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HEALTH AND NUTRITIONAL ATTRIBUTES OF DIFFERENT SOYFOODS

By Virginia Messina, MPH, RD

From both culinary and health perspectives, individual soyfoods have varying attributes, making them easy to incorporate into diets of people with different tastes and nutritional needs.

Soyfoods are often classified as either traditional Asian foods, like tofu and soymilk which have been consumed for centuries by some Asian populations, or as modern soyfoods, like plant-based meat alternatives made from soy protein. Among traditional Asian products, soyfoods are further divided into 2 groups: fermented and unfermented. However, these types of classifications can't fully describe differences among these foods because even different forms and brands of a single type of soyfood can vary.

As with most plant foods, nutrient composition depends on growing conditions, location and variety of the parent soybean.[1] For example, the protein content of soybeans ranges from 28.7-44.5% of calories.[2] Generally, soybeans are around 38% protein making them higher in protein than other legumes.[3] Many traditional soy products such as tofu, soymilk, and tempeh are good sources of protein. Modern soyfoods, including textured vegetable protein (TVP) and foods made from soy protein isolate (SPI) and soy protein concentrate (SPC), often provide even more of this macronutrient. SPI and SPC are about 90% and 65% protein, respectively.[4]

These concentrated sources of soy protein can be especially helpful for people who want to maintain a high protein intake while eating a diet comprised of more plant foods. Modern soy products can make it easier to achieve intake of 25g/d of soy protein, which has been shown to reduce LDL-cholesterol levels[5,6] and possibly to benefit patients with chronic renal disease.[7]

Whereas most beans are nearly fat-free, soybeans derive almost 50% of their calories from fat.[3] The fat – soybean oil — is predominantly polyunsaturated (~62%) and includes both the essential omega-6 and omega-3 fatty acids.[8] Soybean oil was awarded a health claim by the U.S. Food and Drug Administration in 2017 that states "supportive but not conclusive scientific evidence suggests that eating about 1½ tablespoons (20.5 grams) daily of soybean oil, which contains unsaturated fat, may reduce the risk of coronary heart disease."[9]

Differences in processing affect the isoflavone composition of soyfoods. In traditional Asian unfermented soyfoods, each gram of protein is associated with about 3-4mg isoflavones primarily in the glycoside form.[10] In contrast, in fermented soyfoods the isoflavones occur in the aglycone form to varying degrees.[11-15] The health implications of the different forms of isoflavones continue to be investigated.[16]

Not only can processing affect the form of isoflavones, but it can also reduce isoflavone content. The isoflavone content of SPI and SPC is typically ≤25% of the isoflavone content of traditional Asian soyfoods expressed on a mg/g protein basis.[17] To this point,

the *Impossible* burger provides 19g protein per patty, most of which comes from SPC, and contains only about 2mg isoflavones,[18] whereas a cup of soymilk made from whole soybeans provides about 25mg isoflavones.[10]

Overview of Common Soyfoods

Traditional Non-fermented Soyfoods

Whole Soybeans

Because these foods are minimally processed, their nutrient and phytochemical content is preserved. Whole soybeans are an excellent source of protein, fiber and iron, are predominantly polyunsaturated fat, have isoflavones and are a source of choline, a nutrient that can be low in plant-based diets such as flexitarian, vegetarian, and vegan.[19,20]

Mature soybeans can be purchased in dried form or as a canned product. Most often though, whole soybeans are consumed as edamame (green soybeans), which are soybeans harvested at about 80% maturity, accounting for their higher moisture and sugar content.[21] They are usually preferred to whole, mature soybeans for their milder, sweeter flavor and lower content of oligosaccharides.[22]

Oligosaccharides can cause intestinal discomfort and flatulence in some individuals but may also have health benefits. These poorly digested sugars are prebiotics that stimulate the growth of beneficial bacteria in the colon.[23,24]

Both edamame and mature soybeans can be roasted to create soynuts, a snack item that undergoes minimal processing and therefore, like all whole soyfoods, retains all of the nutrients found in whole soybeans. Soynuts may be made with added oils and flavorings.

Soymilk

Soymilk is the liquid expelled from soaked soybeans. Many versions have a protein content comparable to that of cow's milk and, if fortified, have a comparable calcium content as well. Calcium bioavailability from fortified soymilk was shown in healthy young women to be comparable to calcium bioavailability from cow's milk. [25] Fortified soymilk and soy yogurt are the only plant milk and yogurt included in the milk group of the current Dietary Guidelines for Americans. In addition to calcium, fortified soymilk typically includes vitamin D in the form of ergocalciferol. Although the okara (soybean pulp) is lost during the manufacturing of soymilk, it still contains about 1.5g of fiber per cup whereas cow's milk provides none.[26]

Tofu

Tofu is made by adding a coagulant to soymilk and pressing the resulting curds into a solid block. It's a good source of protein and can contribute calcium when a calcium-containing coagulant (calcium sulfate) is used. The use of other coagulants like nigari (magnesium chloride) produces tofu that is lower in calcium. Some manufacturers use more than 1 type of coagulant. As is the case for calcium-fortified soymilk, in a study involving premenopausal women, calcium bioavailability from tofu was shown to be similar to the bioavailability of calcium from cow's milk.[27]

The degree to which tofu is pressed also affects its nutrient content. Firm tofu is often higher in protein and calcium than soft tofu. Silken tofu is a more custard-like product in which the curds are not pressed, and it tends to be lower in nutrients than its pressed counterpart. Because of the various methods and ingredients used in tofu production, nutrient content varies greatly and it's best to depend on package labels for nutrient information rather than food databases.

One entry in the USDA Food Central database shows a calcium content of 683mg for 100g of raw firm tofu, but package labels suggest that calcium content is more likely to range between 75-200mg/100g. Tofu is low in total carbohydrate and, therefore, can be included in low-carbohydrate diets.

Traditional Fermented Soyfoods

Consumption of fermented soyfoods varies among Asian countries although globally, most soy is consumed in unfermented form. The 3 most common fermented soyfoods — tempeh, miso, and natto — are all made using the whole soybean. Some research indicates fermentation can increase antioxidant content[28,29] and may in general enhance nutrient bioavailability although results are somewhat mixed on this point.[30] Typically, these foods are not a source of vitamin B12 as is sometimes promoted.

Miso

Miso is produced by fermentation of soybeans and rice or barley with koji mold (Aspergillus oryzae) and added salt. It is widely used as a condiment in Japan where countless variations of this product are available. Miso may have a number of health benefits including that it may improve immune function, inhibit oxidation, and function as a probiotic.[31] However, miso is often high in sodium.[32]

Natto

Natto is a traditional Japanese food made from whole soybeans that have been fermented with *Bacillus subtilis var. natto*. With a distinctive odor and viscous texture, natto has not gained popularity outside of traditional Japanese cooking. In Japan, it is often served with rice as a breakfast food. There has been interest in natto because *Bacillus natto* produces *nattokinase*, an enzyme which exhibits a fibrinolytic activity[33] and some data suggest it may contribute to the reduction of CVD mortality.[34] Natto is also among one of the few plant sources of vitamin K2, which may promote bone health.[35]

Tempeh

Although tofu is widely consumed in Indonesia, tempeh is considered the country's staple source of protein.[36] Tempeh is produced through a fermentation process that binds soybeans into a cake form. Fermentation is achieved by aging the tempeh with a starter, which is a Rhizopus fungus. In Indonesia, tempeh making is often a home-based art where the soybeans are wrapped in banana leaves and left to ferment. Several studies suggest tempeh has a role in combating anemia.[36]

Modern Soyfoods

Soy Flour

Soy flour is made from ground roasted soybeans and is available as either a full-fat or defatted product. It is a good source of protein and has isoflavones. Soy flour is often added to baked goods for its beneficial effects on texture due to its content of both protein and lecithin. It is also sometimes used as an egg replacer in vegan baked products. Soy flour is typically 50% protein on a caloric basis.[4]

Textured Vegetable Protein (TVP)

TVP is a dried granular product made from defatted soy flour. It is sometimes flavored to taste like beef or chicken and must be rehydrated before using in recipes. Because TVP is an excellent source of protein (11g/half-cup prepared) and has a long shelf life, it is a common ingredient in ready-to-eat meals for camping, survival kits, and the military. It is an especially economical protein source that is valuable for preparing low-cost meals.

Plant-Based Meat Alternatives

An extensive variety of plant-based meat alternatives made from SPI and SPC are available. The composition of these products varies depending upon the main ingredients, source of fat, and micronutrients that are added. They are almost always an excellent source of protein, with some providing as much as 15g/serving. Some are also fortified with micronutrients, such as vitamin B12 and zinc. In Canada, all plant-based meat alternatives are fortified with vitamin B12. Different types of fat are used in their production, and sodium amounts may vary. A recent analysis concluded that despite the degree to which they are processed, soy-based burgers compare well with meat-based burgers with respect to overall nutritional and health attributes.[26]

ABOUT THE AUTHOR

Virginia Messina, MPH, RD, is co-author of *The Dietitians Guide to Vegetarian Diets and Vegan for Life* in addition to seven other books on plant-based nutrition. She was twice a co-author of the Academy's Position on Vegetarian Diets. As a nutrition consultant, she writes and speaks about social, ethical, and nutritional aspects of vegan diets. She has taught nutrition to university students and worked as a public health nutritionist. Her website is TheVeganRD.com

ROUNDING OUT YOUR PLATE WITH SOY

By Abbie Gellman, MS, RD, CDN

Soyfoods have a place on every plate. These nutrient powerhouses add vitamins, minerals, and more to your day, including protein and fiber.[1] Integrating soy into your diet can be very simple. Here are some ways to add a variety of soyfoods to your meals.

Tofu can be found in a few different forms, such as silken, soft, firm, and extra firm. Tofu's neutral taste makes it extremely versatile and easy to add to many dishes.

- Silken tofu can be used in pureed soups, smoothies, dips, and desserts, adding extra creaminess and protein.
- Firm and extra firm tofu can be diced, marinated, then baked or sauteed, and showcased as the main protein for the meal alongside roasted vegetables and whole grains, or it can be added to a salad, grain bowl, or stir fry.

Tempeh is a textured cake of fermented, cooked soybeans with a chewy bite. To remove any bitter flavors, steam or boil tempeh for 10-15 minutes prior to using in a recipe. Once steamed, tempeh can be baked, sauteed, fried, grilled, or added to dishes like chili or Bolognese sauce. Tempeh also holds up well when marinated prior to cooking.

Soy-based meat alternatives have become more popular over the last few years and can be found in most grocery stores nationwide. These products come in the form of patties, crumbles, sausages, nuggets, or meatballs and are easy to cook via stove, oven, or microwave. These options are a great way to add plant protein to your plate. Pair them with non-starchy vegetables such as broccoli, cauliflower, or leafy greens, and round out the meal with some whole grains or starchy vegetables like roasted sweet potatoes. Soy-based meat alternatives can also be used in sauces, soups, stews, wraps, tacos, and more.

Edamame is easy to prepare and is a great introduction to soyfoods for kids. Frozen edamame in pods can be cooked by boiling or steaming in the microwave and enjoyed as a snack or appetizer. The beans can also be pureed into a dip or added to soup, salad, and stir fry dishes for additional protein, texture, and color.

Soymilk, available in plain and flavored varieties, is both a delicious and nutritious beverage on its own or added to other recipes and dishes, including cereal and oatmeal. It is a great way to add plant protein and potassium to your day and, when fortified, also calcium and vitamin D.

ABOUT THE AUTHOR

Abbie Gellman, MS, RD, CDN, is a spokesperson, recipe and product developer, author, and educator; she creates, produces, and hosts cooking and nutrition videos and works with a wide variety of food companies/brands/commodity boards, foodservice operators, health professionals, and private clients. Learn more about her at ChefAbbieGellman.com and connect with her via @ChefAbbieGellman on Instagram, YouTube, Facebook, and Pinterest.

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Overview of Common Soyfoods

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Traditional Non-Fermented Soyfoods

Whole Soybeans

- Are an excellent source of protein, fiber and iron, are predominantly polyunsaturated fat, have isoflavones and are a source of choline, a nutrient that can be low in plant-based diets such as flexitarian, vegetarian, and vegan.[1,2]
- Mature soybeans can be purchased in dried form or as a canned product.
- Most often consumed as edamame (green soybeans), which are soybeans harvested at about 80% maturity, accounting for their higher moisture and sugar content.[3]
- Can be roasted to create soynuts, a snack item that undergoes minimal processing and therefore, like all whole soyfoods, retains all of the nutrients found in whole soybeans. Soynuts may be made with added oils and flavorings.

Soymilk

- Liquid expelled from soaked soybeans.
- Many versions have a protein content comparable to that of cow's milk and, if fortified, have a comparable calcium content as well.

- Calcium bioavailability from fortified soymilk was shown in healthy young women to be comparable to calcium bioavailability from cow's milk.[4]
- Fortified soymilk and soy yogurt are the only plant-based milk and yogurt included in the milk group of the current Dietary Guidelines for Americans.
- In addition to calcium, fortified soymilk typically includes vitamin D in the form of ergocalciferol.

Tofu

- Made by adding a coagulant to soymilk and pressing the resulting curds into a solid block.
- Good source of protein and can contribute calcium when a calcium-containing coagulant (calcium sulfate) is used.
- In a study involving premenopausal women, calcium bioavailability from tofu was shown to be similar to the bioavailability of calcium from cow's milk.[5]
- Firm tofu is often higher in protein and calcium than soft tofu.
- Silken tofu is a more custard-like product in which the curds are not pressed, and it tends to be lower in nutrients than its pressed counterpart.
- Because of the various methods and ingredients used in tofu production, nutrient content varies greatly and it's best to depend on package labels for nutrient information rather than food databases.

Traditional Fermented Soyfoods

Miso

- Produced by fermentation of soybeans and rice or barley with koji mold (Aspergillus oryzae) and added salt.
- Widely used as a condiment in Japan where countless variations of this product are available.
- May have a number of health benefits including that it may improve immune function, inhibit oxidation and function as a probiotic.[6]
- Often high in sodium.[7]

Natto

- Traditional Japanese food made from whole soybeans that have been fermented with Bacillus subtilis var. natto.
- Has a distinctive odor and viscous texture and has not gained popularity outside of traditional Japanese cooking.
- In Japan, it is often served with rice as a breakfast food.
- Bacillus natto produces nattokinase, an enzyme which exhibits a fibrinolytic activity[8] and some data suggest it may contribute to the reduction of CVD mortality.[9]
- One of the few plant sources of vitamin K2, which may promote bone health.[10]

Tempeh

- Considered Indonesia's staple source of protein.[11]
- Produced through a fermentation process that binds soybeans into a cake form. Fermentation is achieved by aging the tempeh with a starter, which is a Rhizopus fungus.

- In Indonesia, tempeh making is often a home-based art where the soybeans are wrapped in banana leaves and left to ferment.
- Several studies suggest tempeh has a role in combating anemia.[11]

Modern Soyfoods

Soy Flour

- Made from ground roasted soybeans and is available as either a full-fat or defatted product.
- Good source of protein and has isoflavones.
- Often added to baked goods for its beneficial effects on texture due to its content of both protein and lecithin.
- Sometimes used as an egg replacer in vegan baked products.
- Typically 50% protein on a caloric basis.[12]

Textured Vegetable Protein (TVP)

- Dried granular product made from defatted soy flour.
- Sometimes flavored to taste like beef or chicken and must be rehydrated before using in recipes.
- Excellent source of protein (11 g/half-cup prepared) with a long shelf life and is a common ingredient in ready-to-eat meals for camping, survival kits, and the military.
- Economical protein source that is valuable for preparing low-cost meals.

Plant-Based Meat Alternatives

- Extensive variety of plant-based meat alternatives made from SPI and SPC are available.
- Composition varies depending upon the main ingredients, source of fat, and micronutrients that are added.
- Almost always an excellent source of protein, with some providing as much as 15g/serving. Some plant-based meat alternatives are fortified with micronutrients, such as vitamin B12 and zinc. In Canada, all plant-based meat alternatives are fortified with vitamin B12.
- Different types of fat are used in production, and sodium amounts may vary.
- A recent analysis concluded that despite the degree to which they are processed, soy-based burgers compare well with meat-based burgers with respect to nutritional and health attributes.[13]

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Round Out Your Plate With Soy

Food Pairings

By Abbie Gellman, MS, RD, CDN

Breakfast

Overnight Oats made with **soymilk**, rolled oats, chia seeds, frozen blueberries, nuts, and maple syrup.

Lunch

Butternut Squash Soup made with cooked butternut squash, onion, garlic, spices/seasonings (salt, pepper, turmeric, cumin, coriander, ginger), and vegetable broth, then pureed with **silken tofu**.

Dinner

Tempeh sliced, marinated, and baked tossed with sauteed onion, garlic, tomatoes, artichoke hearts, basil, and lemon served over grain of choice.

Snack

Steamed **edamame** in pods, and pair with a piece of fruit.

Dessert

Pumpkin Mousse made with pumpkin puree, **silken tofu**, maple syrup, lemon zest and juice, vanilla extract, and spices (cinnamon, ginger, cloves).

Pumpkin Mousse

Ingredients

8 ounces silken tofu
¼ cup maple syrup
½ teaspoon lemon zest
1 tablespoon lemon juice
½ teaspoon vanilla
¼ teaspoon cinnamon
⅛ teaspoon ground ginger
⅛ teaspoon ground cloves
¼ teaspoon kosher salt
1 (14.5-ounce) can pureed pumpkin
Optional: vanilla wafer cookies or whipped cream

Directions

In a food processor or high-speed blender, add tofu, maple syrup, zest, juice, vanilla, cinnamon, ginger, cloves, and salt. Process till smooth.
Add in half of pumpkin and puree.
Transfer mixture to a bowl and add remaining pumpkin. Whisk together till creamy. Cover and place in refrigerator for at least 3 hours, or overnight.
Serve sprinkled with vanilla wafer cookies or a dollop of whipped cream.

Recipe created by
Chef Abbie Gellman, MS, RD, CDN

Total Time: 3 hours, 10 minutes

Makes: 4 servings

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