

Pulse Crops and their Key Role as Staple Foods in Healthful Eating Patterns

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Crop Series | Production

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What are Pulse Crops?

Pulse crops, also called grain legumes, are plants from the legume family (Leguminosae) that are strictly harvested for their dried seeds. The term “pulse” is derived from the Latin word “puls,” meaning thick soup, potage, or broth. Some of the most popular types of pulses include:

- Chickpeas (*Cicer arietinum* L.)
- Common beans (*Phaseolus vulgaris* L.), such as pinto, black, and kidney beans
- Dry peas (*Pisum sativum* L.)
- Lentils (*Lens culinaris* Medikus)
- Cowpeas (*Vigna unguiculata* L. Walp), such as black-eyed peas

Fresh legumes (e.g., fresh beans, peas, and pods) and oilseed legumes (e.g., soybeans and peanuts) are not considered pulses, although they also belong to the legume family (see Figure 1). Pulses have been consumed by humans for millennia and are among the most extensively used staple foods in the world. Although pulse crops are an integral part of the diets of billions of people worldwide, notably in Africa and South Asia, they have a much smaller role in Western countries, including the United States.

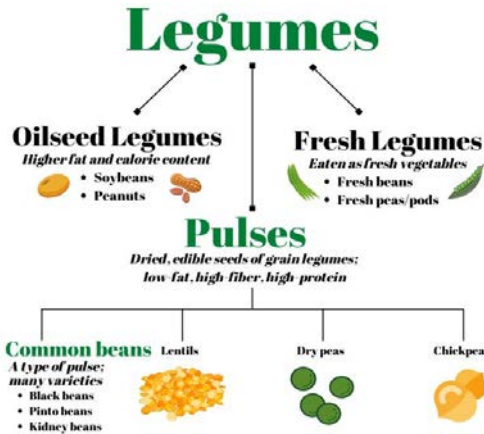


Figure 1. Differentiating the terms legumes and pulses. Along with fresh legumes and oilseed legumes, pulses also belong to the legume family. Common beans are one of the most popular types of pulse crops worldwide.

Nutritional Value of Pulse Crops

Although the nutritional value can vary slightly among species, all pulses are nutrient-dense, providing a rich source of fiber, protein, minerals (e.g., iron), and vitamins (e.g., folate). Furthermore, they are gluten-free, cholesterol-free, and – unlike their oilseed legume counterparts – pulses are low in fat.

- **Fiber:** Although pulses contain a high concentration of carbohydrate (50 to 65%), their fiber-rich profile results in slower digestion and a lower glycemic index compared to other carbohydrate-rich foods like rice,



Quick Facts

- Pulses (such as common beans, chickpeas, lentils) have been consumed by humans for millennia and are among the most extensively used staple foods in the world
- All pulses are nutrient-dense, providing a rich source of fiber, protein, minerals (e.g., iron), and vitamins.
- Pulses are rich sources of protein and are much more affordable than other protein sources.
- Pulse consumption is linked to healthy weight maintenance and the prevention of several chronic diseases, including cancer, cardiovascular disease, digestive health problems, obesity, and type 2 diabetes.
- As a natural cholesterol-free, gluten-free, and vegetarian/vegan food, they can easily be incorporated into special eating patterns such as diabetic diets, gluten-free diets, vegetarian diets, and weight management diets.

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- white bread, or potatoes (1). Whole-grain cereal crops like brown rice and oats are often promoted for their fiber content. However, pulses contain 2-3 times more fiber and protein than cereal crops (2).
- *Protein*: For every gram of fiber in pulses, there is approximately 1 gram of protein, making pulses one of the richest sources of plant-based protein.
- *Minerals*: Some of the key minerals found in pulses include iron, potassium, magnesium, and zinc (3).
- *Vitamins*: Pulses are also abundant in B vitamins, including folate, thiamin, and niacin (3).

Many of the nutrients provided by pulses are low in American diets (2, 4). Thus, including pulses as a staple food can improve food security and provide numerous health benefits. See Table 1 for a nutritional analysis of four pulses, although nutrition facts may vary slightly based on factors such as varietal of pulse (e.g., the type of lentil) and brand.

Diverse Roles of Pulses in Healthful Eating Patterns

The nutrient-dense profile of pulses makes them a nutritional powerhouse that can contribute to a healthy and balanced eating pattern. Although further research is needed to clarify the benefits and mechanisms by which positive health outcomes may occur, pulse consumption is linked to healthy weight maintenance and the prevention of several chronic diseases, including:

- *Cancer*: Pulse consumption may help protect against cancer, due to compounds such as fiber and phytonutrients with antioxidant capacity. Since a high-fiber diet has been associated with a reduced risk of certain cancers (e.g., colorectal cancer), the World Cancer Research Fund (WCRF) and the American Institute for Cancer Research recommend including pulses in most meals (5).

Table 1. Nutritional analysis of 1/2-cup serving of different pulses. Information is from the United States and Department of Agriculture (USDA) FoodData Central (FDC), <https://fdc.nal.usda.gov/>. FDC ID numbers are as follows: 574172 for chickpeas, 702764 for common beans, 172429 for dry peas, and 784289 for lentils.

Nutrient	Chickpeas	Common Beans (Black Beans)	Dry Peas	Lentils
Energy (kcal)	120	120	116	104
Protein (g)	6	8	8	8
Fat (g)	2	1	0.5	0
Carbohydrate (g)	20	21	21	18
Fiber, total dietary (g)	4	6	8	7
Calcium (mg)	40	40	14	17
Iron (mg)	1.4	2	1.3	3
Potassium (mg)	230	360	355	330

- *Cardiovascular disease:* Due to containing a high amount of fiber, folate, and phytochemicals and low amount of saturated fat and sodium (in their whole unprocessed form), pulses may benefit heart health. A meta-analysis of populations in the USA, Japan, Spain, Greece, Finland, and Iran showed that the highest category of dietary legume consumption was associated with a 10% reduction in cardiovascular disease risk (6).
- *Digestive health problems:* Pulse consumption is associated with positive gut health outcomes, such as the presence of beneficial gut microbes. These benefits are often attributed to beneficial compounds in pulses, such as fiber (7).
- *Obesity and weight management:* Pulses may help maintain a healthy weight and reverse obesity. A meta-analysis showed that eating 132 grams of pulses per day for a median duration of 6 weeks resulted in a weight reduction of 0.75 pounds (8). Also, data from the U.S. National Health and Nutrition Examination Survey (NHANES) suggests that bean consumers have lower body weight, smaller waist circumference, and a lower risk of obesity when compared to non-bean consumers (9).
- *Type 2 diabetes:* Optimal glycemic control is critical in diabetes management. The consumption of high-fiber, low glycemic index carbohydrates can reduce the risk of developing type 2 diabetes. Pulses have a low glycemic index and are one of the most fiber-rich whole foods, making them a great food choice for people with diabetes.

Many organizations and eating patterns recommend regularly eating pulses, such as USDA MyPlate, the American Heart Association, the American Diabetes Association, and the Dietary Approaches to Stop Hypertension

(DASH) diet. Although further research is needed to determine the ideal serving size of pulses – which may vary among individuals – it is clear that incorporating pulses in daily eating patterns as a staple food can have multiple health benefits.

Special Eating Patterns

Pulses can be an excellent part of any eating pattern. As a natural cholesterol-free, gluten-free, and vegetarian/vegan food, they can easily be incorporated into special eating patterns, such as:

- *Diabetic diet:* Pulses have a low glycemic index and may help with blood glucose management. The American Diabetes Association calls beans a ‘diabetes superfood’ (10).
- *Gluten-free diet:* Pulses contain no gluten; therefore, people with celiac disease and gluten intolerance can enjoy whole pulses or pulse powders (also known as flours). However, despite being naturally gluten-free, due to production, processing, and retail settings (e.g., bulk sections), pulses may come into contact with gluten. Therefore, individuals with severe sensitivity to gluten are advised to seek certified gluten-free pulses.
- *Sustainable diet:* Pulses have numerous benefits for environmental sustainability, including their ability to improve soil fertility and reduce greenhouse gas emissions (11).
- *Vegetarian/Vegan diet:* Pulses are rich in protein, fiber, vitamins, and minerals, making them an excellent food choice for vegetarians and vegans.
- *Weight management diet:* Pulse consumption has been associated with healthy weight management.

Misinformation about Pulses

Worldwide, pulse consumption has been declining in recent decades. This decline is largely attributed to negative perceptions consumers may have about pulses. However, there is support in the literature to contradict these false perceptions.

- *Antinutrients*: Pulses contain several compounds often called ‘antinutrients’ that may affect the nutritional quality of pulses (e.g., enzyme inhibitors may lower the digestibility of protein). Pulse breeding programs over the last three decades have focused on breeding cultivars that contain a lesser concentration of antinutrients. Furthermore, proper preparation of pulses eliminates or reduces these factors; for instance, lectins can be completely inactivated through the cooking process (12, 13). Importantly, many of these so-called antinutrients (e.g., phytic acid and phenolic compounds) have been linked to potential health benefits, such as anti-cancer, antioxidant, and anti-diabetic activity (14).
- *Long cooking times*: Soaking pulses is one way to reduce cooking times and levels of antinutrients. However, some types do not require soaking. For instance, soaking lentils is not necessary, yet they still cook in about the same amount of time it takes to prepare rice.
- *Flatulence*: Pulses contain non-digestible carbohydrates, such as galacto-oligosaccharides which cannot be digested by humans because we lack the enzyme α -galactosidase. Fermentation of these compounds by gut microbiota can result in bloating and the production of gas. However, many individuals do not experience increased flatulence, and those

- subside as they adapt to pulse-rich eating patterns (15). Soaking and cooking beans properly can also reduce any flatulence that may be experienced.

Buying and Preparing Pulses

Pulses are an economical, versatile, and healthful food that can be purchased from almost all grocery stores in different forms, such as canned, as powders/flours (e.g., chickpea flour), dry in plastic bags or bulk, and as the ingredients of various products. Pulses are much more affordable than other protein sources. For example, the cost per serving of lentils is \$0.10 compared to \$1.49 for beef, \$0.73 for pork, and \$0.63 for chicken (16). Generally, pulses are soaked for 8-12 hours before cooking, however, there are exceptions (e.g., lentils do not require soaking, as mentioned above).

Pulse Recipes

Pulses can be used to make delicious and healthful breakfasts, appetizers, snacks, salads, entrées, soups, and desserts. There are many pulse recipe databases to search, including:

- Alberta Pulse Growers:
<https://albertapulse.com/recipe/>
- American Pulse Association and USA Dry Pea & Lentil Council: <https://pulses.org/us/pulse-recipes/>
- Northern Pulse Growers Association:
<https://www.northernpulse.com/recipes>
- Ontario Bean Growers:
<http://ontariobean.ca/recipe-library/>
- Pulse Canada:
<http://www.pulsecanada.com/resources/>
- Saskatchewan Pulse Growers:
<https://www.lentils.org/recipes-cooking/>

Benefits of Growing Pulse Crops for Farmers and Sustainability

Pulses are among the most versatile crops that farmers can choose to grow and play an important role in making cropping systems more sustainable. Pulses can fix and use atmospheric nitrogen (under favorable conditions), potentially reducing the need for synthetic nitrogen fertilizer thus its associated environmental concerns (nitrate leaching, nitrous oxide emission, etc.). Compared to many other common crops, e.g., corn and forages, they require less irrigation water, which is especially important in dry regions like Colorado. Also, pulse crops have a lower carbon footprint compared to many other crops and can improve system productivity through positive impacts on other crops in the rotation (17). Moreover, the same equipment used for growing grain crops can be used for pulse crop production in most cases, thereby preventing the need to invest in new equipment. Currently, Colorado State University is evaluating the production potential of various cool-season pulses (peas, lentils, chickpea, and faba beans) across Colorado under dryland and irrigated conditions. The results of that project will be available in 2021.

Pulses as a Staple Food: For Healthy People and a Healthy Planet

Legumes are categorized as both a vegetable and a protein source in the USDA 2015-2020 Dietary Guidelines for Americans and the USDA MyPlate. Although this dual listing speaks to the unique nutrient-density of pulses, it can be confusing to consumers. If the goal is to obtain health benefits associated with pulse crops, most evidence

indicates that their proper place in the diet is as a staple food. A staple food is a food that is eaten routinely in such quantities that it constitutes a dominant portion of an individual's diet. In this role, pulses would provide a large fraction of daily energy, fiber, and protein needs as well as a significant proportion of the intake of other nutrients. While the number of dietary intervention studies in which one or more pulses were fed as a staple food is limited, human health benefits have been observed at intakes of 1.5 cups of cooked pulses per day (18, 19). One approach to increasing intake and achieving the associated benefits is to eat a ¼-cup (cooked) of each of the main four types of pulses (i.e., chickpeas, common beans, dry peas, and lentils) each day and to slowly increase this amount. Ultimately, more consumption of pulses as staple foods can benefit both human and environmental well-being.

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Disclaimer:

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References

1. Hillen C, Hillen C, Garden Robinson J. Composition, nutritional value, and health benefits of pulses. *Cereal Chemistry*. 2017;94(1):11-31.
2. Thompson HJ, Brick MA. Perspective: Closing the dietary fiber gap: An ancient solution for a 21st century problem. *Advances in Nutrition*. 2016;7(4):623-6.
3. Dahl WJ. Health benefits of pulses: Springer; 2019.
4. Fulgoni III VL, Keast DR, Bailey RL, Dwyer J. Foods, fortificants, and supplements: where do Americans get their nutrients? *The Journal of nutrition*. 2011;141(10):1847-54.
5. Health HTHCSop. Legumes and Pulses. <https://www.hsph.harvard.edu/nutritionsource/legumes-pulses/>. 2020.
6. Marventano S, Pulido MI, Sánchez-González C, Godos J, Speciani A, Galvano F, et al. Legume consumption and CVD risk: a systematic review and meta-analysis. *Public health nutrition*. 2017;20(2):245-54.
7. Clemente A, Olias R. Beneficial effects of legumes in gut health. *Current Opinion in Food Science*. 2017;14:32-6.
8. Kim SJ, De Souza RJ, Choo VL, Ha V, Cozma AI, Chiavaroli L, et al. Effects of dietary pulse consumption on body weight: a systematic review and meta-analysis of randomized controlled trials. *The American journal of clinical nutrition*. 2016;103(5):1213-23.
9. Papanikolaou Y, Fulgoni III VL. Bean consumption is associated with greater nutrient intake, reduced systolic blood pressure, lower body weight, and a smaller waist circumference in adults: results from the National Health and Nutrition Examination Survey 1999-2002. *Journal of the American College of Nutrition*. 2008;27(5):569-76.
10. Diabetes Superfoods: American Diabetes Association; [Available from: <https://www.diabetes.org/nutrition/healthy-food-choices-made-easy/diabetes-superfoods>.
11. Foyer CH, Lam H-M, Nguyen HT, Siddique KH, Varshney RK, Colmer TD, et al. Neglecting legumes has compromised human health and sustainable food production. *Nature plants*. 2016;2(8):1-10.
12. Nciri N, Cho N, Mhamdi FE, Ismail HB, Mansour AB, Sassi FH, et al. Toxicity assessment of common beans (*Phaseolus vulgaris* L.) widely consumed by Tunisian population. *Journal of medicinal food*. 2015;18(9):1049-64.
13. Thompson HJ. Improving human dietary choices through understanding of the tolerance and toxicity of pulse crop constituents. *Current Opinion in Food Science*. 2019;30:93-7.
14. Muzquiz M, Varela A, Burbano C, Cuadrado C, Guillaumon E, Pedrosa MM. Bioactive compounds in legumes: pronutritive and antinutritive actions. Implications for nutrition and health. *Phytochemistry reviews*. 2012;11(2):227-44.
15. Veenstra J, Duncan A, Cryne C, Deschambault B, Boye J, Benali M, et al. Effect of pulse consumption on perceived flatulence and gastrointestinal function in healthy males. *Food Research International*. 2010;43(2):553-9.
16. Anonymous. AFFORDABILITY AND FOOD SECURITY. Available online: <https://www.usapulses.org/consumers/about-pulses/affordable#:~:text=In%20the%20Classroom-,Affordable,out%20for%20ingredients%20containing%20pulses!> 2020.
17. Stagnari F, Maggio A, Galieni A, Pisante M. Multiple benefits of legumes for agriculture sustainability: an overview. *Chemical and Biological Technologies in Agriculture*. 2017;4(1):2.
18. Hartman TJ, Albert PS, Zhang Z, Bagshaw D, Kris-Etherton PM, Ulbrecht J, et al. Consumption of a legume-enriched, low-glycemic index diet is associated with biomarkers of insulin resistance and inflammation among men at risk for colorectal cancer. *The Journal of nutrition*. 2010;140(1):60-7.
19. Zhang Z, Lanza E, Kris-Etherton PM, Colburn NH, Bagshaw D, Rovine MJ, et al. A high legume low glycemic index diet improves serum lipid profiles in men. *Lipids*. 2010;45(9):765-75.

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