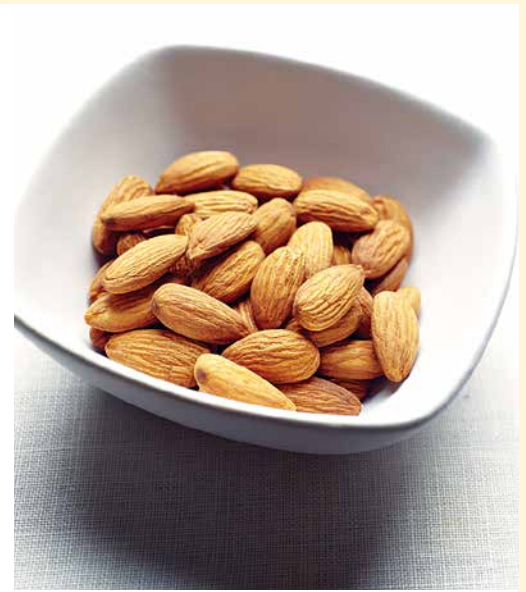




ALMONDS: NUTRITION AND SCIENTIFIC RESEARCH

UPDATED AUGUST 2015



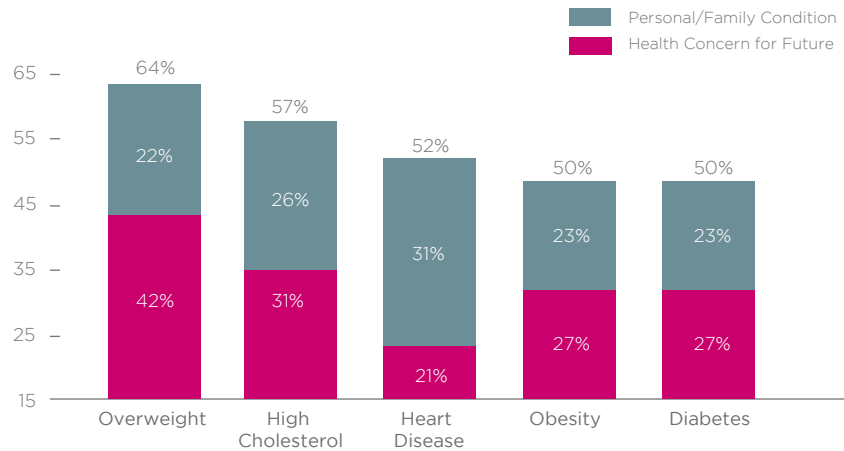
ALMONDS: NUTRITION AND SCIENTIFIC RESEARCH

For two decades, Almond Board of California has invested in sound science to better understand the nutrient composition and health benefits of almonds. The ever-expanding body of almond nutrition research totals 120 scientific publications to date, in areas including heart health, digestive health, weight management, diabetes prevention and treatment, and nutrient composition. Growing interest in weight management and smart snacking has prompted a shift in emphasis from the well-established body of evidence on heart health toward weight management and satiety research to support

a healthy, active lifestyle. (See Figure 1.)

The powerful nutrient package of almonds—low on the glycemic index and providing six grams of plant-based protein, four grams of filling dietary fiber, 13 grams of unsaturated fats¹ and important vitamins and minerals including vitamin E (35% DV), magnesium (20% DV) and potassium (6% DV) per one-ounce serving—makes them an ideal fit for heart-healthy, weight-wise diets and a deliciously easy way to snack smarter.

Figure 1: Concerns about health condition
(n = 5,500 global consumers)



Source: Almond Board Global Perceptions Study, 2013.

Question: For the following health concerns, please indicate how impacted you are by each. (select all that apply.)

1. U.S. Dietary Guidelines recommend that the majority of your fat intake be unsaturated. One serving of almonds (28 grams) has 13 grams of unsaturated fat and only 1 gram of saturated fat.



ALMONDS: A HEART-SMART SOLUTION

NEARLY TWO DECADES OF RESEARCH SHOWS THAT ALMONDS CAN HELP MAINTAIN A HEALTHY HEART AND CHOLESTEROL LEVELS.

Although heart disease remains the number one cause of death in the United States and worldwide, it is estimated that at least 80% of premature deaths from cardiovascular disease can be avoided if diet and lifestyle risk factors are controlled? Diet is integral to managing cardiovascular risk, and nearly two decades of research support the role of almonds in helping to maintain a healthy heart. In fact, the U.S. Food and Drug Administration says that scientific evidence suggests, but does not prove, that eating 1.5 ounces of almonds as part of a diet low in saturated fat and cholesterol may reduce the risk of heart disease!

Many randomized controlled studies have been conducted to examine the relation of eating almonds to heart-health markers, such as total and LDL cholesterol, HDL cholesterol, blood pressure, abdominal fat and inflammation.

ALMONDS AND CHOLESTEROL

The research supporting the role of almonds in heart health began in 1992, with the first study demonstrating that an almond-based diet (with 100 grams or 3.5 ounces of almonds

PROTEIN
6g

VITAMIN E
7.3mg
35% DV

FIBER
4g
16% DV

UNSATURATED FATS
13g

POTASSIUM
200mg
6% DV

MAGNESIUM
77mg
20% DV



1 OZ = 23 ALMONDS



per day) improved cholesterol levels.³ This landmark study helped set the stage for the almond nutrition research program and provided compelling evidence that despite their high fat and calorie content, almonds could be included as part of a heart-healthy diet. A second foundational study, conducted in 30 adults with high cholesterol, found that 3.5 ounces of almonds per day lowered LDL (bad) cholesterol while maintaining HDL (good) cholesterol.⁴ Test meals were partially provided in these studies.

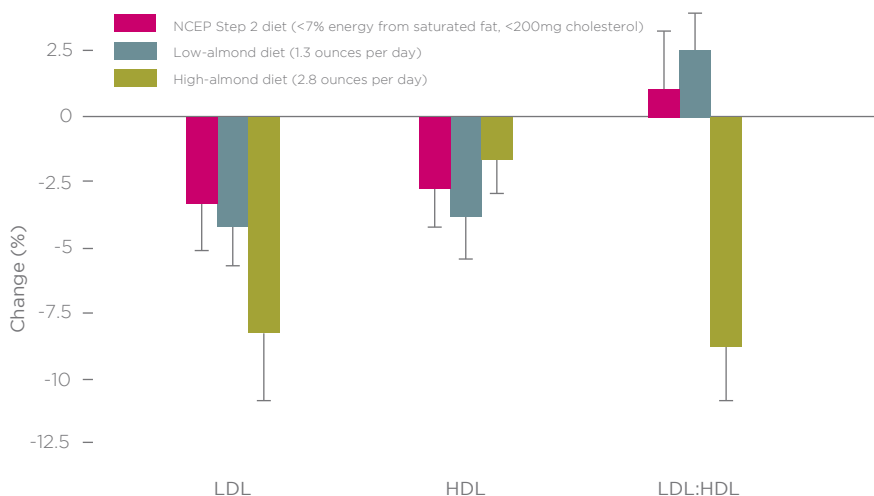
In the majority of studies of people with high cholesterol, the daily consumption of 1 to 4 ounces of almonds per day resulted in significant reductions in total and LDL cholesterol levels.^{4,5,6} In one study, 27 adults with high cholesterol ate heart-healthy diets with one of three snacks over a three-month period: 2.8 ounces of almonds, 1.3 ounces of almonds or a low-saturated-fat whole-wheat muffin as a daily snack⁵ (See Figure 2.) Researchers found that participants lowered LDL cholesterol an average of 4.4% with the 1.3-ounce portion of almonds and 9.4% with the 2.8-ounce portion. These results suggest there is a “dose effect” of almonds on cholesterol levels—that

higher intakes are associated with greater cholesterol-lowering effects. Another year-long crossover study on 81 U.S. adults (43 men and 38 women, age ~49 years, BMI ~25 kg/m²) found that daily consumption of usual diet plus 52 grams (~1.8 oz) per day of almonds for six months without any additional dietary advice vs. their usual diet without almonds improved both TC:HDL and LDL:HDL ratios. Participants with high cholesterol levels showed greater response in changes in total cholesterol, LDL and TC:HDL and LDL:HDL ratios than those with normal cholesterol levels.⁷

Most recently, a four-week randomized analysis of previously collected data from 27 adults with elevated LDL showed that eating almonds daily as part of a healthy diet improved participants’ serum fatty acid profiles and reduced estimated (based on the Framingham equation) 10-year coronary heart disease risk scores by 3.5%.⁸ Limitations included lack of randomization in the diet order and lack of control over external factors that may have affected dietary behaviors over the course of the study⁷, and a relatively high drop-out rate and potential confounding of MUFA intake.⁸

Research has also investigated the effects of almonds as part of a group of cholesterol-lowering foods including plant sterols and soluble fiber. This diet, known as the Portfolio Eating Plan, consists of a National Cholesterol Education Program (NCEP) “Step 2” diet (saturated fat less than 7% of calories; less than 200 mg cholesterol) plus almonds (30 g or 1 oz per day) viscous fiber (~20 grams per day) such as oats, barley, psyllium, legumes, eggplant and okra; vegetable protein (~80 grams per day, half from soy) such as soy foods, beans, chick peas and lentils; and plant sterols (~2 grams per day) such as plant sterol margarine. Initial studies that were done in a controlled environment (with all meals provided) resulted in LDL cholesterol reductions of nearly 30% in study participants, 46 adults with high cholesterol.⁹ Later studies conducted in people with high cholesterol who followed the Portfolio Eating Plan on their own showed more modest, but still significant, reductions in LDL, with an average reduction of 13% after one year of following the diet. The results from this collection of studies demonstrate that almonds can be part of a heart-healthy diet that—in combination with other cholesterol-improving components—effectively lowers cholesterol in study participants with high cholesterol.

Figure 2: Change from baseline at four weeks in blood lipids on control, half-dose almonds, and full-dose almonds. Values are mean ± SEM



- Spiller, GA et al. Effect of a diet high in monounsaturated fat from almonds on plasma cholesterol and lipoproteins. *Journal of the American College of Nutrition*. 1992 Apr;1(2):126-30.
- Spiller GA, Jenkins DA, Bosello O, Gates JE, Cragen LN, Bruce B. Nuts and plasma lipids: an almonds-based diet lowers LDL-C while preserving HDL-C. *Journal of the American College of Nutrition*. 1998; 17(3): 285-90.
- Tamizifar et al., 2005.
- Jenkins DJ, Kendall CW, Marchie A, Parker TL, Connelly PW, Qian W, Haight JS, Faulkner D, Vidgen E, Lapsley KG, Spiller GA. Dose response of almonds on coronary heart disease risk factors: blood lipids, oxidized low-density lipoproteins, lipoprotein(a), homocysteine, and pulmonary nitric oxide: a randomized, controlled, crossover trial. *Circulation*. 2002; 106(11): 1327-32.
- Jaceldo-Siegl K, et al. Influence of body mass index and serum lipids on the cholesterol-lowering effects of almonds in free-living individuals. *Nutrition, Metabolism and Cardiovascular Diseases*. 2011; 21, S7-S13.
- Nishi S, Kendall CW, Gascoyne AM, et al. Effect of almond consumption on the serum fatty acid profile: a dose response study. *British Journal of Nutrition* 2014, 1-10, doi:10.1017/S0007114514001640
- Jenkins DJ, Kendall CW, Marchie A, Faulkner DA, Wong JM, de Souza R, Emam A, Parker TL, Vidgen E, Lapsley KG, Trautwein EA, Josse RG, Leiter LA, Connelly PW. Effects of a dietary portfolio of cholesterol-lowering foods vs lovastatin on serum lipids and C-reactive protein. *Journal of the American Medical Association*. 2003 Jul 23;290(4):502



While the majority of studies have been conducted in people with elevated cholesterol levels, there have also been studies investigating the impact of eating almonds on cholesterol in healthy people. The studies suggest that almonds have no detrimental effects on blood lipids and, in fact, in one controlled-feeding study, eating 2.4 ounces of almonds per day for a period of four weeks actually improved the blood lipid profiles of healthy men and women by significantly reducing total and LDL cholesterol levels and improving the ratio of LDL to HDL compared to no almond consumption, a remarkable finding given that all participants were consuming a low-saturated fat, National Cholesterol Education Program (NCEP) Step I diet.¹⁰ A second study assessed the effect of eating either a control diet (no almonds), a low-almond diet (10% of calories) and a high-almond diet (20% of calories) in 16 healthy men and women (mean age 41 years).¹¹ The high-

almond diets significantly lowered average total cholesterol (-10 mg/dL) and LDL cholesterol (-10 mg/dL) compared to the control diets, while also increasing vitamin E levels in a dose-response manner.

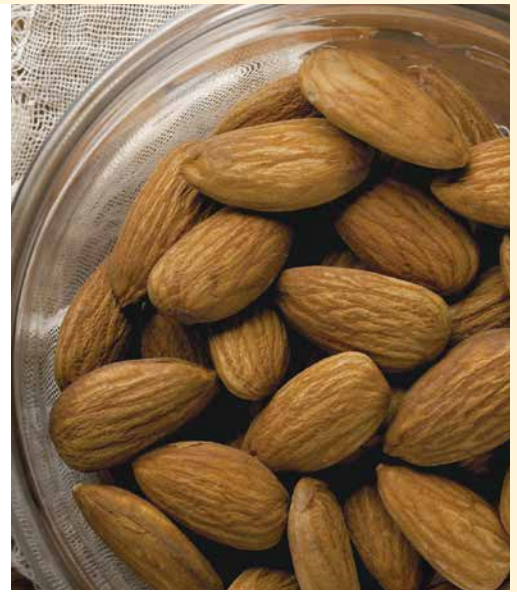
A review of the literature published by researchers at Pennsylvania State University and Columbia University states that almonds have a consistent LDL-lowering effect in healthy individuals and those with high cholesterol and diabetes, in both controlled and free-living settings.¹² While further research is needed to understand all mechanisms by which almonds reduce LDL and other heart disease risk factors, researchers propose that the benefits are likely associated with their unique package of cardioprotective nutrients.

EMERGING RISK FACTORS: INFLAMMATION AND BELLY FAT

More recent studies have investigated the effects on emerging risk factors for cardiovascular disease such as inflammation and abdominal (belly) fat. One randomized controlled crossover feeding study assessed the effect of almonds on markers of inflammation in 25 healthy adults (ages 22-53). Participants were fed three different diets for four weeks each: a heart-healthy control diet (no nuts, <30% of calories from fat), a moderate-almond diet (10% of calories from almonds), and a high-almond diet (20% of calories from almonds).¹³ E-selectin (an inflammatory marker) decreased as percentage of energy from almonds increased. C-reactive protein was lower in both almond diets compared to the control

10. Sabaté, J.; Haddad, E.; Tanzman, J.S.; Jambazian, P.; & Rajaram, S. (2003). Serum lipid response to the graduated enrichment of a Step I diet with almonds: a randomized feeding trial. *American Journal of Clinical Nutrition* : 77(6):1379-1384.

11. Jambazian PR, Haddad E, Rajaram S, Tanzman J, Sabaté J. Almonds in the diet simultaneously improve plasma alpha-tocopherol concentrations and reduce plasma lipids. *Journal of the American Dietetic Association* 2005; 105(3):449-54.



diet, and E-selectin (another inflammatory marker) decreased as percentage of energy from almonds increased. While not all markers of inflammation were improved, these findings suggest that including almonds in a heart-healthy diet may help decrease inflammation, which can contribute to the prevention of heart disease.

In another study, 30 normal weight men with mildly elevated cholesterol consumed 60 grams (~2 ounces) of almonds daily for four weeks in addition to their usual diets. After four weeks, eating almonds significantly decreased total and LDL cholesterol, as well as apolipoprotein B100, another form of bad cholesterol.¹⁴ Almond consumption was also associated with an improvement in lipid oxidation parameters, suggesting that almonds may reduce the ability of fats to become oxidized in the body, a process that can lead to increased heart disease risk.

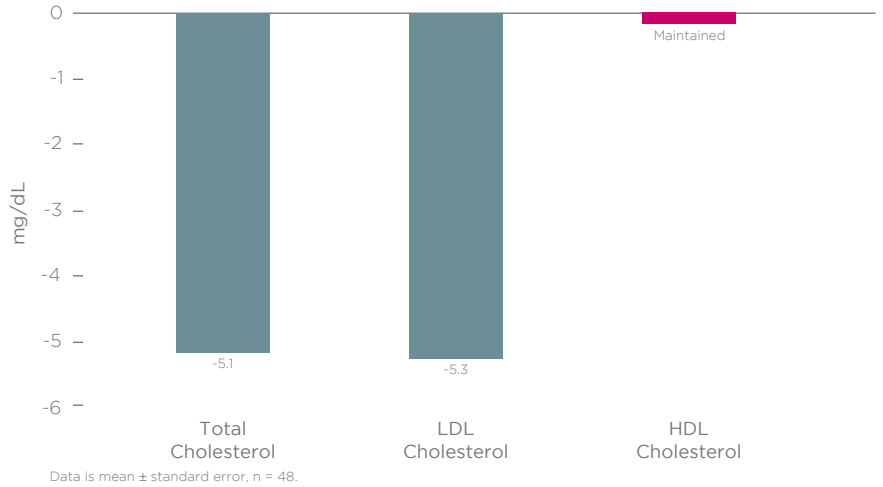
Another study, just published in the *Journal of the American Heart Association*, showed that snacking on almonds daily for six weeks not only reduced LDL and total cholesterol, but also reduced abdominal fat and waist circumference in study participants.¹⁵ During this study, 52 adult participants (who were overweight with elevated LDL cholesterol but otherwise healthy) ate standard healthy diets that were identical except for the snack, either 1.5 ounces of almonds or a high-carbohydrate muffin with the same number of calories. Compared with snacking on muffins, eating almonds significantly decreased total cholesterol (-5.1 mg/dL) and LDL cholesterol (-5.3 mg/dL) and maintained HDL cholesterol (compared to a drop with muffins) (See Figure 3.) There was a small weight loss in both groups that did not differ between the diets, but snacking on almonds reduced abdominal fat (-0.15 pounds) and waist circumference (-0.31 inches) compared with snacking on muffins. The overall diets were not matched for macronutrient content. The study suggests that regularly choosing almonds instead of a high-carb snack may be a simple dietary strategy to help improve

body composition and prevent the onset of cardiovascular disease.

CONCLUSIONS

Dietary changes are often the first and one of the most effective ways to reduce the risk of cardiovascular disease, and the body of research suggests that eating almonds can help in maintaining a healthy heart.

Figure 3: Effects of eating 1.5 ounces of almonds per day compared to 150-calorie muffin on lipid profiles in adults with high cholesterol from baseline to six weeks



12. Berryman, C.E., A.G. Preston, W. Karmally, R.J. Deckelbaum, P.M. Kris-Etherton. Effects of almond consumption on the reduction of LDL-cholesterol: a discussion of potential mechanisms and future research directions. *Nutrition Reviews* 2011; 69(4): 171-185.

13. Rajaram, S., K.M. Connell, J. Sabate. 2010. Effect of almond-enriched high monounsaturated fat diet on selected markers of inflammation: a randomized, controlled, crossover study *British Journal of Nutrition* 2010; 103: 907-912.

14. Jalali-Khanabadi, B.-A., H. Mozaffair-Khosravi, N. Parsaeyan. Effects of almond dietary supplementation on coronary heart disease lipid risk factors and serum lipid oxidation parameters in men with mild hyperlipidemia. *Journal of Alternative Complementary Medicine* 2010; 16(12):1-5.

15. Berryman CE, West SG, Fleming JA, Bordi PL, Kris-Etherton PM. Effects of Daily Almond Consumption on Cardiometabolic Risk and Abdominal Adiposity in Healthy Adults with Elevated LDL-Cholesterol: A Randomized Controlled Trial. *Journal of the American Heart Association* 2015; 4:e000993 DOI: 10.1161/JAHA.114.000993.

ALMONDS AND DIABETES

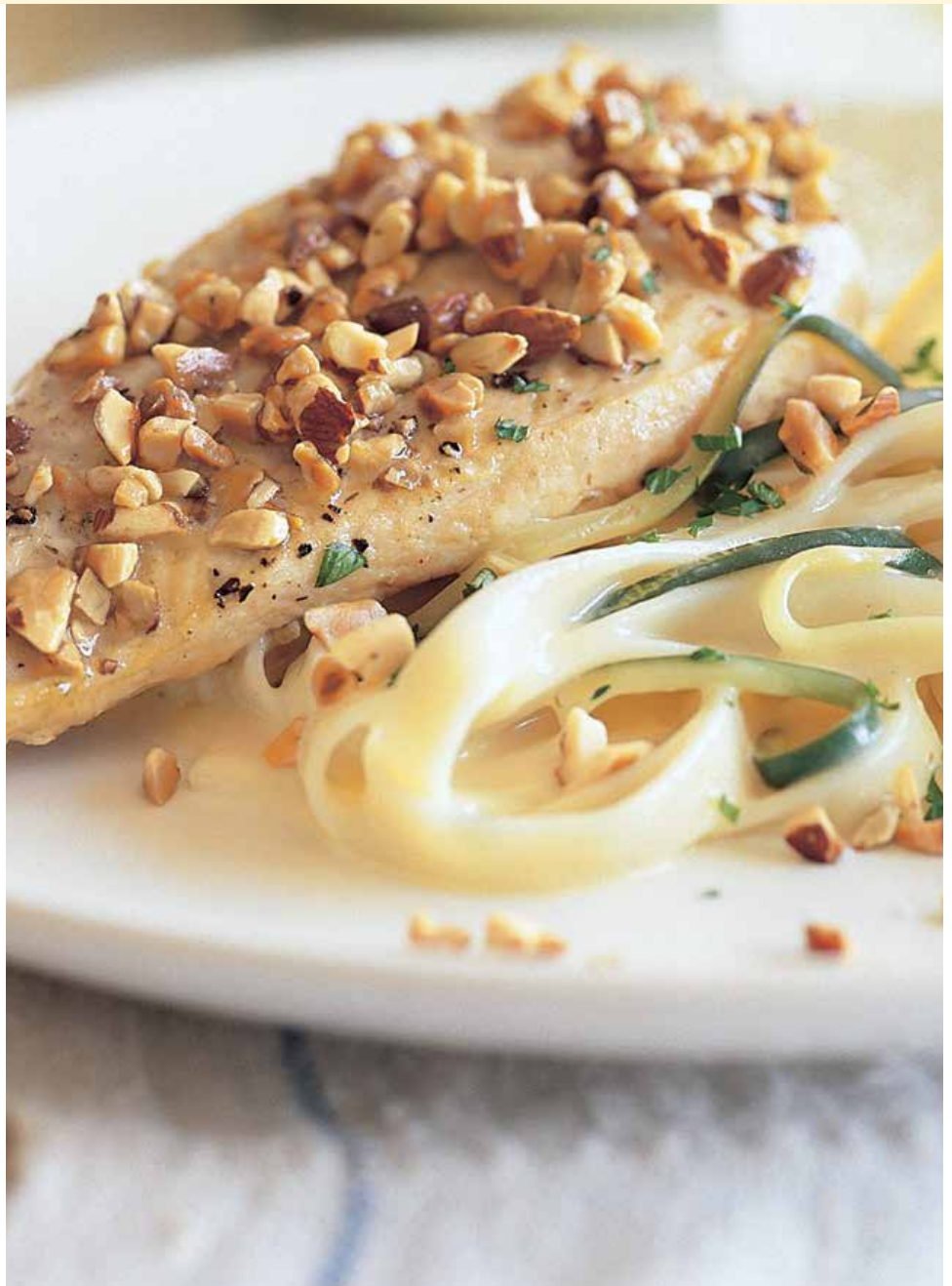
THE UNIQUE NUTRIENT PACKAGE IN ALMONDS MAKES THEM A SMART CHOICE FOR MANAGING HEALTHY BLOOD SUGAR LEVELS.

The prevalence of type 2 diabetes is rapidly increasing. In fact, during the past three and a half decades, the number of Americans with diagnosed diabetes has more than tripled from 5.6 million to 25.8 million, with many more people thought to be at risk. Diabetes is also a contributing risk factor for other chronic diseases, such as heart disease and stroke. Dietary and lifestyle interventions are a critical component of diabetes management, and evidence continues to mount supporting the role of almonds and other tree nuts as part of an overall dietary pattern that is beneficial for those with type 2 diabetes. The nutrient profile of almonds—low-glycemic index and providing a satisfying combination of protein (6 grams per ounce), fiber (4 grams per ounce), and monounsaturated fats—makes them an ideal snack and addition to meals for individuals with impaired glucose tolerance or type 2 diabetes.

Many randomized controlled studies have been conducted to examine eating almonds in relation to blood glucose control. These studies were conducted in different population groups, including people with normal blood glucose control, people with pre-diabetes and people with type 2 diabetes (T2D).

IMPACT OF ALMONDS IN PARTICIPANTS WITH TYPE 2 DIABETES

A number of randomized, controlled studies of the effects of almonds on measures related to blood glucose control have been conducted in subjects with T2D, evaluating both post-meal effects and longer-term (over at least four weeks) measures. In three of the four longer-term studies, eating an almond-enriched diet resulted in significant reductions in fasting glucose and insulin levels control, when compared to an almond-free diet. A randomized trial in 19 U.S. adults (including 7 with T2D) reported a 30% reduction in post-prandial glycemia in participants with T2D following the consumption of a test meal containing one ounce (28 grams) of almonds compared to an almond-free test meal similar in calories, fat and available carbohydrate, although the effect was not significant in those without T2D.¹⁶ These same researchers conducted a pilot study on the longer-term effects of almonds on glucose control in 13 adults



with T2D. Participants consumed a daily one ounce serving of almonds (5 days per week for 12 weeks) or a cheese snack with the same number of calories. After 12 weeks, hemoglobin A1c in individuals with T2D was reduced by 4% in participants who consumed almonds daily compared to baseline.

Another 10-week randomized crossover trial in 20 Chinese adults with T2D and mild hyperlipidemia (9 male, 11 female; age -58 years; BMI -26 kg/m²) investigated the effects of a four-week diet containing two ounces (56 grams) of almonds per day versus a no-almond control diet.¹⁷ The study demonstrated that almond consumption helped improve glycemic control by lowering fasting insulin and fasting glucose as well as decreasing the risk for heart disease through significant reductions on total cholesterol (-6%) LDL cholesterol

(-11.6%) and LDL: HDL ratio when compared to the control. In a third long-term study, participants (65 overweight and obese adults) consumed three ounces of almonds per day as part of a healthy diet for 12 weeks and showed improvements in HbA1c:¹⁸

These results suggest that modest almond consumption respectively improves both short-term and long-term markers of glucose control in individuals with T2D. The studies were well controlled and of sufficient duration to determine effects on glycemic control; they are limited by their small sample size and limited generalizability to free-living conditions in the studies in which meals were provided to participants.

16. Cohen A, et al. Almond ingestion at mealtime reduces postprandial glycemia and chronic ingestion reduces hemoglobin A1c in individuals with well-controlled type 2 diabetes mellitus. *Metabolism*. 2011; 60(9): 1312-1317.



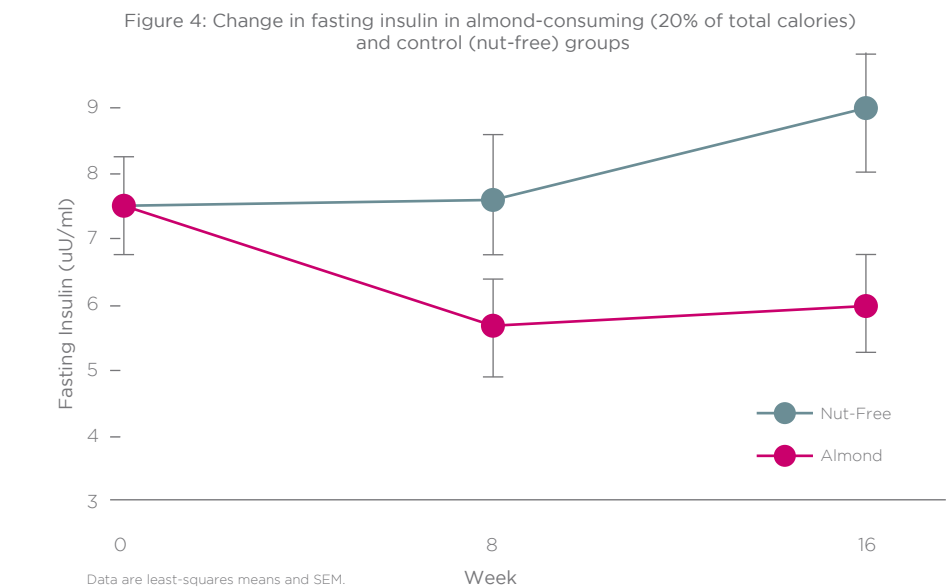
ALMONDS AND PRE-DIABETES

Studies also suggest that almonds may have benefits for people with pre-diabetes. One short-term, post-meal study in 14 adults with impaired glucose tolerance showed that the consumption of a 580-kcal breakfast meal containing 1.5 ounces (44.5 grams) of almonds resulted in significant reductions in study participants' blood glucose levels both acutely after breakfast and after a second meal relative to the consumption of a 347-kcal control breakfast meal, which differed in total dietary energy but provided the same amount of available carbohydrate.¹⁹ A long-term 16-week randomized controlled trial on 65 middle-aged U.S. adults (48 women and 17 men) with pre-diabetes investigated the effects of consuming an American Diabetes Association diet consisting of 20% of calories from almonds (approximately 2 ounces per day) on the progression of T2D and CVD. The group that consumed the almond-enriched diet showed significantly improved LDL cholesterol levels and measures of insulin sensitivity, both of which are risk factors for heart disease and T2D.²⁰ (See Figure 4.) The study was of sufficient duration to examine effects on markers of long-term blood glucose control; however, reliance on a single fasting sample for measurement of insulin resistance is an analytical limitation.

EFFECT OF ALMONDS ON BLOOD GLUCOSE MEASURES IN HEALTHY PEOPLE

Post-meal studies conducted in healthy or hyperlipidemic participants with normal blood glucose control cumulatively suggest that almonds have neutral or beneficial effects on post-meal blood glucose and insulin responses; in some studies, almonds actually reduced post-meal blood glucose and insulin spikes as well as blood glucose and insulin levels over a two-hour time period relative to an almond-free meal.^{21,22}

In longer-term four-week studies, eating



about 1.2 or 2.5 ounces (35 or 70 grams) of almonds per day resulted in significant reductions in a marker of insulin secretion, suggesting a decrease in insulin resistance;²³ as well as significant dose-dependent improvements in total cholesterol and other blood lipids.²⁴ Calorie intake was similar between the control and almond diets in both studies, but the duration was too short to discern effects on long-term blood glucose control.

CONCLUSIONS

Based on the totality of scientific evidence from randomized controlled studies, almonds, when eaten as part of a healthy diet, may have beneficial effects on blood glucose and insulin responses, both in the

short term after consuming a meal and over the longer term, especially in those with impaired glucose tolerance and/or T2D. Dietary changes are often the first and one of the most effective ways to manage diabetes, and the body of research suggests that eating almonds can help maintain healthy blood sugar levels.

17. Li S, et al. Almond consumption improved glycemic control and lipid profiles in patients with type 2 diabetes mellitus. *Metabolism*. 2011; 60(4): 474-479.
 18. Wien M, A.; Sabate J, M.; Ikke, D, N.; Cole, S, E.; & Kandeel, F, R. (2003). Almonds vs complex carbohydrates in a weight reduction program. *Int. J. Obes. Relat. Metab. Disord.* 27 (11):1365-1372.
 19. Mori A, et al. Acute and second-meal effects of almond form in impaired glucose tolerant adults: a randomized crossover trial. *Nutr Metab (Lond)*. 2011; 8(1):6.
 20. Wien M, et al. Almond consumption and cardiovascular risk factors in adults with pre-diabetes. *Journal of the American College of Nutrition*. 2010; 29(3): 189-197.
 21. Josse, A.R.; Kendall, C.W.C.; Augustin, L.S.A.; Ellis, P.R.; & Jenkins, D.J.A. (2007). Almonds and postprandial glycemia--a dose-response

study. *Metabolism* 56 (3):400-404.
 22. Jenkins, D.J.A.; Kendall, C.W.C.; Josse, A.R.; Salvatore, S.; Brighenti, F.; Augustin, L.S.A.; Ellis, P.R.; Vidgen, E.; & Rao, A.V. (2006). Almonds decrease postprandial glycemia, insulinemia, and oxidative damage in healthy individuals. *J. Nutr.* 136 (12):2987-2992.
 23. Jenkins, D.J.A.; Kendall, C.W.C.; Marchie, A.; Josse, A.R.; Nguyen, T.H.; Faulkner, D.A.; Lapsley, K.G.; & Singer, W. (2008). Effect of almonds on insulin secretion and insulin resistance in nondiabetic hyperlipidemic subjects: a randomized controlled crossover trial. *Metabolism* 57 (7):882-887.
 24. Sabate, J.; Haddad, E.; Tanzman, J.S.; Jambazian, P.; & Rajaram, S. (2003). Serum lipid response to the graduated enrichment of a Step I diet with almonds: a randomized feeding Trial. *American Journal of Clinical Nutrition*. 77 (6):1379-1384.



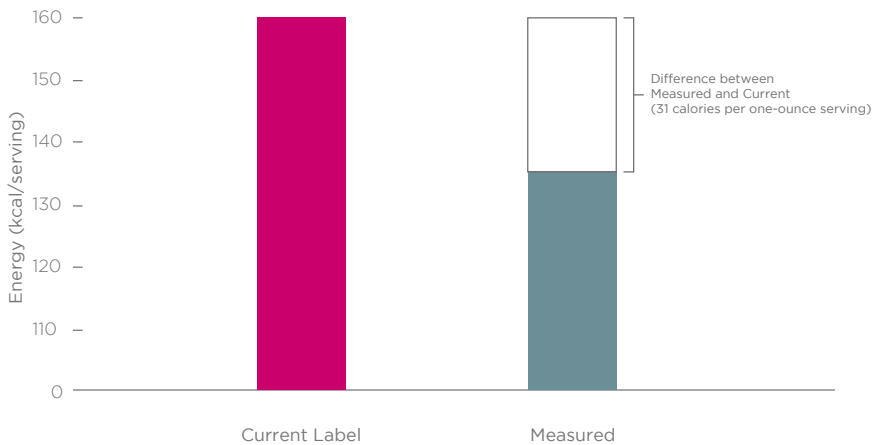
ALMONDS: A SATISFYING WEIGHT-WISE SNACK

A DAILY HANDFUL OF ALMONDS IS A DELICIOUS WAY TO MANAGE CRAVINGS AND HELP MAINTAIN A HEALTHY BODY WEIGHT.

The prevalence of overweight and obesity continues to be a major public health issue worldwide. In the U.S., more than 78 million (35.7%) adults and 12.5 million (17%) children and adolescents are obese. Given that snacking has become nearly universal behavior, with an estimated 97% of Americans reporting snacking at least once a day²⁵ combined with persistently high obesity rates, identifying nutrient-rich snack options that pose little risk for weight gain is of growing importance. The nutrients in almonds, including monounsaturated fat (13 grams per ounce), protein (6 grams per ounce) and fiber (4 grams per ounce), are associated with improved satiety, suggesting they would be an ideal snack for those concerned about weight management.

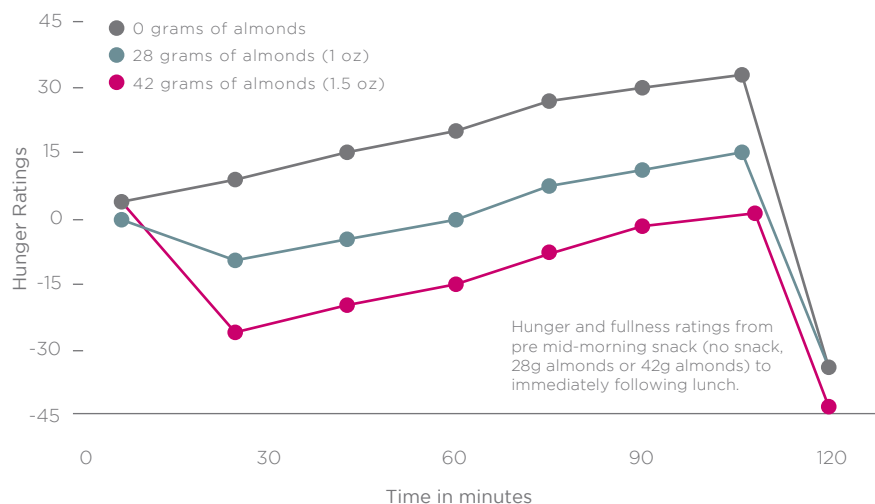
Additionally, a recent study measuring digestibility found—surprisingly—that whole almonds contain 20% fewer calories than the Nutrition Facts Panel states, suggesting that because of their rigid cell structure, not all calories are available for absorption²⁶ (See Figure 5.) Further research is needed

Figure 5: Energy digestibility of almonds



25. Piernas C, Popkin BM. *J Nutr* 2010; 140: 325-332.
 26. Novotny JA, et al. Discrepancy between the Atwater factor predicted and empirically measured energy values of almonds in human diets. *Am J Clin Nutr*. 2012;96(2):296-301.

Figure 6: A mid-morning snack of almonds generates satiety



to better understand how this technique for calculating calories could potentially affect the calorie count of other foods.

Many randomized controlled studies have been conducted to examine the effects of almonds, consumed as part of a sensible eating plan, on outcomes related to satiety (like hunger, fullness, desire to eat and prospective food consumption) and/or body composition (like body weight, body mass index (BMI) body fat and waist circumference). These studies were conducted in different population groups, including people with normal body weight, as well as overweight or obese people.

IMPACT OF EATING ALMONDS ON MEASURES OF HUNGER, SATIETY AND SUBSEQUENT CALORIE INTAKE IN NORMAL WEIGHT PEOPLE

In post-meal studies, the daily consumption of almonds is associated with improving ratings of hunger and satiety in healthy people. In one study, the daily consumption of 2.8 ounces (80.4 grams) of almonds reduced subjective ratings of hunger²⁷ and a second study investigated the effects of two different portion sizes of almonds (1 and 1.5 ounce) as a mid-morning snack on satiety and energy intake, in comparison to having no snack. (See Figure 6.) There were no significant differences in total daily energy intake between any of the groups, indicating that participants, 32 healthy, Caucasian women, naturally compensated for the almond calories consumed, whether they had one (160 calories) or 1.5 servings (250 calories) of almonds as the mid-morning snack²⁸ After eating their usual breakfast and having the mid-morning almond snack, participants were fed lunch midday and permitted to eat as much as they wanted until they were comfortably full. Ratings of appetite and fullness were dose dependent, with participants reporting being the least hungry when they ate 1.5 ounces of almonds and the hungriest on the

day when they didn't eat almonds. Although habitual almond intake was not controlled for and a control snack was not tested, the studies suggest that snacking on nutrient-rich almonds may improve satiety and help control cravings.

A longer-term four-week randomized, controlled clinical study in which 137 adults who were at risk of T2D but otherwise healthy were given 1.5 ounces (43 grams) of almonds as a snack or with meals also showed significantly greater reductions in the daylong ratings of hunger and desire to eat in participants who consumed almonds either as a snack or as part of a meal relative to those who did not consume almonds.²⁹ Despite consuming approximately 250 calories from almonds every day for four weeks, participants did not increase their daily total calorie intake or experience any change in weight over the course of the study. Although the study was of relatively short duration, these findings suggest almonds may be a satisfying snack option

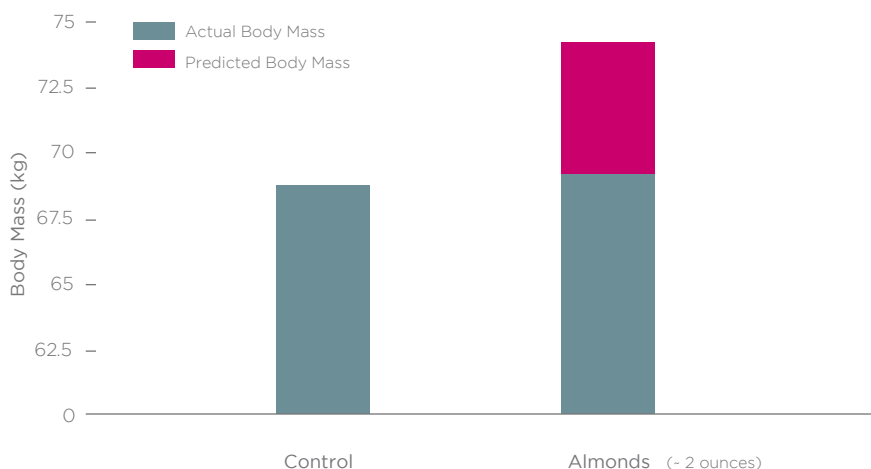
to help maintain a healthy weight.

In another 10-week study, 20 healthy adult women consumed their normal diets plus 344 calories (approximately 2 ounces) of almonds per day for 10 weeks and then followed their normal diet without almonds for 10 weeks, with a three-week washout period in between.³⁰ (See Figure 7.) There were no differences in body weight, metabolic rate or energy expenditure observed, suggesting that participants used almonds to replace other foods and, therefore, did not increase overall calorie intake.

EFFECTS OF EATING ALMONDS ON SATIETY AND WEIGHT IN PEOPLE WHO ARE OVERWEIGHT OR OBESE

There have been a number of studies investigating the short- and long-term effects of almonds on measures related to body composition and weight in overweight or obese adults (BMI ≥ 25 kg/m²). In one

Figure 7: Changes in body composition due to the consumption of 344 calories per day of almonds for 10 weeks in healthy adult women (n = 20)

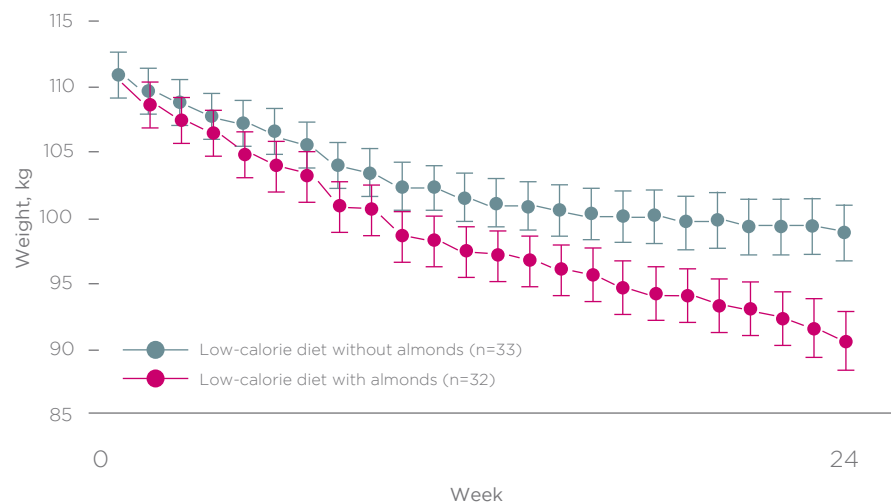


27. Kirkmeyer SV, Mattes RD (2000). Effects of food attributes on hunger /and food intake. *Int J Obes Relat Metab Disord* 24(9):1167
 28. Hull S, Re R, Chambers L, Echaniz A, Wickham S.J. A mid-morning snack generates satiety and appropriate adjustment of subsequent food intake in healthy women. *European Journal of Nutrition* 2014; DOI 10.1007/s00394-014-0759-z.

29. Tan YT, Mattes RD. Appetitive, dietary and health effects of almonds consumed with meals or as snacks: a randomised, controlled trial. *European Journal of Clinical Nutrition* 2013; 67: 1205-14.
 30. Hollis, J., R. Mattes. Effect of chronic consumption of almonds on body weight in healthy humans. *Br J Nutr* 2007; 98:651-656.



Figure 8: Weekly change in body weight in low-calorie diet with almonds vs. low-calorie diet without almonds



post-meal study, overweight women who consumed a meal containing 1 ounce (28 grams) of almonds reported feeling more hungry, less full, more desire to eat, with a greater food consumption later in the day relative to when they consumed a control meal containing a mixture of safflower and corn oils; although differences in satiety ratings were not observed in overweight men.³¹ In the other post-meal study conducted in obese adults, the consumption of a meal containing 1.5 ounces (42.5 grams) of almonds resulted in significant increases in fullness ratings in the afternoon and throughout the day relative to the consumption of a control meal without almonds, which was lower in total dietary energy but provided the same amount of available carbohydrate.³²

Long-term studies cumulatively suggest that almonds have no detrimental effects on body composition in overweight or obese subjects; in fact, significant improvements in body composition have been observed in two studies.

In obese adults with type 2 diabetes, the consumption of one ounce (28 grams) of almonds five days per week for 12 weeks resulted in a significant decrease in BMI relative to no almond consumption.³³ In another study, 65 overweight and obese participants who consumed three ounces (84 grams) of almonds daily for 24 weeks had significantly greater reductions in body weight, BMI, waist circumference, fat mass, and total body water compared to participants who did not consume almonds.³⁴ (See Figure 8.) These findings are remarkable, given that subjects consumed the almonds as part of a healthy low-calorie diet.

Another 18-month clinical trial examined the effects of a low-calorie diet containing two ounces per day of almonds compared to a low-calorie, nut-free diet on weight loss and heart disease risk factors in 123

overweight or obese adults. Although both groups lost a similar and significant amount of weight after 18 months, compared with the nut-free group, the almond-enriched diet was associated with greater reductions in total cholesterol TL:HDL ratio, and triglycerides.³⁵ Strengths of the long-term studies include sufficient study duration to discern the effects on body weight and adequate control of the total energy intake between the control and almond diets. The studies are limited by inadequate control of the confounding effects of physical activity.

CONCLUSIONS

Despite their relatively high energy density, the body of scientific evidence suggests that almonds, when eaten as part of a healthy diet, do not cause weight gain and may even have beneficial effects on body composition, especially in overweight or obese adults. Several mechanisms give explanation for the positive associations between almonds and other nuts and energy balance and body weight, including their strong satiety effects, incomplete energy bioaccessibility and possible enhancement of resting energy expenditure.³⁶ Although many commonly

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consumed snacks provide empty calories, the unique nutrient package in almonds makes them a satisfying, weight-wise snack.

