

Plant-Based Milks: Soy¹

Jessica Goldberg, Daniela Rivero Mendoza, and Wendy J. Dahl²

Soy milk is a plant-based milk made from soybeans (*Glycine max*). Unlike some of the recently marketed plant-based milks, soy milk has a long history as a beverage around the world and has been marketed in the United States for more than a century (Shurtleff et al. 2013). If you have wondered how it compares to cow's milk, this publication describes the ingredients and nutrient content of commercially produced soy milk and its potential benefits and risks to health.

How is store-bought soy milk made?

To manufacture soy milk, whole soybeans are dehulled, heated, soaked, and rinsed to remove any beany flavor and decrease antinutrient content, and are then ground and filtered (Chen 1989). During this process the soy pulp, containing much of the insoluble fiber and some protein, is removed while most of the soy protein is retained (Chen 1989). The filtered soybean liquid that is produced creates soy milk (Chen 1989).

Commercially, the ingredients in soy milk are typically filtered water, soybean, a vitamin and mineral blend, salt, natural flavor, and a gum for thickening (Silk n.d.-b). Some brands add soy protein concentrate. Sugar is added to sweetened, flavored varieties (Silk n.d.-c). Soy milk is typically fortified with calcium and vitamins A and D to levels similar to or higher than those of cow's milk. This plant-based milk is available in several varieties and flavors,

including original, light, organic, unsweetened, vanilla, and chocolate (Silk n.d.-d).



Figure 1.
Credits: Lincoln Zotarelli, UF/IFAS

How does the nutrient profile of soy milk compare to cow's milk?

Table 1 shows the nutrient profiles of three types of soy milk (unsweetened, light, and nonfat) and three types of cow's milk (fat-free, low-fat, and whole). The serving size for this comparison is 1 cup (8 oz). Unsweetened soy milk is similar in calorie content to fat-free cow's milk. Unsweetened soy milk is the closest plant-based milk that is comparable to cow's milk in terms of protein and key vitamins and minerals. Unsweetened soy milk is also lower in saturated fat than cow's milk. Per serving, the 12–13 grams of carbohydrates in cow's milk are from a naturally occurring sugar in milk (lactose), whereas unsweetened soy

1. This document is FSHN20-54, one of a series of the Food Science and Human Nutrition Department, UF/IFAS Extension. Original publication date December 2020. Revised May 2024. Visit the EDIS website at <https://edis.ifas.ufl.edu> for the currently supported version of this publication.
2. Jessica Goldberg, graduate student, Food Science and Human Nutrition Department; Daniela Rivero Mendoza, Extension and research coordinator; and Wendy J. Dahl, associate professor, Food Science and Human Nutrition Department; UF/IFAS Extension, Gainesville, FL 32611.

milk contains only 3 grams of carbohydrates, with 2 grams being fiber. However, many brands and varieties of soy milk, including light soy milk and nonfat plain soy milk, have added sugars. However, these two soy milk versions are also lower in calories and fats than the unsweetened soy milk and any type of cow's milk, with just slightly lower amounts of protein.

What are the potential health benefits of soy milk?

Soy milk is a source of essential fatty acids (USDA n.d.). Because it is low in saturated fat, it may be ideal for those limiting their saturated fat intake to reduce their risk of cardiovascular disease. Keep in mind that the Dietary Guidelines for Americans recommends consuming less than 10 percent of calories per day from saturated fats (USDA and USDHHS 2020). The protein found in soy milk is highly digestible; it is also considered complete because it contains all 9 essential amino acids (the building blocks of proteins) and thus is a good source of high-quality protein (Hughes et al. 2011) compared to other plant-based milks, which are typically low in protein. Soy milk also provides dietary fiber. Although most insoluble fiber is removed in the manufacturing of soy milk, there is some soluble fiber in soy milk.

Isoflavones are phytochemicals in soybeans with known bioactivity in the body, such as inhibiting bone loss and stimulating bone formation in menopausal women (Ma et al. 2008), as well as improving their cognitive function and visual memories (Cheng et al. 2015). However, to attain the beneficial effects of soy isoflavones, intake must be at least 60–100 mg per day. The isoflavone content in soy milk ranges from about 3 to 50 mg per 1 cup serving, depending on the brand of soy milk (USDA 2015). Though soybeans are considered one of the foods that are higher in isoflavones, some commercial soy milk may not provide levels adequate to exert a health benefit (USDA 2015; Bhagwat, Haytowitz, and Wasswa-Kintu 2019).

External estrogen, such as contraceptives and hormonal replacement therapy, may increase the risk of breast cancer (Anothaisintawee et al. 2013). However, higher consumption of soy foods containing isoflavones (phytoestrogens) is associated with a lower risk of developing breast cancer (Zhao et al. 2019) and lower recurrence (Qiu et al. 2019). Soy is also associated with a decreased risk of prostate cancer (Applegate et al. 2018), colorectal cancer (Yu et al. 2016), and endometrial cancer (Zhong et al. 2018).

Consuming soy is associated with a decreased risk of cardiovascular disease, stroke, and coronary heart disease (Li et al. 2020). In menopausal women, soy may help relieve hot flashes and other menopausal discomforts (Taku et al. 2012); it also provides protein that enhances bone health (George et al. 2020). Fortified soy milk is a good source of calcium (USDA n.d.). Because soy provides plant protein and is low in carbohydrate, consuming unsweetened soy milk may help manage glycemic response in diabetes and insulin-resistant patients. A higher intake of soy products has been shown to be associated with a lower risk of type 2 diabetes mellitus (Li et al. 2018).

What are the possible risks of soy milk?

Does soy have “feminizing effects”? This is a common misconception about soy. Isoflavone (soy phytoestrogen) has a structure similar but not identical to estrogen (a hormone that plays various roles in the female body, including developing and maintaining female characteristics and the reproductive system). A review of studies found that there is no evidence suggesting that isoflavone exposure increases blood estrogen levels in men (Messina 2010). Neither soy foods nor isoflavone supplements altered levels of reproductive hormones, such as testosterone, in men (Li et al. 2020). Also, no effects were found on thyroid hormones (Li et al. 2020).

Soy milk may interact with certain medications, such as warfarin, resulting in decreased efficacy (Cambria-Kiely 2002). It is recommended that individuals consult their physician or pharmacist for more information on potential soy-medication interactions. Soy milk is free of lactose (milk sugar) and milk protein, making it an appropriate choice for people who have an intolerance to lactose or an allergy to cow's milk protein, respectively. However, soy is one of the 8 major food allergens (Food and Drug Administration [FDA] 2018). Soy milk must be avoided by individuals with a soy allergy.

Is soy milk an appropriate choice for children?

One 8 oz serving of soy milk contains 53% and 37% of the recommended daily protein intake for toddlers and young children, respectively, based on their average weight (Singhal et al. 2017). Soy milk may be an adequate replacement for cow's milk in vegan children or those who are allergic to cow's milk protein. Unsweetened soy milk is preferable because it does not contain added sugars.

Soy milk should never be provided to infants; however, soy-based infant formulas may be appropriate for infants whose mothers cannot breastfeed or otherwise receive human milk. For many reasons, breastfeeding is one of the most effective ways to ensure child health; human milk provides adequate energy and all the nutrients the infant needs for at least the first six months of life (World Health Organization n.d.).

Summary

Soy milk is a plant-based milk alternative that is comparable to cow's milk in terms of protein and other key nutrients. It is a source of isoflavones, which are associated with health benefits, including decreased risk of some types of cancer and protective effects on cardiovascular, bone, and possibly cognitive health. Because unsweetened soy milk is low in carbohydrate, it may be an appropriate beverage choice for people with diabetes needing to manage their blood glucose. Although there have been concerns regarding soy consumption and hormone effects, soy foods have not been shown to alter reproductive hormones in men. For children, such as those following a vegan diet, soy milk is an appropriate plant-based replacement for cow's milk.

References

- Anothaisintawee, Thunyarat, Cholatip Wiratkapun, Panuwat Lerdsitthichai, Vijj Kasamesup, Sansanee Wongwaisayawan, Jiraporn Srinakarin, Siriporn Hirunpat, Piyanoot Woodtichartpreecha, Sarawan Boonlikit, and Yot Teerawattananon. 2013. "Risk Factors of Breast Cancer: A Systematic Review and Meta-analysis." *Asia Pacific Journal of Public Health* 25 (5): 368–387. <https://doi.org/10.1177/1010539513488795>
- Applegate, Catherine C., Joe L. Rowles, Katherine M. Ranard, Sookyoung Jeon, and John W. Erdman. 2018. "Soy Consumption and the Risk of Prostate Cancer: An Updated Systematic Review and Meta-analysis." *Nutrients* 10 (1): 40.
- Bhagwat, S., D. B. Haytowitz, and S. Wasswa-Kintu. 2019. "USDA Special Interest Databases on Flavonoids." Accessed November 6, 2020. <https://data.nal.usda.gov/dataset/usda-special-interest-databases-flavonoids>
- Cambria-Kiely, Josie A. 2002. "Effect of Soy Milk on Warfarin Efficacy." *Annals of Pharmacotherapy* 36 (12): 1893–1896. <https://doi.org/10.1345/aph.1C160>
- Chen, Steve. 1989. "Preparation of Fluid Soymilk." In *Vegetable Protein Utilization in Human Foods and Animal Feedstuffs*, 341–352. Champaign, Illinois: American Oil Chemists' Society.
- Cheng, Peng-Fei, Jian-Jun Chen, Xin-Yu Zhou, Yi-Fei Ren, Wen Huang, Jing-Jing Zhou, and Peng Xie. 2015. "Do Soy Isoflavones Improve Cognitive Function in Postmenopausal Women? A Meta-analysis." *Menopause* 22 (2): 198–206. <https://doi.org/10.1097/GME.0000000000000290>
- Food and Drug Administration (FDA). 2018. "Food Allergies: What You Need to Know." Accessed August 10, 2022. <https://www.fda.gov/food/buy-store-serve-safe-food/food-allergies-what-you-need-know>
- George, Kelli S., Joseph Muñoz, Neda S. Akhavan, Elizabeth M. Foley, Shalom C. Siebert, Gershon Tenenbaum, Dania A. Khalil, Sheau C. Chai, and Bahram H. Arjmandi. 2020. "Is Soy Protein Effective in Reducing Cholesterol and Improving Bone Health?" *Food & Function* 11 (1): 544–551. <https://doi.org/10.1039/C9FO01081E>
- Heaney, R. P., C. M. Weaver, and M. L. Fitzsimmons. 1991. "Soybean Phytate Content: Effect on Calcium Absorption." *American Journal of Clinical Nutrition* 53 (3): 745–7. <https://doi.org/10.1093/ajcn/53.3.745>
- Hughes, Glenna J., David J. Ryan, Ratna Mukherjea, and Charles S. Schasteen. 2011. "Protein Digestibility-Corrected Amino Acid Scores (PDCAAS) for Soy Protein Isolates and Concentrate: Criteria for Evaluation." *Journal of Agricultural and Food Chemistry* 59 (23): 12707–12712. <https://doi.org/10.1021/jf203220v>
- Li, Ni, Xiaoting Wu, Wen Zhuang, Lin Xia, Yi Chen, Rui Zhao, Mengshi Yi, Qianyi Wan, Liang Du, and Yong Zhou. 2020. "Soy and Isoflavone Consumption and Multiple Health Outcomes: Umbrella Review of Systematic Reviews and Meta-Analyses of Observational Studies and Randomized Trials in Humans." *Molecular Nutrition & Food Research* 64 (4): 1900751. <https://doi.org/10.1002/mnfr.201900751>
- Li, Wenzhen, Wenyu Ruan, Ying Peng, and Dongming Wang. 2018. "Soy and the Risk of Type 2 Diabetes Mellitus: A Systematic Review and Meta-analysis of Observational Studies." *Diabetes Research and Clinical Practice* 137:190–199. <https://doi.org/10.1016/j.diabres.2018.01.010>

- Ma, D. F., L. Q. Qin, P. Y. Wang, and R. Katoh. 2008. "Soy Isoflavone Intake Inhibits Bone Resorption and Stimulates Bone Formation in Menopausal Women: Meta-analysis of Randomized Controlled Trials." *European Journal of Clinical Nutrition* 62 (2): 155–161. <https://doi.org/10.1038/sj.ejcn.1602748>
- Messina, Mark. 2010. "Soybean Isoflavone Exposure Does Not Have Feminizing Effects on Men: A Critical Examination of the Clinical Evidence." *Fertility and Sterility* 93 (7): 2095–2104. <https://doi.org/10.1016/j.fertnstert.2010.03.002>
- Qiu, Shumin, and Chongmin Jiang. 2019. "Soy and Isoflavones Consumption and Breast Cancer Survival and Recurrence: A Systematic Review and Meta-analysis." *European Journal of Nutrition* 58 (8): 3079–3090. <https://doi.org/10.1007/s00394-018-1853-4>
- Shurtleff, William, and Akiko Aoyagi. 2013. *History of Soy milk and Other Non-Dairy Milks (1126 to 2013)*. Soyinfo Center.
- Silk. n.d.-a. "Light Original Soy milk." Accessed November 6, 2020. <https://silk.com/plant-based-products/soymilk/light-original-soymilk/>
- Silk. n.d.-b. "Organic Unsweet Soy milk." Accessed November 6, 2020. <https://silk.com/plant-based-products/soymilk/organic-unsweet-soymilk>
- Silk. n.d.-c. "Original Soy milk." Accessed November 6, 2020. <https://silk.com/products/original-soymilk>
- Silk. n.d.-d. "Soy milk." Accessed November 6, 2020. <https://silk.com/plant-based-products/soymilk/>
- Singhal, Sarita, Robert D. Baker, and Susan S. Baker. 2017. "A Comparison of the Nutritional Value of Cow's Milk and Nondairy Beverages." *Journal of Pediatric Gastroenterology and Nutrition* 64 (5): 799–805. <https://doi.org/10.1097/MPG.0000000000001380>
- Taku, K., M. K. Melby, F. Kronenberg, M. S. Kurzer, and M. Messina. 2012. "Extracted or Synthesized Soybean Isoflavones Reduce Menopausal Hot Flash Frequency and Severity: Systematic Review and Meta-analysis of Randomized Controlled Trials." *Menopause* 19 (7): 776–90. <https://doi.org/10.1097/gme.0b013e3182410159>
- U.S. Department of Agriculture and U.S. Department of Health and Human Services. *Dietary Guidelines for Americans, 2020–2025*. 9th Edition. December 2020. Available at DietaryGuidelines.gov.
- U.S. Department of Agriculture. 2015. "USDA Database for the Isoflavone Content of Selected Foods." https://www.ars.usda.gov/ARSEUserFiles/80400525/Data/isoflav/Isoflav_R2-1.pdf
- U.S. Department of Agriculture. n.d. "Fooddata Central." Accessed September 30, 2020. <https://fdc.nal.usda.gov/index.html>
- Westsoy. n.d. "Non Fat Plain." Accessed November 6, 2020. <http://www.westsoymilk.com/products/non-fat/nonfat-plain/>
- World Health Organization. n.d. "Maternal, Newborn, Child and Adolescent Health: Breastfeeding." Accessed November 6, 2020. <https://www.who.int/maternal-child-adolescent/topics/child/nutrition/breastfeeding/en/>
- Yu, Yi, Xiaoli Jing, Hui Li, Xiang Zhao, and Dongping Wang. 2016. "Soy Isoflavone Consumption and Colorectal Cancer Risk: A Systematic Review and Meta-analysis." *Scientific Reports* 6 (1): 25939. <https://doi.org/10.1038/srep25939>
- Zhao, Ting-Ting, Feng Jin, Ji-Guang Li, Ying-Ying Xu, Hui-Ting Dong, Qun Liu, Peng Xing, Guo-Lian Zhu, Hao Xu, and Zhi-Feng Miao. 2019. "Dietary Isoflavones or Isoflavone-Rich Food Intake and Breast Cancer Risk: A Meta-analysis of Prospective Cohort Studies." *Clinical Nutrition* 38 (1): 136–145. <https://doi.org/10.1016/j.clnu.2017.12.006>
- Zhong, Xue-shan, Jing Ge, Shao-wei Chen, Yi-quan Xiong, Shu-juan Ma, and Qing Chen. 2018. "Association between Dietary Isoflavones in Soy and Legumes and Endometrial Cancer: A Systematic Review and Meta-analysis." *Journal of the Academy of Nutrition and Dietetics* 118 (4): 637–651. <https://doi.org/10.1016/j.jand.2016.09.036>

Table 1. Nutrient profiles of soy milk compared to fat-free, low-fat, and whole cow's milk.

	Unsweetened soy milk (1 cup)	Light soy milk (1 cup)	Nonfat plain soy milk (1 cup)	Fat-free skim milk (1 cup)	Low-fat milk (1%) (1 cup)	Whole milk (1 cup)
Energy (Calories)	80	60	70	83	105	146
Protein (g)	7	6	6	8	8	8
Total fat (g)	4	2	0	0.2	2.3	8
Saturated fat (g)	0.5	0	0	0.1	1.4	4.5
Polyunsaturated fat (g)	2.5	1	0	0	0	0.3
Monounsaturated fat (g)	1	0.5	0	0	0.5	1.7
Carbohydrate (g)	3	5	10	12	13	12
Fiber (g)	2	1	<1	0	0	0
Total sugars (g)	1	3	9	12	12	12
Vitamin A (mcg)	150	150	150	156	142	78
Vitamin B12 (mcg)	3	3	NR	1	1	1
Vitamin D (mcg)	3	3	2.5	3	3	3
Calcium (mg)	300	451	250	322	307	300
Sodium (mg)	75	115	105	100	95	93
Potassium (mg)	350	341	210	407	388	366
NR: Not reported. Source: (Silk n.d.-a, Silk n.d.-b, United States Department of Agriculture (USDA) n.d., Westsoy n.d.)						