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Health benefits of almond

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Abstract
In India many species of almond are appreciated as food and used in traditional diets. In this mini review proximate composition and mineral composition of four species are summarized and discussed. Clinical interventions are also summarized and discussed which elucidates the health benefits of almonds in prevention and management of diabetes. Almonds also possess certain bio active compounds which help to control the dietary glycemic load of diabetic patients.

Keywords: almonds, nutritional composition, health benefits, diabetes

Introduction
Almond seeds contain proteins and certain minerals such as calcium and magnesium. Almond seeds are a useful food remedy for anemia. They are also rich source of vitamin E, dietary fiber, B-vitamins, essential minerals, mono-unsaturated fats and phytosterols which have cholesterol lowering properties. They are beneficial in the treatment of constipation and various skin diseases like eczema, pimples. Almond seeds are also useful in treating gastro-enteritis, kidney pains, diabetes, head lice, facial neuralgia and gastric ulcers (Hari Jagannadha Rao and Lakshmi, 2012) [10]. Almond kernel with skin can also be a good source of fiber and is used as a snack food or as an ingredient in the manufacture of a variety of food products such as peanut butter and peanut brittle (Shakuntala and Shadadsharaswamy, 1987) [18]. Mir (2016) [14] studied the problems of export of dry fruits in Jammu and Kashmir. Jammu and Kashmir is the business model maker of the almond production. Budgam, Pulwama and Anantnag districts of Kashmir region and Doda district of Jammu region are the places where rich sources of almonds are found in the state. Makhdoom, Shalimar, Merced, Wais and California paper shell are the different verities of almonds found in the state. The production of almond in India is concentrated in Uttar Pradesh, Himachal Pradesh and Jammu and Kashmir. Kashmir region enjoys hub of almond industry in the country and almond production is increasing every year. Annual production of almonds in Kashmir valley is 1.5 million tonnes as per the report of horticulture department (Anonymous, 2016) [3]. Almond seeds versatile utility as a medicine and functional food motivated us to write a comprehensive review on the nutritional attributes of this plant which is of high economic value. Therefore, in this review, effects of almond consumption on human health are highlighted.

Proximate Composition
Dry matter content of fresh almond seeds is relatively high that is around 97 to 98 percent and is mainly composed of carbohydrate, protein, fibre, ash, minerals etc. The nuts of Indian almond have high protein, fibre, fat and ash and can be regarded as high energy food. Because of low starch and high protein content, it can be incorporated into biscuits, cookies, ready to eat cereals and cakes for diabetic patients (Sathe 1993) [16]. Data on proximate composition of four Indian varieties of almonds are given in Table 1. The study of nutritional characteristics was conducted by Agunblade and Olanlokun (2006) [1] on Indian almond (*Prunus amygaldus*) which showed the proximate composition as dry matter 99.90%, carbohydrate 54.87%, protein 11.52%, Fibre 5.90% and ash 6.76%. These research findings were also similar to the reports on peerless variety (Anonymous 1991). The almond contains almost all nutritionally or physiologically obligatory constituents. Another study was conducted by Akpakpan and Akpaboi (2012) [2] for almond (*Terminalia Cattapa*) seeds and results revealed proximate composition as dry matter 95.00%, carbohydrate 25.47%, protein 33.66%, fiber 3.11%, fat 32.73% and ash 5.00%. This study also revealed that almond seeds have a higher level of most of chemical compositions. Yada *et al*. (2011) [20] reported in a global reviewed research that

nutrient composition of almonds is mainly genotype dependent, and may also be influenced by environmental factors, such as growing region, cultivation methods, climatic conditions that vary between harvest years, and kernel maturity, or interactions of these factors. In addition, variability in the nutrient composition of almonds, even within a cultivar, can be expected. Yada *et al.* (2011) [20] also reported dry matter in the range of 95 to 98 percent, carbohydrate was reported in the range of 3 to 12 percent, protein 16 to 22, fibre 10 to 14, fat 44 to 61 and ash 2 to 5 percent. Thus, *Prunus dulcis,* the cultivated swe*et al*mond, has also been recognized as a source of nutrients in many traditional diets, and is increasingly promoted as a healthy snack and ingredient. California almond varieties were investigated by Yada *et al.* (2013) [21] in a multi-year study in which seven major almond varieties (Butte, Carmel, Fritz, Mission, Monterey, Nonpareil and Sonora) were collected over three separate harvests and from various orchards in the north, central and south growing regions in California. The results recorded dry matter in the range of 93 to 96, protein 20 to 22, fibre 11 to 14, fat 48 to 50 and ash 2 to 3 percent.

Table 1: Proximate composition of some edible almonds *species* of India (mean values; % of dry matter).

Reference	Species	Dry matter (%)	Carbohydrate (%)	Protein (%)	Fibre (%)	Fat (%)	Ash (%)
Agunblade *et al*. 2006 [1]	*Prunus Amygdalus*	97.70	54.87	11.52	5.90	21.76	6.76
Yada *et al*. 2011 [20]	*Prunus dulcis*	95 to 98	3 to 12	16 to 22	10 to 14	44 to 61	2 to 5
Akparpan *et al*. 2012	*Terminalia Cattapa*	95.00	25.47	33.69	3.11	32.73	5.00
Yada *et al*. 2013 [21]	*California*	93 to 96	-------	20 to 22	11 to 14	48 to 50	2 to 3

Mineral Composition

Almonds contain more alkaline forming minerals than acid forming minerals, which makes them a rare protein-rich, bone protecting, alkalizing food. Phosphorous, potassium and calcium are present in high amounts in almonds. Phosphorus is a mineral found in many foods. Phosphorus builds up in your blood (Dawson *et al.* 1997) [7] and works with calcium to build bones. Your body works best when these minerals are in balance. When calcium and phosphorus are out of balance one may have the risk of bone tissue forming in your heart, liver, and blood vessels. Some common symptoms of high phosphorus include bone & joint pain, weakness, itching, bone weakness and red eyes (Salpietro, 2005) [15]. Calcium is essential for living organisms. Almost 99 percent of the body's calcium is store in bones and teeth. Humans absorb about 30 % of the calcium in foods, but this depends on the type of food consumed. Inadequate intakes of dietary calcium from food can produce hypocalcaemia. To ensure adequate calcium intakes, Almonds are considered a high value food regarding to this aspect (Iaconoa, 2008) [11]. Data on six minerals determined in four almond species from India are given in Table 2. The study of mineral composition was conducted by Agunblade and Olanlokun (2006) [1] of Indian almond (*Prunus amygaldus*) which showed the phosphorus (0.19%), potassium (0.17%), iron (70.62ppm), magnesium (0.25%), calcium (845.45ppm) and sodium (245.65ppm). Yada *et al*, 2011 [20] also reported the phosphorus in the range of (440 to 510 mg/100g), potassium (390 to 810 mg/100g iron (3.8 to 4.9 mg/100g), magnesium (230 to 300 mg/100g), calcium (280 to 300 mg/100g) and sodium (1 to 2 mg/100g). Another study was conducted by Akpakpan and Akpaboi (2012) [2] for almond (*Terminalia Cattapa*) seeds revealed the phosphorus (10.00 mg/100g), potassium (350.00 mg/100g), iron (375.00 mg/100g), magnesium (26.40 mg/100g), calcium (36.10 mg/100g) and sodium (5.00 mg/100g). Another study was reported by Yada *et al*., 2013 [21] of *California* Almonds which showed phosphorus (462 to 526 mg/100g), potassium (664 to 773 mg/100g), iron (3.27 to 3.84 mg/100g), magnesium (260 to 278 mg/100g) and calcium (234 to 290 mg/100g).

Table 2: Mineral composition of some edible almonds *species* of India (mean values; % of dry matter)

Reference	Species	Phosphorus	Potassium	Iron	Magnesium	Calcium	Sodium
Agunblade*et al*., 2006 [1]	*Prunus Amygdalus*	0.19%	0.17%	70.62 ppm	0.25%	845.45 ppm	245.65 ppm
Yada *et al*., 2011 [20]	*Prunus dulcis*	440 to 510 mg/100g	390 to 810 mg/100g	3.8 to 4.9 mg/100g	230 to 300 mg/100g	280to 300 mg/100g	1 to 2 mg/100g
Akparpan *et al*., 2012	*Terminalia Cattapa*	10.00 mg/100g	350.00 mg/100g	375.00 mg/100g	26.40 mg/100g	36.10 mg/100g	5.00 mg/100g
Yada *et al*., 2013 [21]	*California*	462 to 526 mg/100g	664 to 773 mg/100g	3.27 to 3.84mg/100g	260 to 278 mg/100g	234 to 290 mg/100g	-----

Nutritional value of almond and effect on diabetes and glycemic control.

The almond is a popular nutritious food, rich in healthy fats, protein, minerals and vitamins. It also has medicinal value used for treating various diseases. The seeds of *prunus amygdalus* possess various pharmacological properties such as anti-stress, anti-oxidant, immune stimulant, lipid lowering and laxative. Almonds are a useful food remedy for anemia, as they contain copper, iron and vitamins (Hari Jagannadha Rao and Lakshmi, 2012) [10]. Studies on almond and health benefits associated with almond consumption are summarized in Table 3. Population with Type 2 diabetes are at higher risk of developing heart diseases and intake of almonds can help high risk population against cardio vascular diseases (Kendell *et al*., 2010) [12]. In 2002 analysis, type 2 diabetes population was served 4 diets (high fat, high almond; low fat, high almond; high fat; control (olive oil)) resulting no main effect of fat source or fat level on any glucose or insulin parameters (Lovejoy *et al*., 2002) [3]. Scott *et al*., (2003) [17] has observed 42 week intervention in 35 patients with metabolic disorder and type 2 diabetes using almonds with high protein, high fat (25% protein, 40% fat and 22% MUFA (monounsaturated fatty acid) in diets. The result showed the control in glycemic index was normalized in all 10 patients, 12 patients were dropped out in first week and weight loss was observed. Thus, controlled diet can be a synonym with heart healthy diet. Clinical intervention shows that almond can improve markers other than serum lipids with type 2 diabetes and had also intervention with the risk of cardio vascular disease. Glycemic control is critical for anticipation and management

of type 2 diabetes. Low glycemic index foods have been effective in increasing insulin sensitivity preventing hyperinsulinemia (Kendell *et al*., 2010) [12]. Almond consumption governs satiety and can improve HDL (high density lipoprotein) in blood, thereby, improving cognitive function (Tan *et al*., 2013; Berryman *et al*., 2015: De souza *et al*., 2017) [19, 5, 8]. Tan *et al*., (2013) [19] studied 137 participants with increased risk of type 2 diabetes. There was a greater decrease in the feeling of hunger and serum glucose concentration to the population that consumed almond at snack time and also despite of taking almond there was no weight gain (De souza *et al*., 2017) [8]. In another study by Burns *et al*., (2016) [6], 29 parents and 29 children's consumed almonds, 1.5 oz per day. It was reported that almonds promote cognitive function, and energy restricted over weight for obese adults (De souza *et al*., 2017) [8]. Recent study by Dhillon *et al*., (2017) [9] showed memory increase in obese children and improvement in diet quality.

Table 3: Effect of almond on markers of glycemic control in long term clinical intervention

Reference	Study population	Design	Control group	Intervention group/ treatment diet	Health outcome of almond consumption
Lovejoy *et al*., (2002) [13]	Type 2 diabetes	Cross-over (4weeks)	1) high fat control (HFC;37% total fat, 10% from the MUFAs olive or canola oil) 2) low-fat control (LFC;25% total fat, 10% from olive or canola oil)	1) Almonds (10% total energy: 57-113g/d) +HFA 2) Almonds (10% total energy:57-113g/d) +LFA	No main effect of fat source or fat level on any glucose or insulin parameters
Scott *et al*., (2003) [17]	Metabolic syndrome & Type 2 Diabetes	Parallel (42 weeks)	American Heart Association diet (15% protein, 30% fat, and 15% MUFAs**)**	Almonds + High Protein, High Fat (25% protein, 40% fat, and 22% MUFAs**)**	1) No difference between treatments 2) glycemic control was normalized in all 10 patients with impaired fasting glucose; it was also normalized in 2 and reduced to impaired fasting glucose in 3 of 7 patients with diabetes
Tan *et al*., (2013) [19]	137 participants with increased risk for type 2 diabetes (48/89) (18–60 years)	Randomized, parallel-arm study (4 weeks)	Habitual diet without almonds	43 g/day of almonds with breakfast (BF) or lunch (LN), alone as a morning (MS) or afternoon (AS) snack	Decrease Hunger, fullness, and desire to eat levels before the subsequent meal in all intervention groups. Hunger levels were suppressed more and remained below baseline when consumed as snacks (acute); Decrease AUC of glucose postprandial; Increase MUFA ingestion; No changes in BW and fasting blood markers.
Burns *et al*. (2016) [6]	29 parents (18–40 years) and 29 children (3–6 years; pairs	Randomized controlled crossover trial (3 weeks/period) and 4 weeks of washouts	Habitual diet without almonds	1.5 oz/day of almonds for parents and 0.5 oz/day of almonds for children	Increase Total Healthy Eating Index score in parents and children (12.5% in both); Genus-level changes in microbiota occurred with nut intake, especially in children; Increase Mg and vitamin E ingestion in parents and child.
Dhillon *et al*. (2017) [9]	86 overweight and obese adults(21/65) (18–60 years)	Randomized clinical trial (12 weeks) or acute effect of a specific lunch	Nut-free control diet achieving 500 kcal/day or a high-CHO lunch (>85% energy from CHO	Almond-enriched diet (AED) achieving 500 kcal/day or an almond-enriched high-fat lunch (A-HFL) (>55% energy from fat, almonds contributing 70–75% energy)	Increase Total Healthy Eating Index score in parents and children (12.5% in both); Genus-level changes in microbiota occurred with nut intake, especially in children; Increase Mg and vitamin E ingestion in parents and child.

HFA: High Fat Almond, LFA: Low Fat Almond, MUFA: Mono Unsaturated Fatty Acid

Conclusion

The nutrient composition of almond varies from one species to another species because of genotype, environmental conditions, growing conditions, cultivation methods etc. Almond has been recognized as a source of nutrients in many traditional diets. Research also indicates beneficial effect of almond on heart disease risk and type 2 diabetes. Many research results suggest that almond also possess bio active compounds which help the diabetic patient to control glycemic index. Due to high energy density of almonds, it was believed that consumption could increase weight gain, however there is no weight gain reported so far because it helps in controlling of satiety and promote increase in quality conclusion of diet. So in order to understand the diverse role of almonds in disease prevention, more long term clinical interventions are needed.

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