

ABOUT THIS HANDBOOK

This handbook is a compilation of all-things-California Prunes as it relates to nutrition research and more. From the history of the California Prune, to the latest research on prunes and bone and digestive health, to cooking and baking ideas, this handbook is designed to be your go-to source for California Prune information.





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Introduction



WONDERS WORTHY OF PASSION

California Prunes are so well-known for good digestive health that it's hard to believe they could be good for anything else. But, in fact, California Prunes embody all kinds of wonders worth getting excited about.

For starters, there's no better place on earth to grow prunes than the lush valleys of California, where the trees reach into soils nourished by ancient rivers and up to an endless sun. Generations of farmers have brought a rigor to cultivating those trees that surpasses the most stringent agricultural oversight of any nation.

In the process they have created one of the most expertly tended growing regions in the world. The result is an extraordinary and consistent fruit that is then dried in a process perfected by California growers. As the prunes rest in climate-controlled tunnels for precise periods of time and at exacting dehydration levels, a flavor unlike any other prune in the world emerges.

It's that one-of-a-kind flavor that makes California Prunes so enjoyable and brings such a fresh taste to savory dishes or a sweet and creamy nuance to baked goods.

California Prunes have zero fat, sodium, cholesterol or added sugar, but they're famous for their fiber, which promotes a healthy gut microbiome. They also have copper, vitamin K, and polyphenols, which act as antioxidants. Best of all, new research suggests that eating five to six California Prunes every day helps support good bone health.

Whether you're a health professional, or just a fan, it makes you wonder:

What exciting things will California Prunes do next?



ABOUT CALIFORNIA PRUNES

California Prune growers have invested more than 150 years in perfecting the growing and harvesting techniques required to deliver the ultimate premium crop recognized throughout the world for its legendary flavor and quality. The combination of fertile soil and temperate climate has contributed to making California the world leader in agricultural production of prunes. California produces 99% of the United States' and 43% of the world's supply of prunes, a convenient, healthy snack for today's busy lifestyle.

ABOUT THE CALIFORNIA PRUNE BOARD

Since 1952, the State of California has had a Marketing Order for California Dried Plums (California Prunes) that conducts global promotion and directs nutrition and crop research on behalf of California's approximately 800 prune growers and 28 prune handlers under the authority of the Secretary of Food and Agriculture.

CALIFORNIA PRUNES AND NUTRITION RESEARCH

The California Prune Board established a nutrition advisory panel in 1997 and continues to lead the way in supporting scientifically rigorous research on the nutritional and health benefits of incorporating California Prunes into the diet. Key areas of research include: digestive health, bone health, managing hunger/satiety and microbial changes in the gut. Research indicates prunes may be one of the most valuable foods to be top of mind when describing healthful eating patterns.



California Prunes:

PRUNES 101



HISTORY OF CALIFORNIA PRUNES

Prunes are a fruit with an ancient heritage. Western Asia, specifically an area near the Caucasus Mountains bordering the Caspian Sea, is the recorded point of origin. From there, prunes were carried west and eventually found their way into Southern, Central, and Western Europe as well as the Balkans, where they have thrived ever since.

ALTHOUGH ALL PRUNES ARE PLUMS, NOT ALL PLUMS CAN BE PRUNES.

Only certain varieties have the qualities necessary to be effectively dehydrated, turning them into prunes. California Prunes are the “Improved French” variety of plums. This variety is an offshoot of La Petite D’Agen, a plum native to Southwest France. Plum trees were introduced to North American soil in 1856 by Louis Pellier, a French nurseryman who came to California in 1848 in search of gold. After his unsuccessful mining venture, he purchased land in the fertile Santa Clara Valley in 1850 and went back into the nursery business. The original D’Agen plum graft stock was in the selection he bought back to California in 1856. By 1900, prune orchards in California covered approximately 90,000 acres.

Today, there are about 46,000 production prune orchard acres concentrated in the Sacramento and San Joaquin valleys. Revered as part of California’s rich history, the prune remains a vital player in California’s economic wealth.



LIFE CYCLE OF A CALIFORNIA PRUNE



FROM WINTER REST TO SUMMER SUN

The prune tree is deciduous, which means that it goes dormant during the winter months. But this “quiet time” for the trees gives growers a chance to ensure that the tree is growing optimally, by controlling fruit size and maintaining a healthy growth pattern.

When spring comes, 46,000 acres of California orchards are covered in a fragrant blanket of white prune blossoms. But after just a week, the blossoms drift to the ground and the orchards’ palette shifts to a deep chartreuse as new fruit forms and leaf buds burst.

During the summer, California gets very little rain, so growers irrigate the orchards using modern methods and technology to ensure efficient use of water. By using precision irrigation instead of relying on rain, the growers have more control over the quality of the fruit. They give the trees just the amount of water they need to top off what’s available underground.

IN THE ORCHARD

When growers plant a prune tree, they have a four- to six-year wait before they see the fruits of their labor. Even then, a tree needs 8 to 12 years in the ground before it reaches full production capacity of 150 to 200 pounds of raw fruit per year. At that point, an orchard can look forward to about two decades of commercial productivity, during which time it produces the fine-quality California Prunes that consumers know and love.



THE TIME IS RIPE

By mid-August, the orchards are ready for harvest, which usually takes about 30 days. Prunes are tree-ripened so growers determine harvest time by checking fruit firmness and sugar content with a tool called a light refractometer.

Once upon a time, growers smoothed and softened the soil beneath the trees and let the prunes drop before gathering them to take to the dehydrator. This method required three to four “pickings” to strip an orchard completely of fruit.

In order to become more efficient and deliver consistent top-quality fruit, harvesting today is done by machines. A mechanical shaker grabs a tree’s trunk and, in a matter of seconds, shakes the fruit onto a receiver that catches the fruit and then conveys it into a large bin. From there, it’s a quick ride for the bins to the dehydrator.

DRIED, PACKED AND READY TO GO

Processors waste no time transferring their freshly harvested fruit to the dryers, where three pounds of fresh fruit become one pound of prunes. After the fruit is washed and placed on large wooden trays, the fruit is dehydrated in a craft-like sequence of carefully controlled and strict sanitary operations that maximize premium taste and texture while ensuring product consistency and safety. Super-sensitive thermostats keep temperatures under tight control to yield the uniform high-quality fruit that make California Prunes famous.

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From the dehydrator, the prunes go to state-of-the-art packing plants, where trained personnel inspect them, grade them for size and store them ahead of final processing and packaging. Because prunes store best at 21% moisture, post-harvest dehydration targets this level. There they remain, in storage facilities, until needed for further processing.

Unlike the majority of dried fruits, prunes are packed to order, which means that they are rehydrated, steam pasteurized and put through a final inspection before being packaged for shipping. This is the standard procedure whether the order calls for 25- or 30-pound bulk cases or the 1- to 2-pound packages of California Prunes frequently seen on grocery store shelves.



PRODUCTS, AVAILABILITY AND STORAGE

California Prunes are a very versatile fruit available in retail stores in various forms including whole prunes, pitted prunes, diced prunes and prune juice.

Prunes are typically packed in bags, cartons and canisters. Prunes can usually be found with other dried fruits in the produce section, the canned fruit section or the baking section. Prunes are ready-to-eat right from the package as a healthful snack or can be used as a versatile cooking or baking ingredient, often pureed and used to enhance flavor or lower the fat and calorie content as an alternative to other ingredients. They do not require refrigeration but once a package has been opened, it should be resealed and stored under cool, dry conditions. Sealing the unused prunes in an airtight container and storing them in the refrigerator will also help keep them moist and juicy.

Prune juice is typically available in bottles and cans and is found in the juice section of the grocery store.



California Prunes:

NUTRITION FACTS



THE BASICS

For under 100 calories, a serving of 4 prunes has:

- 3 g fiber (11% Daily Value)**
 At 3 g per serving, prunes are a good source of fiber. Fiber has been identified by the Dietary Guidelines Advisory Committee (DGAC) as a nutrient of public health concern, as under-consumption of fiber has been linked to unfavorable health conditions.
- 280 mg potassium (6% Daily Value)**
 Potassium was also identified by the DGAC as a nutrient of concern. Potassium helps muscles contract (including the heart), regulates water and mineral balance, and may play a role in maintaining healthy bones.
- 23 mcg of vitamin K (20% of the Daily Value)**
 Prunes are an excellent source of vitamin K, which is important for blood clotting and bone metabolism.
- No added sugar.
- No cholesterol, no sodium and no fat.
- Prunes also have magnesium, riboflavin, niacin and B6, which contribute to a nutritious diet when eaten consistently over time.

The Nutrition Facts label is based on the U.S. Department of Agriculture, Agricultural Research Service, FoodData Central, 2019 found at fdc.nal.usda.gov. Values have been rounded to reflect current regulations. Nutrition Facts labels for branded products may differ. Throughout this handbook unless otherwise noted, 4 prunes are considered a serving.

Nutrition Facts	
Varied Servings Per Container	
Serving size	4 prunes (38g)
Amount per serving	
Calories	90
	% Daily Value*
Total Fat 0g	0%
Saturated Fat 0g	0%
Trans Fat 0g	
Cholesterol 0mg	0%
Sodium 0mg	0%
Total Carbohydrate 24g	9%
Dietary Fiber 3g	11%
Total Sugars 14g	
Includes 0g Added Sugars	0%
Protein 1g	
Vitamin D 0mcg	0%
Calcium 20mg	2%
Iron 0.4mg	2%
Potassium 280mg	6%
Vitamin A 10mcg	2%
Vitamin C 0mg	0%
Vitamin K 23mcg	20%
Riboflavin 0.1mg	8%
Niacin 0.9mg	6%
Vitamin B6 0.1mg	6%
Pantothenic Acid 0.2mg	4%
Magnesium 15mg	4%
Copper 0.1mg	10%
Manganese 0.1mg	4%

*The % Daily Value (DV) tells you how much a nutrient in a serving of food contributes to a daily diet. 2,000 calories a day is used for general nutrition advice.

DIETARY FIBER

At 3 g per serving, California Prunes are a good source of dietary fiber and provide both soluble and insoluble dietary fiber.

Dietary fiber is a complex carbohydrate that is found only in plant foods and is made up of many sugar molecules bound together in a way that they cannot be broken down by digestive enzymes. Dietary fiber is considered a nutrient of public health concern because most Americans fail to meet the recommended Daily Value of 28 g per day, based on a 2,000 calorie per day diet.

The role of fiber in health includes benefits on risk factors for cardiovascular disease, weight management, immune function, and the overall health of the digestive tract, including laxation. These benefits may be related to the combined protective nutrients found along with fiber in fruits, vegetables, whole grains, nuts, seeds and legumes.

CARBOHYDRATES AND SUGARS

A serving of 4 prunes (38 g) has 24 g of total carbohydrate that provide energy, 14 g of naturally occurring sugars (slightly less than 10 g glucose and 5 g fructose) and almost no sucrose per serving. Prunes have no added sugars and about 6 g of sorbitol (a sugar alcohol) per serving. (Stacewicz-Sapuntzakis M. et al 2013).

GLYCEMIC INDEX (GI) AND GLYCEMIC LOAD (GL)

Prunes have a low glycemic index (GI) of 29. The presence of fiber and sorbitol in prunes may contribute to this low GI. (Foster-Powell K, Holt S, Brand-Miller J. International table of glycemic index and glycemic load values. Am J Clin Nutr.2002: 76; 5–56).

The glycemic index (GI) measures the impact of carbohydrate foods on raising blood sugar levels. The glycemic index (GI) measures, over a two-hour period, an individual's response to eating a carbohydrate-containing food (usually 50 grams of available carbohydrates) compared to the individual's response to the same amount of carbohydrates from either white bread or glucose. Carbohydrate foods are then classified as high (above 70), intermediate (56–69), or low (0–55) GI (Foster-Powell 2002).

The glycemic load (GL) of a food is determined by multiplying the glycemic index by the amount of carbohydrates per serving and then dividing by 100. The GL of California Prunes per 60-gram serving is 10 based (Foster-Powell 2002). Low GI foods are thought to help stabilize blood sugar and insulin response. Research continues on the benefits of consuming diets with a low glycemic load (GL) in managing diabetes, cardiovascular disease, cancer and obesity.



POLYPHENOLS, BIOACTIVES, AND ANTIOXIDANT FUNCTION

Beyond their basic nutrient composition, plants produce a variety of compounds that have biological activities with potential to improve health. Polyphenols are among the major classes of these plant phytochemicals. Neochlorogenic and chlorogenic acids are the dominant phenolic compounds in prunes (Donovan et al 1998).

Polyphenols in prunes are thought to be among the compounds that contribute to prunes' role in bone health through their antioxidant or anti-inflammatory properties. Phenolic compounds are the main source of antioxidants in prunes. The term "antioxidant" refers to the ability to decrease or slow damage to cells caused by the formation of free radicals, unpaired, unstable electrons that can begin certain disease processes when they bombard healthy cells seeking a pair. Antioxidants give up electrons to free radicals thus making them more stable. Antioxidant intake has been associated with lowering chronic disease risk.

The body produces free radicals when metabolizing food but external sources (sun, environment, cigarette smoke) can result in exposure to free radicals. The body has its own internal antioxidant system but there are many different antioxidant compounds in foods including vitamins C, E, carotenoids, and minerals such as selenium. Other non-nutrient compounds include polyphenols, compounds that contribute to a food's color, taste, bitterness and other sensory flavors, and are thought to be responsible for a major portion of the antioxidant capacity in plant-based foods.

California Prunes:

NUTRITION
RESEARCH





CALIFORNIA PRUNES, DIGESTIVE AND GUT HEALTH

Maintaining digestive health is an important component of overall well-being. Prunes contribute to digestive health in several ways through the provision of dietary fiber, sorbitol and polyphenols with the potential to change the gut microbiome.

Prunes are the only natural, whole fruit to achieve the following authorized health claim in Europe: Prunes contribute to normal bowel function when 100 g (about 10) are eaten daily (European Food Safety Authority). Research also suggests that eating 80 g (about 8) prunes may offer the same desired effect (Lever E et al 2018).

Responses to a bowel habits questionnaire used in research with postmenopausal women eating 0 g, 50 g or 100 g of prunes for 6 months indicated that moderate consumption had no undesirable changes in bowel function. Constipation ratings were higher in the control group, suggesting that prunes

may decrease discomfort associated with bowel movements (Shamloufard P, Kern M, Hooshmand et al 2016).

Research with subjects with chronic constipation compared the effects of prunes (50 g twice daily) with psyllium (11 g daily) matched for 6 g of fiber, and discovered that prunes were safe, palatable and “more effective than psyllium for the treatment of mild to moderate constipation and should be considered as first line therapy.” (Attaluri A, Donahoe R, Valestin J, Brown K, Rao S. et al 2011).

A randomized control trial in healthy adults with low fiber intake looked at the effect of prunes on the gut microbiota in addition to other gastrointestinal functions. Participants were randomized into a control group (0 prunes), 80 g or 120 g prunes. There was an increase in Bifidobacteria in the 120 g prune group although there were no significant changes in

the other bacteria measured. (Lever E et al 2018). Bifidobacteria are considered beneficial and are thought to confer positive health effects. Hence Bifidobacteria often are the targets for prebiotics, complex carbohydrates that resist digestion in the small intestine and reach the colon where they are fermented by the gut microflora. More research is needed to explore California Prunes’ influence on the gut microbiota and potential to function as a prebiotic.

Research discovered that rats fed a prune diet, at levels equivalent to a 40 g serving, had fewer precancerous colon cancer lesions (aberrant crypt foci) than rats fed the control diet (Seidel D, Hicks K, Taddeo S, Azcarate-Peril M, Carroll R, Turner N. et al 2015).

The prune-fed rats also had different distributions of colonic microbiota. Subsequent analysis discovered

numerous differences in these compounds based on the location in the colon, the diet (control or prune) and the interaction between the location and diet. Some of the compounds endogenous to prunes were found in animals fed the prune diet but were not detected in the control animals. These included sugar alcohols (mannitol/sorbitol), sugar derived metabolites and other plant-associated compounds. Animals fed the prune diet also had an increase in microbially-derived metabolites suggesting that consumption of the whole fruit delivered a unique combination of prune bioactives to the colon. These results suggest that prunes - either through their endogenous compounds or through microbially-derived metabolites - change the colon environment, which may have contributed to the reduction of precancerous lesions seen in the earlier work (Seidel D, Taddeo S, Azcarate-Peril M, Carroll R, Turner N. et al 2017).

California Prunes for Better Bones

It's never too early—or too late—to start thinking about nutrition and exercise for healthy bones.

FOR UNDER 100 CALORIES, A SERVING OF 4 PRUNES HAS:

- 3 g fiber (11% of the Daily Value)
- 280 mg potassium (6% of the Daily Value)
- 23 mcg of vitamin K (20% of the Daily Value)
- No added sugar, cholesterol, sodium or fat
- Contains vitamins and minerals, potassium, copper, and boron, which may have bone protective qualities

RESEARCH SUGGESTS ...

Five to six prunes per day **may help prevent bone loss** in post-menopausal women.¹

90% of peak bone mass is acquired by **age 18 in girls and 20 in boys.**³

Bone injuries are among the most common sport-related injuries for children.⁴

Kids/Teens

Do **60 minutes** of moderate to vigorous activity every day to maintain healthy bodies and build strong bones.⁵



Bone development reaches a maximum around **age 30.**⁶

20s/30s

Do **30 minutes** of weight bearing **4x /week** activities to maintain muscle mass and preserve bone strength.⁷

4x /week

1 in 2 women and up to **1 in 4 men** over 50 will break a bone due to osteoporosis.⁸



40s/50s

Keep moving **4-5 days** a week to maintain strength.



Women can lose **up to 20%** of their bone density 5-7 years after menopause.⁹

60s & Beyond

1 in 5 women develops osteoporosis by age 70.¹⁰



WWW.CALIFORNIAPRUNES.ORG



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CALIFORNIA PRUNES AND BONE HEALTH

Prunes' role in promoting bone health is an active area of preclinical and clinical research in models of hormone deficiency, aging and exposure to certain types of radiation. Strong, healthy bones are the foundation for lifelong vitality and independence. The bone mass attained early in life—around age 30 or so—is an important determinant of bone health throughout aging. Prunes have nutrients reported to influence bone health including boron, potassium and vitamin K. Prunes' phenolic compounds are thought to inhibit bone resorption and stimulate bone formation as well as function as antioxidants.

Reviews summarizing the current knowledge on prunes and bone health noted that although the exact mechanism for the protective effects of prunes remains to be determined, it is thought that the additive and/or synergistic effects of prunes' bioactive phenolics and nutrients are partly responsible (Wallace TC. et al 2017; Arjmandi

B, Johnson S, Pourafshar S, Navaei N, George K, Hooshmand S, Chai S, Akhavan N. et al 2017). Preclinical animal and cell studies suggest that prunes and/or their extracts enhance bone formation and inhibit bone resorption through their actions on cell signaling pathways that influence osteoblast and osteoclast differentiation and are consistent with clinical studies that show that prunes may exert beneficial effects on bone mineral density (BMD).

CLINICAL TRIALS IN POSTMENOPAUSAL WOMEN

A 3-month study in 58 postmenopausal women discovered that 100 g (10-12) prunes (75 g dried apple comparative control) resulted in borderline significant increases in biomarkers of bone turnover (Arjmandi BH, Khalil DA, Lucas EA, Georgis A, Stoecker BJ, Hardin C, Payton ME, Wild RA. et al 2002).

A year-long study measured changes in bone mineral density in 100 osteopenic, postmenopausal women consuming 100 g prunes or 75 g dried apple as the comparative control. Participants also received 500 mg calcium and 10 ug vitamin D. Both dried fruit interventions resulted in positive changes from baseline in ulna, spine, femoral neck, total hip and whole-body BMD. However, increases in BMD in the ulna and spine were significantly greater in the prune group compared to dried apple control (Hooshmand S, Chai S, Saadat R, Payton M, Brummel-Smith K, Arjmandi B. et al 2011).

A 6-month randomized control trial in 48 older (ages 65-79) osteopenic, postmenopausal women discovered that consumption of 50 g (about 5-6) prunes may be as effective as 100 g in preventing bone loss in this age group. All participants received 500 mg calcium and 10 ug vitamin D. Total body, hip and lumbar BMD were evaluated at baseline

and at 6 months. Biomarkers of bone metabolism and inflammation were also measured at baseline, 3 and 6 months. Both doses of prunes provided bone-protective effects in that there was no net change from baseline in total BMD while the control group continued to lose bone. There was slight but non-significant improvement in lumbar BMD but no detectable differences in the ulna and hip between the groups. Both doses of prunes resulted in lower levels of TRAP 5b, a marker of bone resorption. Thus, results suggest that the bone-protective effects may be attributed to the inhibition of bone resorption with the concurrent maintenance of bone formation (Hooshmand S, Kern M, Metti D, Shamloufard P, Chai S, Johnson S, Payton M, Arjmandi B. et al 2016).

Preliminary findings in a very small follow up study of postmenopausal women who consumed 100 g prunes for one year suggest retention of BMD with prunes. Of the 100 women who completed the initial

clinical trial, 20 returned for a follow-up visit: 8 from the prune group and 12 from the dried apple group. Those in the prune group retained BMD of the ulna and spine to a greater extent than those in the dried apple group after 5 years even though they reported no longer regularly consuming prunes. (Hooshmand S, Chai S, Saadat R, Payton M, Brummel-Smith K, Arjmandi B. et al 2011; Arjmandi B, Johnson S, Pourafshar S, Navaei N, George K, Hooshmand S, Chai S, Akhavan N. et al 2017). Overall diet and physical activity were not evaluated in this study and further research is needed to study the extent to which bone density is retained following the cessation of an intervention with prunes.

FINDINGS FROM ANIMAL STUDIES

Results in rodent models suggest that prunes can prevent the loss of bone during aging, restore bone that has been lost, promote attainment of peak bone mass, and protect bone from exposure to certain types of radiation.

Investigators fed adult and old male mice either a normal diet or diets with 0%, 15% or 25% prune powder by weight for 6 months to determine whether the loss of bone with aging can be prevented and replaced. Bone mass and structure were examined before, during, and after dietary intervention. The diet with 25% prune increased bone volume above basal levels by nearly 50% in the adult and 40% in the old mice and also replaced bone that had already been lost due to aging. Although both adult and old mice responded to the prune intervention, the effects were greatest in the adult mice. The adult, but not the old mice, also gained bone on the 15% prune diet (Halloran B, Wronski T, VonHerzen D, Chu V, Xia X, Pingel J, Williams A, Smith B. et al 2010).

Research also looked at whether 5%, 15% or 25% prune powder by weight could increase bone volume prior to peak bone mass in young, growing mice. Results discovered that bone volume increased by 25%, 49% and 94% respectively. The highest prune intervention – 25% - represents about 20 prunes for humans. The authors noted that because aging seems to blunt response, the equivalent of about 4 prunes a day may be expected to have beneficial effects on bone in children (Shahnazari M, Turner R, Iwaniec U, Wronski T, Li M, Ferruzzi M, Nissenson R, Halloran B. et al 2016).

Investigators looked at the bone-preserving role of prunes when animals were exposed to ionizing radiation, which can increase oxidative damage in skeletal tissues. Such exposure is experienced by astronauts in space, and those receiving radiation therapy as part of treatment for cancer. In this animal study, the interventions included an antioxidant cocktail (vitamins C, E and selenium along with other known antioxidants); dihydrolipoic acid, ibuprofen, and prunes at 25% weight of the diet. The prune intervention was the most effective in reducing undesired bone marrow cells' responses to radiation compared to the other interventions. In addition, mice on the prune diet did not exhibit bone volume loss after radiation exposure (Schreurs A, Shirazi-Fard Y, Shahnazari M, Alwood J, Truong T, Tahimic C, Limoli C, Turner N, Halloran B, Globus R. et al 2016).

Based on the bone-preserving properties of prunes' polyphenols in postmenopausal women and animals, researchers evaluated whether prunes could alleviate the destruction of joints associated with rheumatoid arthritis using transgenic mice that overexpress tumor necrosis factor (TNF), an

inflammatory mediator. The research also included a cell study to investigate the anti-inflammatory effect of neochlorogenic acid. According to the Arthritis Foundation, rheumatoid arthritis (RA) is an autoimmune disease in which the body's immune system mistakenly attacks the joints. This creates inflammation causing tissue that lines the inside of joints (the synovium) to thicken, resulting in swelling and pain in and around the joints (Arthritis.org).

Compared to transgenic mice on a regular diet, four weeks of a 20% prune powder diet protected joint bones from destruction in the transgenic mice. This was associated with fewer cells responsible for bone resorption. Neochlorogenic acid, the major polyphenol in prunes, down-regulated the TNF-induced inflammatory mediators in human synovial fibroblasts, which suggests, according to the investigators, that neochlorogenic acid is the bioactive compound in prunes that controls inflammation mediated signaling of osteoclastogenesis. The authors also noted that prunes' bioactive polyphenols effects on bone anabolism require further study (Mirza F, Lorenzo J, Drissi H, Lee F, Soung D. et al 2018).

POSSIBLE MECHANISM AND BIOACTIVE COMPOUNDS

While the exact mechanism – or mechanisms – by which prunes support bone health is not thoroughly understood, existing research suggests several possibilities linked to prunes' nutrient composition and polyphenolic bioactive compounds, which probably act synergistically. Hydroxycinnamate acids represent 98% of the polyphenols currently identified in prunes, with neochlorogenic acid the most abundant (Donovan et al 1998).

Two separate studies were undertaken to identify the most bioactive polyphenolic fractions of prunes on osteogenic activity and their activity under normal and inflammatory conditions. Six fractions of polyphenolic compounds were prepared from a crude extract of prune powder. In each subsequent experiment, 6 polyphenol fractions were tested on cell lines to see which had the greatest potential to either increase the differentiation and function of osteoblasts or decrease differentiation and activity of osteoclasts compared to the control. Initial screening revealed that two fractions had the greatest osteogenic potential. Of the polyphenols known in prunes – chlorogenic acid, cryptochlorogenic acid, neochlorogenic acid, caffeic acid, quinic acid, o-coumaric acid, m-coumaric acid, ferulic acid, cyanidin3-rutinoside, cyanidin 3-glucoside, quercetin, rutin, sorbic acid, and 5-hydroxymethyl-2 furaldehyde - only cryptochlorogenic acid, neochlorogenic acid, and rutin were detected in the 2 fractions.

The identified polyphenol fractions were used on bone marrow from mice under normal and inflammatory conditions (by the addition of TNF- α) to further test their effects on expression of genes and proteins involved in osteoclast and osteoblast differentiation and mineralization. Although both fractions were able to suppress osteoclast differentiation and activity, one fraction appeared to have a more robust effect, especially under inflammatory conditions. Both fractions also enhanced osteoblast activity. Treatment with the fractions resulted in a trend for the maintenance of mineralization in the inflammatory environment to the level of the control. However, a higher dose of the fractions or a combination of the fractions might



be needed to protect the differentiating osteoblasts from the detrimental effects of TNF- α (Graef J, Rendina-Ruedy E, Crockett E, Ouyang P, Wu L, King J, Cichewicz R, Lin D, Lucas E, Smith B. et al 2017) (Graef J, Rendina-Ruedy E, Crockett E, Ouyang P, King J, Cichewicz R, Lucas E, Smith B. et al 2017).

Research investigating the ability of prunes' polyphenols, vitamin K and potassium to restore bone in an aged, postmenopausal osteopenic animal model found that the most pronounced effect on restoring bone loss occurred when prunes' polyphenols were combined with vitamin K and potassium to levels consistent to the amount in whole prunes. The polyphenol extract from prunes

was the primary component responsible for 60 to 80% of the effect on bone.

Although the study did not focus on the mechanism by which the extract influenced bone, the authors noted that the polyphenols likely contributed to prunes' antioxidant and anti-inflammatory properties and/or act at the cellular level to increase early bone cell activity at formation and breakdown. (Graef JL, Ouyang P, Wang Y, Rendina-Ruedy E, Lerner MR, Marlow D, Lucas EA, Smith BJ. et al 2018).

Q&A WITH BONE HEALTH EXPERT, DR. SHIRIN HOOSHMAND

Shirin Hooshmand, Ph.D., researcher and associate professor at San Diego State University, specializes in nutrition research related to bone and cartilage health. A research consultant to the California Prune industry, many of her studies examine the effect of prunes on bone health.

Q: How did you become interested in bone health?

A: Nutrition plays an essential role in bone health. Bone loss may be prevented, repaired and reversed using nutrition. My research focuses mainly on prevention and reversal of bone loss.

Q: What are common bone health conditions?

A: Osteoporosis is a bone disease that occurs when the body loses too much bone, makes too little bone, or both. Osteoporosis is more typical among the elderly and more common in women due to lower estrogen levels after menopause. Osteopenia refers to bone density that is lower than normal peak density, but not low enough to be considered osteoporosis. Approximately 44 million people in the United States suffer from either osteoporosis or osteopenia due to hormonal problems, medications, genes and other issues.

Q: Can you speak to the nutritional attributes of California Prunes?

A: California Prunes have a variety of nutrients that make them unique. Among other traditional dried fruits, only prunes are high in vitamin K. They are also a source of manganese, magnesium, copper and potassium. The nutrients and vitamins in California Prunes combine to benefit bone health.

Q: Have California Prunes shown favorable results specific to osteoporosis?

A: As we age, we begin to lose bone density, but we may be able to delay and repair bone density loss through nutrition. Several clinical studies have shown that 50 – 100 grams of prunes per day can prevent bone loss in women with low bone density (osteopenia).^{1,2,3}

Q: What is the most exciting finding that your research has revealed about California Prunes?

A: To date, the most exciting findings are from human studies conducted among post-menopausal women. Post-menopausal women lose 1 – 1.5 percent of their bone density per year, but studies show that women who eat prunes daily are actually able to *maintain* their bone density and *prevent* additional loss.^{1,2,3}

Q: What is the one thing you wish more people knew about California Prunes – but, don't?

A: I don't think many people are aware of all of the health benefits of California Prunes. I wish people understood that California Prunes are an amazing fruit and may positively impact bone health beginning at an early age. If people would try California Prunes, I know they – and their bones – would love them!

1 <https://www.ncbi.nlm.nih.gov/pubmed/26902092>

2 <https://www.ncbi.nlm.nih.gov/pubmed/21736808>

3 <https://www.ncbi.nlm.nih.gov/pubmed/28505102>

CALIFORNIA PRUNES SATIETY AND WEIGHT MANAGEMENT

Prunes are a good source of fiber and have a low Glycemic Index which can help manage weight through improved satiety and helping keep blood sugar levels stable. Food intake patterns, particularly those that promote satiety without increasing overall caloric intake, play an important role in energy balance and weight management.

Population studies reported that the equivalent of 1/8 cup dried fruit intake was associated with lower body weight measures and abdominal obesity (Keast DR, O'Neil CE, Jones JM. et al 2011).

A short-term cross-over study involving healthy men and women investigated whether a preload including prunes consumed as a snack before a meal, compared to an isoenergetic and equal weighed bread product preload would: have greater short-term effect on satiety measured by subsequent *ad libitum* meal intake; induce greater satiety as assessed by visual analogue scales (VAS); and reduce the appetite for dessert offered shortly after lunch. When participants consumed the preload that included prunes, they consumed less amount of dessert and had lower total energy intake at the meal. Feelings of hunger, desire and motivation to eat as measured by VAS were lower at all time points between the snack and the meal. Participants also had a small energy intake at the lunch and ate less of the chocolate cake dessert. Since the

macronutrient content of both preloads were similar, the investigators noted that the satiating power of prunes could be due to their fiber content (Farajian P, Katsagani M, Zampelas A. et al 2010).

Healthy women 25-54 years of age participated in a study that assessed responses to two snack choices (prunes and a popular low-fat cookie) matched for macronutrient and sugar contents but differing in fiber. The study measured satiety, subsequent food intake, blood glucose level, insulin and ghrelin responses. Although there was no difference in post-snack consumption between the trials, the satiety index was higher after the prune snack and the rise in plasma glucose and insulin was lower (Furchner-Evanson A, Petrisko Y, Howarth L, Nemoseck T, Kern M. et al 2010).

Although not the primary outcome in a study in postmenopausal women investigating prunes' role in digestive health, women who ate 80 g or 120 g of prunes daily for 4 weeks reported no gain in weight (Lever E et al 2018).

CALIFORNIA PRUNES AND HEART HEALTH

Prunes' nutrient profile can help support heart health. A cholesterol-free food, with no fat, sodium, or added sugars, prunes' soluble fiber can help manage serum cholesterol levels and potassium can help blunt the effects of sodium in the diet.

Men with moderately elevated cholesterol levels experienced a reduction in both total and LDL cholesterol after eating 100 g (10-12) prunes daily, providing about 6-7 g of dietary fiber (Tinker LF, Schneeman BO, Davis PA, Gallaher DD, Waggoner DR. et al 1991).

A mouse study that used prune powder (equivalent to 10-12 prunes) significantly reduced atherosclerotic lesions in the aorta. There was no change in cholesterol levels, suggesting that prunes had a direct effect on the progression of the disease in ways other than lowering cholesterol. Additional research is needed to determine the cause of this effect (Gallaher C, Gallaher D. et al 2009).

A short-term (2 week) cross-over study in adult women investigated the incorporation of two snacks daily of prunes or a low-fat cookie (100 kcal matched) on total energy, nutrient intake and biochemical parameters. Neither snack altered energy intake or weight. Total fat and dietary cholesterol intake tended to decrease with prune consumption and compared to cookies, prunes promoted significantly greater intake of fiber, potassium, riboflavin, niacin, and calcium. Plasma triglycerides remained unchanged with prune consumption but was significantly higher after 2-weeks consumption of the low-fat cookies. Although both snacks provided about the same amount of carbohydrates (27 g prunes; 24 g low-fat cookies), which might raise serum triglyceride levels, elevations were detected only during low-fat cookie consumption phase. The authors noted that prunes' fiber and other nutritive components might have prevented the rise in triglyceride levels compared to the refined carbohydrate snack (Howarth L, Petrisko Y, Furchner-Evanson A, Nemoseck T, Kern M. et al 2010).



CALIFORNIA PRUNES AND DENTAL HEALTH

Tooth decay depends on diet, nutrition, microbial infection and host response. Dental plaque bacteria serve as the important etiologic agent in the formation of dental caries. Food particles and sugar (sucrose) trapped on the surfaces of teeth may serve as ready sources of fermentable carbohydrates by plaque bacteria, which promote acid production that leads to demineralization of enamel and eventually tooth decay.

Prunes have almost no sucrose and sorbitol is not metabolized by the cariogenic bacteria. Research at the College of Dentistry, University of Illinois at Chicago, measured the effect of prune consumption on plaque pH compared to other common snack foods (e.g. other fruits, cookies). Results from this pilot study indicated that prunes did not lower plaque pH to the critical level that would increase the risk of caries due to demineralization (unpublished report to the CDPB).

Foods perceived as sticky – such as dried fruit – often are considered more cariogenic than those that do not stick to the teeth, but some research indicates no correlation between stickiness and retention of foods on teeth. A review that explored the research around the role of dried fruit, the retention of dried fruit including prunes and potential for adverse effects on dental health found a lack of consistent data and suggested more research to ensure evidence-based practice recommendations (Sadler MJ. et al 2016).



OTHER BENEFITS

For a review of prune composition and health benefits, see Stacewicz-Sapuntzakis M. et al 2013.

The review provides detailed information and references on the following:

- Vitamins and minerals
- Antioxidants
- Phenolics
- Metabolites of phenolic compounds
- Composition of some commercially available prune products
- Gastrointestinal health
- Bone health
- Diabetes and atherosclerosis
- Reduction of cancer risk
- Neurological function



California Prunes:

CULINARY
VERSATILITY



COOKING WITH CALIFORNIA PRUNES

California Prunes = Flavor + Versatility

Whether they're whole, diced or puréed, there are endless ways to cook and bake with California Prunes. From sweet to fermented, California Prunes are versatile enough to be used in a myriad of culinary applications. The versatility is due to a rich, deep flavor complexity and a unique natural sweetness that can easily incorporate into many uses without overpowering the other elements in the flavor profile.

The moist fruit has different textures depending upon its packaging. California Prunes purchased from bulk bins tend to be chewier and more suited for culinary applications that demand more structure. Packaged California Prunes may tend to be softer and less structured. It is these elusive components that California Prunes bring to a dish that is not possible to replicate with any other dried fruit. California Prunes can play an essential role in bringing out the inherent best of the other ingredients they are paired with.



EASY CALIFORNIA PRUNE PURÉE

INGREDIENTS:

- 1 1/3 cups pitted California Prunes
- 6 tablespoons hot water

DIRECTIONS:

1. In food processor, process prunes and water until puréed.
2. Use to add moisture and richness to both savory and sweet dishes.
3. Cover and refrigerate up to 1 month.



California Prunes pair very well in recipes that utilize rich and complex flavor notes, and they add depth to items such as espresso, chocolate and chilies.

DARK EARTHY TOASTY COOKED			
CALIFORNIA PRUNES AND ...	TASTING NOTES	CALIFORNIA PRUNES AND ...	TASTING NOTES
WALNUTS	Earthy Tannins Bitter Fatty	MISO	Fermented Salty Sweet
DARK CHOCOLATE	Bitter Tannins Sweet Earthy Deep	CRAFT BEER	Fermented Sweet Bitter Umami
PROSCIUTTO	Salty Fatty Creamy Umami	OLIVE OIL	Bitter mouthfeel Fatty Peppery
GINGER	Earthy Spicy Winter Zingy	SQUASH	Earthy Neutral Sweet Vegetal Autumnal

The fruit's earthy, umami qualities pair with salty, acidic, and fermented ingredients such as olives, capers, vinegar and tamari – perfectly juxtaposing and bringing out the very essence of those flavors.

BRIGHT CONTRASTING FRESH			
CALIFORNIA PRUNES AND ...	TASTING NOTES	CALIFORNIA PRUNES AND ...	TASTING NOTES
OLIVES	Salty Briny Umami Green	MINT	Fresh Herbal Spicy Green
FETA	Tart Salty Creamy Briny Umami	GRAPEFRUIT	Sour Bitter Citrus Bright Fresh
POMEGRANATE	Astringent Sharp Fresh Zingy	PASSIONFRUIT	Sharp Sweet Fruity Fresh
BITTER GREENS (ENDIVE)	Bitter Fresh Green	PRESERVED LEMON	Citrus Salty Bright Bitter



Seasonal Recipes:

**CALIFORNIA PRUNE
BREAKFAST OAT
PUDDING**

**BY LESLIE BONCI,
MPH, RDN, CSSD, LDN**

Yield: 2 servings | Serving Size: 1/4 cup

INGREDIENTS:

- 1/2 cup oats, dry
- 1 cup water
- 1/4 cup finely chopped California Prunes
- 1 tablespoon almond butter
- 1/4 teaspoon ground ginger
- 1/8 teaspoon grated orange peel
- 1/2 cup non-fat vanilla Greek yogurt
- 1 teaspoon maple syrup
- 1 tablespoon sliced almonds

DIRECTIONS:

1. Mix oats, water, ginger and 3 tablespoons of the prunes together.
2. Microwave on HIGH for 2 minutes.
3. Remove from microwave.
4. Stir in the almond butter, Greek yogurt, maple syrup and orange peel and blend well.
5. Top with the remaining 1 tablespoon of prunes and 1 tablespoon of sliced almonds.
6. Enjoy!

Per serving (1/4 cup): Calories: 473, Fat: 14 g, Carbohydrates: 72.5 g, Dietary Fiber: 8.8 g, Protein: 20.1 g, Sugars: 27.1 g



Seasonal Recipes:

**GUACAMOLE
WITH POACHED
CALIFORNIA
PRUNES**

**BY JACKIE NEWGENT,
RDN, CDN**

Yield: 8 servings | Serving Size: 1/4 cup

INGREDIENTS:

- 8 California Prunes, diced
- 1 cup 100% California Prune or apple juice
- 2 1/2 tablespoons fresh lime juice (divided)
- 2 Hass avocados, peeled, pitted, and cubed
- 1/4 cup finely diced red onion
- 1 small jalapeño pepper, with some seeds, minced
- 3 tablespoons chopped fresh cilantro
- 1 clove garlic, minced (optional)
- 1/2 teaspoon sea salt
- 1/4 teaspoon ground coriander
- 1/4 teaspoon ground cumin

DIRECTIONS:

1. Add the diced prunes, prune juice, and 1 tablespoon of the lime juice to a small saucepan. Bring to a simmer over medium heat. Let simmer until the prunes are softened and juicy, about 5 minutes. Drain the prunes through a mesh strainer and let stand in the strainer for at least 15 minutes to fully drain and cool. Reserve the juice for other culinary purpose.
2. To a medium bowl, add the avocados, onion, jalapeño, cilantro, garlic (if using), salt, coriander, cumin, and the remaining 1 1/2 tablespoons lime juice. Gently stir (do not smash avocado) until just combined. Add the prunes and gently stir until evenly combined. Adjust seasoning, and serve.

Per serving (1/4 cup): Calories: 90, Fat: 5 g, Cholesterol: 0 mg, Sodium: 150 mg, Carbohydrates: 11 g, Dietary Fiber: 3 g, Protein: 1 g, Sugars: 5 g

*Seasonal Recipes:***FARRO WITH CALIFORNIA PRUNES, ROASTED BUTTERNUT SQUASH AND PECANS****BY JACKIE NEWGENT, RDN, CDN***Yield: 6 servings | Serving Size: 1 cup***INGREDIENTS:**

- 10 California Prunes, thinly sliced (3 ounces)
- 3 tablespoons apple cider vinegar
- 1/4 cup extra-virgin olive oil (divided)
- 1 1/2 teaspoons sea salt (divided)
- 1 1/2 cups uncooked farro or whole grain of choice
- 4 cups butternut squash cubes (about 1/2-inch)
- 3 scallions, thinly sliced, green and white parts separated
- 1/2 cup packed thinly sliced fresh basil
- 1/4 cup packed chopped fresh flat-leaf parsley
- 1/3 cup pecan pieces or pine nuts, preferably pan-toasted

**DIRECTIONS:**

1. In a medium bowl, whisk together the apple cider vinegar, 2 tablespoons of the olive oil, and 1 teaspoon of the salt. Set aside.
2. Add the farro to 5 cups of cold water in a large saucepan and bring to a boil over high heat. Reduce heat to low, cover, and cook according to package directions until tender. (Note: Cooking time will vary.) Drain well of excess liquid through a fine mesh strainer. Add the cooked farro and sliced prunes to the apple cider mixture; stir to combine and set aside.
3. Meanwhile, heat the remaining 2 tablespoons of olive oil in a large cast iron or other stick-resistant skillet over medium heat. Add the butternut squash cubes and remaining 1/2 teaspoon of salt and cook while stirring occasionally until just-tender and lightly browned, about 15 minutes. Add the white part of the scallions and cook while stirring occasionally until the scallions are lightly browned, about 3 minutes. (Note: Do not over stir to prevent squash from getting mushy.)
4. Add the butternut squash cube mixture and scallion greens to the farro mixture. Gently stir. Adjust seasoning.
5. Stir in the basil, parsley, and pecans and serve warm or at room temperature. Alternatively, chill the farro mixture, then stir in the basil, parsley, and pecans, and serve cool.

Per serving (1 cup): Calories: 330, Fat: 14 g, Cholesterol: 7.5 mg, Sodium: 610 mg, Carbohydrates: 40 g, Dietary Fiber: 8 g, Protein: 8 g, Sugars: 8 g



Seasonal Recipes:

PURPLE POWER SMOOTHIE WITH CALIFORNIA PRUNES

BY CARISSA GALLOWAY, RDN

Yield: 1 serving | Serving Size: 1 cup

INGREDIENTS:

- 1/4 cup diced California Prunes
- 1 cup baby spinach leaves
- 1/2 cup plain Greek yogurt
- 3/4 cup pomegranate juice
- 1/2 cup frozen berries (can be a mixture of berries or just strawberries)
- 1 teaspoon honey
- 1 cup ice

DIRECTIONS:

1. Add all ingredients into a blender except ice.
2. Purée until smooth.
3. Add ice until you achieve desired consistency.
4. Enjoy!

Per serving (1 cup): Calories: 370.6, Fat: 3.2 g, Cholesterol: 7.5 mg, Sodium: 88.6 mg, Carbohydrates: 76.9 g, Dietary Fiber: 7 g, Protein: 14.2 g, Sugars: 56.9 g, Potassium: 764.7 mg



Seasonal Recipes:

SPICY LENTIL CHILI WITH CALIFORNIA PRUNES

BY JACKIE NEWGENT, RDN, CDN

Yield: 6 servings | Serving Size: 1 cup

INGREDIENTS:

- 1 tablespoon avocado or sunflower oil
- 1 small or 1/2 medium red onion, diced
- 1 medium green bell pepper, diced
- 1 jalapeño pepper, minced
- 2 large garlic cloves, minced
- 1 tablespoon chili powder
- 1/2 teaspoon ground cinnamon
- 1 1/4 cups dry brown lentils (8.5 ounces)
- 1 (15-ounce) can diced, no-salt-added fire-roasted tomatoes
- 4 cups vegetable broth (32 fluid ounces)
- 12 California Prunes, finely diced (3.5 ounces)
- 1/4 cup roughly chopped fresh cilantro leaves and tender stems

DIRECTIONS:

1. Heat the oil in a large saucepan over medium-high heat. Add the onion, bell pepper, and jalapeño and cook while stirring until the onion is lightly browned, about 8 minutes. Add the garlic, chili powder, and cinnamon and cook while stirring until fragrant, about 30 seconds.
2. Add the lentils, tomatoes (with liquid), and broth and bring to a boil over high heat. Partially cover, reduce heat to medium-low, and simmer until lentils are just-tender, about 25 minutes.
3. Remove lid, stir in the prunes, and cook while stirring occasionally until desired consistency, about 3 to 4 minutes. Adjust seasoning.
4. Ladle into small bowls, sprinkle with the cilantro, and serve.

Per serving (1 cup): Calories: 240, Fat: 3 g, Cholesterol: 0 mg, Sodium: 580 mg, Carbohydrates: 45 g, Dietary Fiber: 7 g, Protein: 12 g, Sugars: 12 g

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