, important considerations are shell thickness and the opening along the seam of the shell (suture).

When purchasing California almonds, it is possible to order either by classification type or by specific variety, depending on what best suits the ultimate usage. Working with your supplier, you will be able to better define your product needs. For example, ordering California type without further information could result in delivery of various almond varieties that also fall under the Mission type, such as the Butte, Padre or Fritz, which may be a different shape than you need for your application.

As new varieties are more widely grown, this traditional classification approach is not as relevant. Please consult with your supplier to better understand how they classify market varieties to ensure you are sourcing the appropriate characteristics needed for your specific application.

NONPAREIL

With the widest range of uses among the marketing categories, Nonpareil are readily blanched (skin removal) and sliced and cut for processed forms. A thin outer shell and smooth kernel allow for easy, blemish-free processing. As a result, Nonpareil are used anywhere an attractive appearance or a strong almond identification is important.

CALIFORNIA

This classification includes varieties that are generally used in manufactured products. California almonds have a wide range of shell hardness, kernel shapes, skin color and surface characteristics. As a result, they are quite adaptable and well suited for nearly any process or application.

MISSION

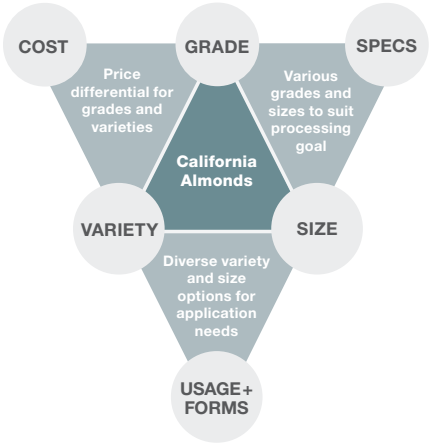
Mission almonds have hard shells, and their kernels are small, wide and often plump. The kernel skin is generally darker than Nonpareil and wrinkled, which enhances salt and flavor adherence.

ALMOND PURCHASING CONSIDERATIONS

FACTOR	PARAMETERS	COMMON TERMINOLOGY
VARIETY	Shape, color, skin texture or smoothness, blanchability	Aldrich, Bennett-Hickman, Butte, Carmel, Fritz, Independence, Monterey, Nonpareil, Padre, Price, Sonora, Supareil, Winters, Wood Colony
SIZE*	Count range of whole almond kernels per ounce (28.35 grams)	18/20, 20/22, 23/25, 25/27, 27/30, 30/32, 32/34, 34/36, 36/40, 34/40, 40/50 or customer-specified range
GRADE	Dissimilar, doubles, chip and scratch, foreign material, particles and dust, split and broken, other defects, and serious defects	U.S. Fancy, U.S. Extra No. 1, U.S. No. 1 (Supreme), U.S. Select Sheller Run (SSR), U.S. Standard Sheller Run (STD), U.S. No. 1 Whole and Broken, U.S. No. 1 Pieces
INSHELL	Shell hardness, shell integrity, suture opening, kernel quality, crack out	Market specific, depending on how inshell will be ultimately sold to consumers, for example: **Traditional:** sold in the shell—semi- or hard shell acceptable, cracked with a mechanical nut cracker **Snack:** sold in the shell—soft shell with greater suture opening to allow seasonings to permeate the shell **Hand Crack:** sold as kernels—soft shell preferred to allow manual cracking

*Individual whole kernel size may vary from year to year as a result of variations in weather, growing conditions and production yields; therefore, availability of specific sizes may be limited in some years.

ALMOND KERNEL SELECTION



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ALDRICH

CLASSIFICATION
California type, Carmel type

SHELL
Soft shell, good shell integrity, fair suture opening

NUT
Medium, narrow shape, slightly wrinkled surface

BENNETT-HICKMAN

CLASSIFICATION
*Not Classified

SHELL
Soft with hard and brittle inner shell, brown color, good shell integrity, fair suture opening

NUT
Medium, flat shape with round top, pale light brown color, surface with a light coarse wrinkle

BUTTE

CLASSIFICATION
California type, Mission type

SHELL
Semi-hard shell, light color, smooth surface, low suture opening

NUT
Small, short plump shape, wrinkled surface

CARMEL

CLASSIFICATION
California type

SHELL
Soft shell, good shell integrity, fair suture opening

NUT
Medium, narrow shape, slightly wrinkled surface

FRITZ

CLASSIFICATION
California type, Mission type

SHELL
Semi-hard shell, good shell integrity, low suture opening

NUT
Small, medium plump shape, fairly wrinkled surface

INDEPENDENCE

CLASSIFICATION
Nonpareil type, California type

SHELL
Soft shell, light color, high suture opening

NUT
Medium, flat shape, smooth surface

MONTEREY

CLASSIFICATION
California type

SHELL
Hard shell, smooth surface, low suture opening

NUT
Large, long narrow shape, deeply wrinkled surface

NONPAREIL

CLASSIFICATION
Nonpareil type

SHELL
Soft shell, light color, high suture opening

NUT
Medium, flat shape, smooth surface

PADRE

CLASSIFICATION
California type, Mission type

SHELL
Hard shell, good shell integrity, no suture opening

NUT
Small, short wide shape, wrinkled surface

PRICE

CLASSIFICATION
California type

SHELL
Soft shell, dark brown color, rough surface, high suture opening

NUT
Small, short narrow shape, fairly wrinkled surface

SONORA

CLASSIFICATION
California type

SHELL
Soft shell, dark brown color, rough surface, high suture opening

NUT
Large, long narrow shape, light color, smooth surface

SUPAREIL

CLASSIFICATION
*Not Classified

SHELL
Semi-soft with flakey outer shell and soft inner shell, light color, good shell integrity, low suture opening

NUT
Medium, flat with a square top, blond color, smooth surface

WINTERS

CLASSIFICATION
*Not Classified

SHELL
Semi-hard with flakey outer shell and tough inner shell, brown color, rough surface, good shell integrity

NUT
Medium, long narrow shape with round pointed belly top, brown color, slightly wrinkled surface

WOOD COLONY

CLASSIFICATION
California type, Carmel type

SHELL
Soft shell, good shell integrity, fair suture opening

NUT
Long and flat medium, narrow shape, slightly wrinkled surface

TYPICAL INSHELL VARIETIES

CARMEL INDEPENDENCE MONTEREY NONPAREIL

USDA Doc. #2023IR0065

* Traditionally, established varieties were classified based on similar characteristics such as shell type, appearance and ease of blanching. With more new and versatile varieties becoming established, traditional classification of these has not been applied. Please consult with your supplier to better understand the attributes of these varieties.

FORMS

California almonds are an exceptionally versatile, value-adding ingredient. Available in more forms than any other tree nut, almonds are an essential ingredient with endless texture and flavor potential in product development across categories. Because they are available in whole, sliced, slivered, chopped, diced and ground forms, with either the skin still on (natural) or removed (blanched), the application opportunities are unlimited. The selection of a particular almond form can vary the appearance, texture, flavor and application potential of the finished product.

California almonds also complement a wide array of food flavors and applications, including confectionery, bakery, dairy, prepared foods and snacks.

Adding almonds as an ingredient, whether it's a snack, a topping on a treat or mixed in with other ingredients, can be a welcome blast of flavor and texture to infuse into everyday eating.

Recommended Forms

Chocolate

- **Natural or blanched, diced, chopped, whole, roasted and unroasted**
- **Consumers surveyed worldwide believe almonds make chocolate more crunchy, nutritious and filling***

*SRG Global Chocolate Study 2022.

Snack Bars

- **Natural or blanched, diced or slivered**
- **Snack bars with almonds garner popularity as they are often viewed as crunchier, more nutritious and tastier**
- **Taste, protein (6 grams per ounce), fiber (4 grams per ounce) and filling are among the main reasons people choose to have snack bars that include almonds**

Snacking

- **Natural or blanched, whole, diced, chopped, slivered, oil or butter/paste**
- **Mix almonds into yogurt or granola, or spread fruit slices with some almond butter**

Visit the recipe center at Almonds.com/Food-Professionals/Recipe-Center for fresh ideas and almond inspiration.

TEXTURE/CRUNCH

California almonds have a hearty, crunchy texture that is retained across a wide range of applications. Entrées, sweets, fruits and creamy dairy products all benefit from the added satisfying crunch of almonds. Some almond forms can also be used to thicken sauces or as a coating for meat and seafood.

CONSUMER POPULARITY

California almonds have broad consumer popularity around the world. Foods that contain almonds, like chocolate and baked goods, are perceived as more upscale and more delicious. Adding almonds also enhances the nutritional profile of foods, offering marketing advantages for today's increasingly health-conscious consumers.

Almonds have also increased in popularity in products that provide a great alternative for some dietary concerns, such as:

- Gluten-free; using almond meal in baked goods
- Lactose-free; almond milk beverages as an alternative to dairy

FLAVOR/TASTE

California almonds blend well with other ingredients. Their subtle buttery taste makes them ideal for seasoning with sweet or savory flavors. Almonds can be roasted by hot air or oil to enhance their flavor and crunch.

AESTHETIC APPEAL

Natural almonds and darker roasted almonds create a beautiful color accent against lighter backgrounds. Blanched almonds contrast wonderfully against colorful foods like chocolates, fruits and vegetables.

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ALMOND VERSATILITY - ALMOND FORMS AND FLAVOR

WHOLE, NATURAL OR BLANCHED

COMMON SPECIFICATIONS

USDA grades for natural almonds; processor or customer specifications for blanched almonds. Roasting brings out a fuller-bodied flavor and aroma.

TYPICAL APPLICATIONS

- Natural, or roasted
- Adds crunch to snacks and trail mixes
- Embedded or enrobed in chocolate, yogurt and flavoring
- Ingredients for confectionery, energy bars, bakery
- Inputs for further processing

SLICED, NATURAL OR BLANCHED

COMMON SPECIFICATIONS

THICKNESS

Thick: 1.5–1.8 mm
Regular: 1.1–1.4 mm
Thin: 0.7–1.0 mm
Extra Thin: 0.5–0.7 mm

TYPICAL APPLICATIONS

- Alternative to whole almonds, for a visual premium appeal
- Applications that require a softer crunch
- Topping for salads and cereals
- Ingredient for cereal and snack bars
- Coating for savory dishes
- Garnishing for baked goods, desserts

SLIVERED, BLANCHED

COMMON SPECIFICATIONS

THICKNESS

Regular: 3.0–5.0 mm
Medium: 4.0–6.0 mm

TYPICAL APPLICATIONS

- Roasted or flavored snacks to add crunch appeal
- Ingredient for baked goods, cereal
- Texture for confectionery
- Topping for prepared foods, salads
- Trail mixes and granola

DICED, NATURAL OR BLANCHED

COMMON SPECIFICATIONS

Large: 28/18.....28/64" & 18/64" (11.1 & 7.1mm)
Medium: 22/8.....22/64" & 8/64" (8.7 & 3.2mm)
Small: 12/8.....12/64" & 8/64" (4.8 & 3.2mm)
Fine: 8/0.....8/64" (3.2mm)

TYPICAL APPLICATIONS

- Topping for dairy items, baked goods
- Coating for ice cream bars
- Filling for bakery or confectionery
- Crust for meats, seafood

MEAL OR FLOUR, NATURAL OR BLANCHED

COMMON SPECIFICATIONS

- Coarse ground
- Fine ground

(Grinders and screens determine particle size)

TYPICAL APPLICATIONS

- Important in European-style bakery, fine ground used in delicate pastries like macarons
- Gluten-free bakery
- Coating for fried foods
- Sauce thickener
- Adds texture to crusts, crackers and baked goods
- Can be substituted in part for wheat flour in breads

PASTE & ALMOND BUTTER, NATURAL OR BLANCHED

TYPICAL APPLICATIONS

- Alternative to other nut butters
- Binder and filling in bars, confectionery and bakery items
- Marzipan
- Almond paste in bakery provides a chewy texture to applications
- Spreads or dips
- Used to drizzle or decorate bars and cookies
- Smoothies

OIL

COMMON SPECIFICATIONS

Cold pressed, light, and pale amber color

TYPICAL APPLICATIONS

- Salad dressings and cold dishes
- Non-food (e.g., cosmetics, moisturizer)

ALMOND MILK

TYPICAL APPLICATIONS

- Beverage, sweetened, unsweetened fortified or blended with other dairy alternatives
- Used as a base for plant-based ice cream, yogurt, cheese
- Dips and spreads
- Smoothies

NEW

DEFATTED ALMOND FLOUR OR POWDER

Finely ground almond flour from which varying percentages of the oil has been removed. The resulting flour has fewer calories and fat and a higher relative percentage of protein and dietary fiber content per serving.

TYPICAL APPLICATIONS

Used to add density to bars, in crusts and as a binder. Ideal where water solubility is desired. Great for vegan applications.

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ALMOND FLAVOR

Almond kernel varieties and ingredient forms create unique textures and flavors, offering limitless formulation opportunities. With almonds, product developers can complement other ingredients without overshadowing other flavors and enrich the textural profile of food formulations.

California only grows sweet varieties of almonds. The dominant flavor comes from amygdalin, which is broken down during chewing to release benzaldehyde contributing to almonds' familiar sweet, marzipan[1] taste.

There are other compounds known as volatile organic compounds (VOCs) contributing to almond flavor. The VOCs in raw and roasted almonds are different and can be used by product developers to create specific flavor combinations.

OVER 50 VOCS IDENTIFIED IN RAW ALMONDS[2]

KEY FLAVOR COMPOUNDS IN RAW ALMONDS	AROMA
Benzaldehyde	Sweet, marzipan
3-methyl-butanol	Alcohol, fruity, whiskey, banana
3-methyl-2-butenol	Fruity, green, lavender
Benzyl alcohol	Floral, phenolic

The roasting process changes the almonds' flavor profile. In roasted almonds, the clean, nutty fresh-roasted flavor drives consumer liking. The Maillard reaction—a form of browning—and lipid oxidation during roasting are two reactions that generate new volatile compounds, changing the flavor profile of roasted almonds from that of raw almonds.

OVER 90 VOCS IDENTIFIED IN ROASTED ALMONDS

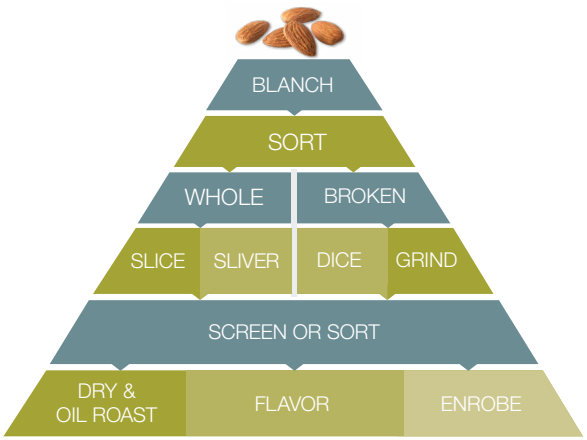
KEY FLAVOR COMPOUNDS IN ROASTED ALMONDS	AROMA
2 & 3-methyl-butanol	Fruity, chocolate, nutty, malty
2,5 -dimethylpyrazine	Coffee, roasted, nuts, cocoa
3-methylpyrazine	Chocolate, roast, nutty
Acetoin	Sweet, buttery cream

With numerous ingredient forms, kernel varieties and flavors to unlock, almonds can take your next innovation to new levels.

For more resources on almond formulation, inspiration, nutrition and more, visit Almonds.com/Food-Professionals.

ALMOND PROCESSING OPTIONS

PROCESS	PRIMARY STEPS	GENERAL DESCRIPTIONS
BLANCH	Scalding, skin removal, drying, cooling, sorting	Almond skins are peeled off after the kernels are scalded in 90°C–100°C water for 2–5 minutes. Kernels are dried by hot air and then cooled to ambient temperature.
SLICE/SLIVER	Plasticizing (heat to soften kernels), cutting, drying, cooling, screening	Almond kernels are made pliable by dry or steam heat prior to being cut by blades into different forms. The cut product is dried and cooled to ambient temperature and then screened for sizing.
DICE/GRIND	Cutting, screening	Almond kernels are diced or ground, then screened for particle sizes.
ROAST	Dry heat or oil roasting, cooling	Almond kernels are roasted by either hot air at a temperature of 130°C–145°C or oil at a temperature of 130°C–170°C for varying times, depending on application needs.
SORT/SCREEN	Electronic or manual sorting; round-hole screens with different diameters	Defects and foreign material are removed prior to further processing. Screens in varying sizes are used throughout processing for uniformity and sizing of the product.



1. Luo et al. (2018), Acta Hortic. 1219: 1-8. King et al. (2019), J Agric. Food Chem 67: 3229-3241
2. Xio et al. (2014), Food Chem, 151: 31-39. Luo et al. (2018), Acta Hortic. 1219: 1-8

 USDA Doc. #2023IR0065

INSHELL ALMONDS

Inshell almonds are those with the kernel contained in the intact shell, with the outer hull removed. Not all varieties, growing practices and/or markets are applicable when it comes to inshell almonds.

A grower's decision to market or sell their product as kernel versus inshell almonds starts with varietal selection and cultural practices, and ends with their marketing decision in conjunction with their handler. A grower must ensure low insect damage in the orchard as inshell deliveries cannot be sorted out for insect damages in the same manner as shelled almonds (kernels). Finally, when it comes time to harvest, it is of critical importance that the moisture content is monitored/controlled for optimal inshell creation during the hulling process. The grower has to ensure prompt drying without rainfall or wet exposure to avoid discoloration of the shell and timely fumigation to stop infestation of insect damage.

PROCESSING FOR INSHELL

The amount of inshell created/sold comes down to a number of different factors, which is why it is of vital importance to understand the almond production realities along with the market expectation.

The huller/sheller is where field run almonds (in-hull almonds) are processed into either shelled almonds (kernels) or inshell almonds. Even for deliveries that are intended to be made into inshell, 100% inshell creation is not possible as inevitably some shelled almonds (loose kernels) are developed during the hulling process. The loose kernels may not be a factor in those markets where the shelling process will be done after arrival at the destination, but they may preferable to the importers of inshell almonds that will go directly into a snack roasting process. Inshell almonds tend to have 4 to 8 months longer shelf stability compared to kernels under the same storage conditions.

VARIETAL CHARACTERISTICS FOR INSHELL ALMONDS

Certain varietal characteristics are important to inshell almond formation. Soft-shell almond varieties are typically prized for higher crackout percentages. The crackout percentage is the kernel weight percentage relative to the weight of the inshell almond.

CRACKOUT PERCENTAGE =
(KERNEL WEIGHT / INSHELL ALMOND WEIGHT) * 100

Higher crackout percentages over 70% are usually preferred by markets where the inshell almonds will be cracked out prior to consumption in the marketplace. Soft-shell, semi-hard shell and hard-shell varieties may be good or acceptable for markets where almonds are presented to consumers in inshell form. Open or closed-shell is another varietal characteristic that may be important for some applications. If almonds are to be roasted inshell prior to consumption, a more open shell may be desired. In some situations a process called corking can be employed where a portion of the shell is removed to open it up while still retaining the inshell almond form.

The table on the following page has been created to help highlight the relationships between varietal selection, farming practices, harvest decisions, market use and others when it comes to inshell almonds.

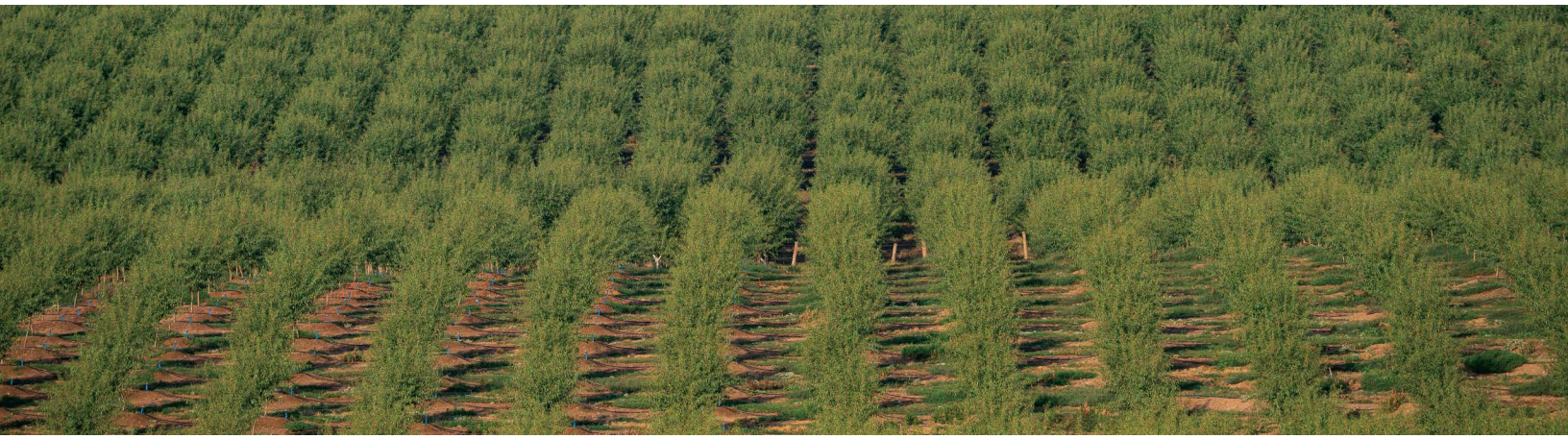
INSHELL AND KERNEL COMPARISON

NONPAREIL

MONTEREY

QUALITY CHARACTERISTICS FOR TWO DISTINCT INSHELL MARKETS

	For Shelling	For Snacking or Roasting
Crackout Rate	High	Medium to High
Loose Kernels	Acceptable	Not Acceptable
Good Inshell Shape	No Preference	Preferred
Open Corked Suture	No Preference	Preferred
Suitable Varieties	Soft Shell	Soft Shell, Semi-Hard Shell
Stain or Mold on Shells	Not Preferred	Not Preferred
Empty Shells	Not Preferred	Not Preferred
Under-developed Inshell	Not Preferred	Not Preferred
Defected Kernels	Sortable	Fewer Means to Remove
Good Kernel Shape	Desirable	Not Critical
Orchards of Low Infestation	Desirable	Critical
Prompt Fumigation to Stop Infestation	Desirable	Critical



 USDA Doc. #2023IR0065

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ALMOND NUTRIENT COMPARISON

Almonds are an excellent source of Vitamin E, magnesium, manganese, copper and riboflavin, and a good source of fiber and phosphorus. A one-ounce serving has 13 grams of "good" unsaturated fats, just 1 gram of saturated fat and is always cholesterol-free.

NATURAL BENEFITS FOR HEALTH, TEXTURE AND FLAVOR

POSITIVE ATTRIBUTES OF ALMONDS FOR PRODUCT DEVELOPMENT

Whether they are roasted, blanched or in their natural state, almonds are an essential ingredient for product developers with endless texture and flavor potential and various nutritional attributes based on how they are prepared. Almonds have been studied extensively for their benefits on heart health, diabetes and weight management.

Utilizing almonds as an ingredient can help deliver premium appeal and "better-for-you" claims to snacking applications. They are a nutritious and natural food that have many benefits for a healthy diet, offering 6 grams of power-packed protein, 4 grams of fiber, 13 grams of unsaturated fat and only 1 gram of saturated fat in one serving.[1] As plant-based eating increasingly becomes a consumer lifestyle, manufacturers can utilize almonds' amino acid profile in combination with complementary plant proteins, like legumes, to develop delicious products that offer complete protein.

CALCULATING COMPOSITION

The U.S. Department of Agriculture (USDA) has been responsible for analyzing the nutrient content of the nation's food supply for over 120 years. The first U.S. food composition tables were published in 1891 by W.O. Atwater and C.D. Woods, who compiled the water, fat, protein, ash and carbohydrate contents of approximately 200 different foods.

Since 1999, Almond Board of California has submitted high-quality nutrient composition data to USDA for California almonds. These data are reflected in the National Nutrient Database for Standard Reference Legacy Release (SR Legacy), which has been the major source of food composition data in the U.S. for decades and provides the foundation for most public and private sector food composition databases. SR Legacy is part of FoodData Central, USDA's new and harmonized portal for food and nutrient profile data.

Almond roasting emphasizes the natural attributes of almonds—deepening the color and flavor profile, and creating crispier, crunchier texture. Blanched almonds have had their skins removed through a process of scalding, skin removal, drying, cooling and sorting. Roasting brings out the flavor and color of blanched almonds while natural almonds have the well-known nutty flavor and are suitable for all-around use.

The Almond Board of California's nutrition research program has over three decades of research in the key areas of skin health, heart health, protein quality and more.

Please visit Almonds.com for more information.

See the chart on the reverse side for nutrient comparisons on all almond forms

1. USDA: One ounce or 23 almonds contains 6 grams of protein, 4 grams of fiber, 13g of unsaturated fat and only 1g of saturated fat.

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ALMOND FORMS[1]

NUTRIENT COMPARISON CHART

Nutrients (per 100 g)	UNITS	WHOLE KERNELS[2]	BLANCHED[3]	OIL ROASTED SALTED[4]	OIL ROASTED UNSALTED[5]	DRY ROASTED SALTED[6]	DRY ROASTED UNSALTED[7]
PROXIMATES							
Calories	kcal	579	590	**607**	**607**	598	598
Water	g	4.41	**4.51**	2.80	2.80	2.41	2.41
Protein	g	14	19	13	17	**22**	20
Lipids (total)	g	49.93	52.52	**55.17**	**55.17**	52.54	52.54
Dietary Fiber	g	**12.5**	9.9	10.5	10.5	10.9	10.9
Sugars	g	4.35	4.63	4.55	4.55	**4.86**	**4.86**
Ash	g	2.97	2.91	**3.13**	**3.13**	3.07	3.07
MINERALS							
Calcium (Ca)	mg	269	236	**291**	**291**	268	268
Iron (Fe)	mg	3.71	3.28	3.68	3.68	**3.73**	**3.73**
Magnesium (Mg)	mg	270	268	274	274	**279**	**279**
Phosphorus (P)	mg	**481**	**481**	466	466	471	471
Potassium (K)	mg	**733**	659	699	699	713	713
Sodium (Na)	mg	1	19	**339**	1	234	3
Zinc (Zn)	mg	3.12	2.97	3.07	3.07	**3.31**	**3.31**
Copper (Cu)	mg	1.03	1.03	0.96	0.96	**1.10**	**1.10**
Manganese (Mn)	mg	2.18	1.84	**2.46**	**2.46**	2.23	2.23
VITAMINS							
Vitamin E (alpha-tocopherol)	mg	25.63	23.75	**25.97**	**25.97**	23.90	23.90
Thiamin	mg	0.21	**0.19**	0.09	0.09	0.08	0.08
Riboflavin	mg	1.14	0.71	0.78	0.78	**1.20**	**1.20**
Niacin	mg	3.62	3.50	**3.67**	**3.67**	3.64	3.64
Pantothenic acid	mg	**0.47**	0.31	0.23	0.23	0.32	0.32
Vitamin B6	mg	**0.14**	0.12	0.12	0.12	**0.14**	**0.14**
Folate, food	mg	44	49	27	27	**55**	**55**
FATTY ACIDS							
Saturated (total)	g	3.80	3.95	**4.21**	**4.21**	4.09	4.09
16:0 Palmitic	g	**3.80**	3.27	3.30	3.30	3.35	3.35
18:0 Stearic	g	0.70	0.67	**0.91**	**0.91**	0.70	0.70
Monounsaturated (total)	g	31.55	33.42	**34.79**	**34.79**	33.08	33.08
16:1 Palmitic	g	0.23	0.24	0.22	0.22	**0.26**	**0.26**
18:1 Oleic	g	31.29	33.11	**34.58**	**34.58**	32.75	32.75
Polyunsaturated (total)	g	12.33	12.37	**13.52**	**13.52**	12.96	12.96
18:2 Linoleic	g	12.32	12.37	**13.52**	**13.52**	12.95	12.95

1. U.S. Department of Agriculture, Agricultural Research Service. 2019. FoodData Central. National Nutrient Database for Standard Reference Legacy Release (SR Legacy). Available at: https://fdc.nal.usda.gov.
2. SR Legacy: Nutrient Database (NBD) No. 12061 Nuts, almonds; updated 2013.
3. SR Legacy: NBD No. 12062 Nuts, almonds, blanched [skin removed]; updated 2010.
4. SR Legacy: NDB No. 12565 Nuts, almonds, oil roasted, with salt added; updated 2001.
5. SR Legacy: NBD No. 12065 Nuts, almonds, oil roasted, without salt added; updated 2006.
6. SR Legacy: NBD No. 12563 Nuts, almonds, dry roasted, with salt added; updated 2016.
7. SR Legacy: NBD No. 12063 Nuts, almonds, dry roasted, without salt added; updated 2013.

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