Systematic Review of Pears and Health

Holly Reiland, BS
Joanne Slavin, PhD, RD

Fruit consumption is universally promoted, yet consumption of fruit remains low in the United States. We conducted a systematic review on pear consumption and health outcomes searching both PubMed and Agricola from 1970 to present. The genus *Pyrus* L. consists of species of pears cultivated in Europe, parts of Asia, South America, and North America. Like most fruit, pears are concentrated in water and sugar. Pears are high in dietary fiber, containing 6 g per serving. Pears, similar to apples, are concentrated in fructose, and the high fiber and fructose in pears probably explain the laxative properties. Pears contain antioxidants and provide between 27 and 41 mg of phenolics per 100 g. Animal studies with pears suggest that pears may regulate alcohol metabolism, protect against ulcers, and lower plasma lipids. Human feeding studies with pears have not been conducted. In epidemiological studies, pears are combined with all fresh fruits or with apples, because they are most similar in composition. The high content of dietary fiber in pears and their effects on gut health set pears apart from other fruit and deserves study. Nutr Today. 2015;50(6):301–305

Fruit consumption is universally promoted in dietary guidance, yet consumption of fruit remains low in the United States.[1] Little is published on the health outcomes associated with consumption of fruit, especially individual fruits.

Pears are 1 of the oldest plants cultivated by man. Fresh pear (*Pyrus* species) fruit is consumed throughout the world and also commonly found in processed products such as drinks, candy, preserved fruits, and jam. Pears have been used as a traditional folk remedy in China for more than 2000 years because of their reported anti-inflammatory, antihyperglycemic, and diuretic activities. Other traditional uses of pears include use as remedies for alcohol hangovers, to relieve cough, and constipation.

Pears are a member of the Rosaceae (Rose) family, and are often called pome fruits—a fruit with a characteristic compartmented core. Pears are natives of Europe and West Asia and were introduced to North America in the 17th century. Commercial pear production is concentrated in the Northwest United States with 75% of the nation's supply coming from Washington, California, and Oregon. There are several thousand varieties of pears in the world, but only about 100 varieties are grown commercially. Three basic types of pears are grown in the United States. The European or French pears include poplar varieties such as Bartlett, Bosc, and D'Anjou. Asian pears are also known as "apple pears," because of their apple-like texture. Oriental hybrid varieties range from gritty in texture to dessert quality.[2] The 10 main varieties grown in the United States are Green and Red Anjou, Bartlett and Red Bartlett, Bosc, Comice, Forelle, Seckel, Starkrimson, and Concorde.

In 2012, US per-capita consumption of fresh pears was 2.8 lb, according to the US Department of Agriculture National Agricultural Statistics Service. Per-capita consumption of all pear products was about 7 lb in 2010. About 60% of the US pear crop is sold as fresh, and 40% is processed, primarily in the form of canned product. The United States is a net exporter of pears. The largest market for fresh pears is Mexico, followed by Canada, Brazil, and Russia.

Bates et al[3] examined dietary patterns and gender differences in food choices in a representative sample of older people living in Britain. Women ate more pears than did men and also had higher intakes of vitamin C.

Locke et al[4] found that pear consumption was highest during fall harvest. They suggest that epidemiologic investigations and public health intervention that examine the consumption of fruits, such as pears, must consider seasonal variation in consumption patterns, making it difficult to get accurate exposure data.

NUTRIENT COMPOSITION OF PEARS

Pears are a source of many nutrients, including fiber, vitamin C, and potassium. Pears are also a source of phytochemicals, especially antioxidants. Pears contain fructose and sorbitol, which have been linked to issues of diarrhea in children.[5]

Holly Reiland, BS, is a Food Science graduate at the University of Minnesota, St Paul, and completed this review as part of an undergraduate research project.

Joanne Slavin, PhD, RD, is a professor in the Department of Food Science and Nutrition, University of Minnesota, St Paul. She grew up on a dairy farm in Walworth, Wisconsin, which she still owns with her 2 sisters. She is a distinguished nutrition scientist who is best known for her work on dietary fiber and protein. She was a member of the 2010 Dietary Guidelines Committee and gave the WO Atwater lecture at Experimental Biology 2015 in Boston, Massachusetts.

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Correspondence: Joanne Slavin, PhD, RD, Department of Food Science and Nutrition, University of Minnesota, 1334 Eckles Ave, St Paul, MN 55108 (jslavin@umn.edu).

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The only vitamin found in pome fruit is vitamin C, and it is more concentrated in the skin. The vitamin C content of pears is about 7 mg, making pears a good source of vitamin C. Medium-sized pears are also concentrated in fiber (6 g) and qualify as an excellent source of dietary fiber. Like all fruits, pears are an important source of potassium (180 mg). Like dietary fiber, potassium is a shortfall nutrient in the US diet.

Kevers et al[6] examined the effect of cultivar, harvest time, storage conditions, and peeling on the antioxidant capacity and phenolic and ascorbic acid contents of pears. Peeling led to a more than 25% decrease in total phenolic and ascorbic acid content. Harvest time had only a limited impact, but significant year-to-year variation was observed.

Pears are particularly rich in fructose and sorbitol, as compared with other fruits. Although most fruits contain sucrose, pears and apples contain 70% fructose, although this information is not available in standardized nutrient databases.[1] Pears contain 4.5% fructose, 4.2% glucose, 2.5% sucrose, and 2.5% sorbitol.[7] Comparisons of apples and pears find that pears are higher in fructose and sorbitol, whereas apples are higher in glucose and sucrose.[8]

Silva et al[9] measured the antioxidant properties and fruit quality of pears during long-term storage. They found that under good storage conditions the antioxidant properties of pears can be maintained for up to 8 months.

Li et al[10] compared the contents of total phenolics, total flavonoids, and total triterpenes between peel and flesh of 10 different pear cultivars. The monomeric compounds were analyzed by high-performance liquid chromatography; antioxidant and anti-inflammatory activities were also measured. Significant differences were found among cultivars. In addition, all the chemical components found in the pear peel were approximately 6 to 20 times higher than those in the flesh of the pear. For the monomeric compounds, arbutin, oleanolic acid, ursolic acid, chlorogenic acid, epicatechin, and rutin were the dominant components contained in the 10 pear cultivars both in peel and in flesh.

Russell et al[11] described the phenolic acid content of fruits consumed and produced in Scotland. Locally produced fruits had higher content of phenolic acids. The majority of the phenolic acids were conjugated to other plant components, suggesting that any health benefits derived from these compounds are likely to be after they are released or metabolized by the colonic microbiota. Pears were exceptional in that they were the only fruit that were particularly rich in methylated phenolic acids, with 70% of the phenolic acids being dimethylated (syringic and sinapic acid) compared with less than 23% for all of the other fruits analyzed.

Although it is often assumed that fruits are high in pectin and other soluble fiber, few studies have examined the specific fibers in fruits. Pears contain 71% insoluble fiber and 29% soluble fiber.[1] Lignins are the noncarbohydrate part of dietary fiber and are generally linked to wheat bran and cereal fibers. Lignins in plants are biotransformed into lignans, which are phytoestrogens, by the bacteria in the gut. This type of dietary fiber also functions as an antioxidant and has been reported to be contained in pears.[12]

Li et al[13] compared the chemical composition and antioxidant activities of 8 pear cultivars. Arbutin and catechin were the dominant polyphenol compounds in the 8 pear varieties, followed by chlorogenic acid, quercetin, and rutin. The pears with high total phenolics and total flavonoids contents had significantly higher antioxidant and anti-inflammatory abilities than did those of other species. Anthocyanins were correlated to antioxidant capacity in pears, whereas total triterpenoids were strongly correlated to anti-inflammatory activity.

SYSTEMATIC REVIEW OF PEAR INTAKE AND HEALTH OUTCOMES

We conducted a systematic review of the health outcomes associated with pear consumption. This review was conducted in September 2013 with the systematic review process used by the Dietary Guidelines Advisory Committee.[14] An updated search was conducted in April 2014 to include any additional studies published on health benefits of pears since this original search. The search process and selection criteria are similar to those described by Clark and Slavin.[15] As there were no reviews in the literature on pears and health outcomes, we searched articles from 1970 to present. In our initial review, we included any study that examined pears and a health outcome. We have divided these articles into animal studies, in vitro studies, clinical studies, and epidemiologic studies. Only studies published in English were included. For epidemiologic studies, pears were often just included as a fruit or were grouped with apples as a member of the Rose family or pome fruits (fruits with a characteristic compartmented core).

IN VITRO STUDIES WITH PEARS

In vitro binding of bile acids by bananas, peaches, pineapple, grapes, pears, apricots, and nectarines was compared.[16] Binding values were as follows: bananas > peaches = pineapple > grapes = pears > apricots > nectarines. The authors suggest that the variability in bile acid binding between the fruits may be related to their phytonutrients, antioxidants, polyphenols, flavonoids (anthocyanins, flavonols, and proanthocyanidins), structure, hydrophobicity of undigested fractions, anionic or cationic nature of the metabolites produced during digestion, or their interactions with active binding sites.

Barbosa et al[17] investigated the phenolic- compounds in aqueous and ethanolic extracts of peel and pulp from 8 different freshly harvested and long-term–stored pear varieties. Total soluble phenolics, 2-2-diphenyl-1-picrylhydrazyl radical scavenging–based antioxidant activity, and associated in vitro α-glucosidase, α-amylase, and angiotensin I–converting inhibitory activities were analyzed. Peel extracts had higher total soluble phenolic content and related antioxidant capacity than pulp extracts. Comice variety had the highest total phenolic contents with positive correlation to total antioxidant activity. Aqueous pulp extracts had high α-amylase inhibitory activities with no correlation to phenolic content. The peel ethanolic extracts had the highest α-glucosidase inhibitory activity with positive correlation to total phenolics.

ANIMAL STUDIES WITH PEARS

The effects of bioactive compounds isolated from pears have been studied in animal models. Hamauzu et al[18] determined the effect of pear procyanidins on gastric lesions induced by HCl/ethanol in rats. Highly polymerized procyanidins extracted from pear fruit, orally administered, exhibited a high level of antiulcer capacity, whereas chlorogenic acid along seems to have a negative effect. The authors suggest that the antiulcer effect of pear procyanidins may be due to their strong antioxidant activity.

Leontowicz et al[19] compared bioactive compounds in apples, peaches, and pears and their effect on lipids and antioxidant capacity in rats. The content of all studied indices in peels was significantly higher than peeled fruits ($P < .05$). A good correlation between the total polyphenols and the total radical-trapping antioxidative potential values was found in all fruits. Diets supplemented with apples and to a lesser extent with peaches and pears improved lipid metabolism and increased the plasma antioxidant potential especially in rats fed with added cholesterol.

CLINICAL STUDIES WITH PEARS

Few feeding studies have been conducted with pears in human subjects. Alvarez-Parrilla et al[20] examined the effect of daily consumption of apple, pear, and orange juice on plasma lipids and total plasma antioxidant capacity (TAC) of smoking and nonsmoking adults. Subjects were given the fruits and juice daily, and TAC and lipid profile were measured after 26 days of consumption.

Fruit consumption increased TAC in nonsmokers, but not in smokers. In nonsmokers, total cholesterol, high-density lipoprotein cholesterol, and low-density lipoprotein cholesterol increased significantly. In smokers, total cholesterol and low-density lipoprotein cholesterol decreased with fruit consumption. Thus, smoking status affected the results; fruit consumption in nonsmokers increased TAC and cholesterol, whereas in smokers it reduced cholesterol without changing TAC.

Polyphenols are a diverse group of secondary plant metabolites. The main polyphenols are flavonoids, phenolic acids, phenolic alcohols, stilbenes, and lignans. Flavonoids, the largest subclass of polyphenols, are divided into 6 subclasses according to the oxidation state of the central pyran ring: flavonols, flavones, flavanones, isoflavone, anthocyanidins, and flavanols. Stilbenes are a type of plant-derived polypeptides including *trans* resveratrol and *trans* piceid. Flavonoids and stilbenes are common in the human diets, especially found in fruits, vegetables, and nuts.

Li et al[21] assessed daily flavonoid and stilbene intakes and evaluated these compounds' association with cardiovascular risk factors such as serum lipids and carotid intima-media thickness in Chinese adults. In this cross-sectional study (n = 1393), dietary flavonoid and stilbene intakes were assessed with a quantitative food frequency questionnaire. The relationship between flavonoids and stilbene intake and cardiovascular risk factors was assessed using either partial correlation coefficients or analysis of covariance.

The richest sources of flavonoids and stilbenes were the fruit group including apple, plum, pear, and peach. Higher dietary flavonoid intake was associated with improved lipid profile in Chinese women, but not for Chinese men. Women did report higher consumption of flavonoids.

The effect of adding fruit or oats to the diet of free-living women on energy consumption and body weight was evaluated.[22] Women with body mass index greater than 25 kg/m^2 were randomly chosen to add 3 apples, 3 pears, or 3 oat cookies to their usual diet for 10 weeks. Energy intake was not controlled, and the oat group consumed more calories. Apples and pears were associated with weight reduction, whereas the weight of the oat group was unchanged. The authors suggest that energy densities of fruits, independent of their fiber amount, can reduce energy consumption and body weight over time.

EPIDEMIOLOGIC STUDIES WITH PEAR AND HEALTH OUTCOMES

Diets high in fruits are widely recommended for their health-promoting properties. Fruits have historically held a place in dietary guidance because of their concentrations of vitamins, especially vitamins C and A; minerals, especially electrolytes; and phytochemicals, especially antioxidants. Fruits also provide dietary fiber.

Although traditionally in nutrition we assume that health benefits of foods are associated with food components, vitamins, minerals, and dietary fiber, for example, more and more evidence suggests that the health benefits of fruits and other plant foods are attributed to the synergy or interactions of bioactive compounds and other nutrients in whole foods. These relationships are difficult to study and provide challenges to design studies to test the protective properties of whole foods.

Fruits contain mostly carbohydrate in the form of sugar and dietary fiber. Generally, fruits are quite perishable and when ripe are difficult to collect and transport. Many fruits consumed in today's world are processed, frozen, canned, or dried. Few studies exist on nutrient retention in fruits with processing. Barrett and Lloyd[23] reviewed processing methods and nutrient losses in fruits and vegetables. Most research suggests that postharvest processing techniques do not significantly decrease nutrients in fruits, but there are limited studies. Also, pears are more shelf stable than some fruits, but present challenges to get fresh pears to consumers at the peak of ripeness.

For epidemiologic studies that use food frequency measures, pears are generally captured as total fruit, either fresh or canned. Pears and apples are often listed together on food frequency instruments because they are botanically related and provide similar nutrient profiles. Larsson et al[24] examined total and specific fruit and vegetable consumption and risk of stroke in a Swedish cohort. They prospectively followed 74 961 participants who had completed a food frequency questionnaire in the autumn of 1997 and were free from stroke, coronary heart disease, and cancer at baseline. Diagnosis of stroke in the cohort during follow-up was ascertained from the Swedish Hospital Discharge Registry. A total of 4089 stroke cases were found during 10.2 years of follow-up. Among individual fruit and vegetable subgroups, inverse associations with total stroke was observed for apples/pears and green leafy vegetables. The study found an inverse association of fruit and vegetable consumption with stroke risk. Particularly consumption of apples and pears and green leafy vegetables was inversely associated with stroke.

Hu et al[25] conducted a meta-analysis to summarize evidence from prospective cohort studies about the association of fruits and vegetable consumption with risk of stroke. Twenty prospective cohort studies were included. They reported protection with fruit and vegetable consumption and suggested that citrus fruits, apples/pears, and leafy vegetables might contribute to the protection.

Other epidemiological studies measured the relationship between intake of major flavonoid subclasses and risk of disease. Wedick et al[26] evaluated whether dietary intakes of major flavonoid subclasses were associated with risk of type 2 diabetes in US adults. Combining 3 large cohorts, they found 12 611 cases of type 2 diabetes during 3 645 585 person-years of follow-up. Consumption of anthocyanin-rich foods, particularly blueberries and apples/pears, was associated with a lower risk of type 2 diabetes. No significant associations were found for total flavonoid intake or other flavonoid subclasses.

Mink et al[27] determined flavonoid intake and cardiovascular disease mortality in postmenopausal women. Individual flavonoid-rich foods associated with significant mortality reduction included apples or pears and coronary heart disease and cardiovascular disease.

Muraki et al[28] determined whether fruit consumption and risk of type 2 diabetes were linked by combining results from 3 longitudinal cohort studies. They reported differences among the individual fruits. Greater consumption of specific whole fruits, particularly blueberries, grapes, and apples/pears, is significantly associated with a lower risk of type 2 diabetes, whereas greater consumption of fruit juice is associated with a higher risk.

Although there is much interest in the Mediterranean diet and improved status, other dietary patterns are also being studied for their health-promoting effects. Olsen et al[29] developed a food index based on traditional Nordic food items with expected health-promoting effects and related that to all-cause mortality in a cohort of Danes (n = 57 053) aged 50 to 64 years. During 12 years of follow-up, 4126 of the cohort died. A healthy Nordic food index, consisting of traditional Nordic food items with expected health-promoting effects (fish, cabbages, rye bread, oatmeal, apples and pears, and root vegetables), was extracted and associated with mortality by Cox proportional hazard models. Whole-grain rye bread intake was the factor most consistently associated with lower mortality in men. The protective effect of the traditional pattern, which included pears, was stronger in men than in women.

Most recent prospective cohort studies on fruits and vegetables and cancer protection show limited associations. Results from the EPIC cohort found that intake of apples and pears was linked to less lung cancer.[30] A study in the National Institutes of Health–AARP Diet and Health Study found some protection against lung cancer with higher consumption of fruits from the Rosaceae group (apples, peaches, nectarines, plums, pears, and strawberries).[31] Later publications from this group found no associations between intake of fruits and vegetables and total cancer incidence.[32]

Thus, few studies exist on the unique health benefits of pears. Apples and pears are generally linked together in food frequency instruments because of their similar composition. The protective properties of the apple-pear intake are generally as good as total fruit and sometime better in prospective cohort studies.

CONCLUSIONS

- Fruit consumption, including pears, is universally promoted in dietary guidance.
- Pears are an excellent source of dietary fiber and a good source of vitamin C. Pears, like most fruit, provide potassium to the diet. Dietary fiber and potassium are nutrients of concern in the US diet.
- Pears are rich in fructose and sorbitol. In combination with dietary fiber, consumption of pears should improve gut health and prevent constipation.
- Pears provide antioxidants and are concentrated in flavonols, particularly anthocyanins. Intake of pears/apples in prospective cohort studies is linked to less type 2 diabetes and stroke.
- The body of evidence for a relationship between pear intake and health outcomes is sparse and diverse. Intervention studies with pears that show positive health outcomes, most likely improvements in gut health, are urgently needed.

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