Soy Sauce

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What's New and Beneficial About Soy Sauce

Recent studies suggest that soy sauce may be able to provide some digestive tract benefits. These benefits are related to the soy sauce fermentation process, and the creation of certain unique carbohydrates (called oligosaccharides) during this process. Some of the micro-organisms involved with soy sauce fermentation contain enzymes that can break apart unique fibers (hemicelluloses) found in soybeans. When these hemicelluloses are broken apart, oligosaccharides are produced, and these oligosaccharides can help support the growth of "friendly" bacteria in our large intestine. (These bacteria include the lactic acid bacteria Lactobacillus bulgaricus and Streptococcus thermophilus.)

Soy sauce is widely regarded as a salty food, and that perception is correct, since it's not unusual for a tablespoon of soy sauce to contain 1,000 milligrams of sodium. ("Salt" and "sodium" can be used pretty much interchangeably in this context, since table salt is composed of sodium and chloride; it's the sodium part that is involved with health problems in salt-sensitive individuals.) It's true that 1,000 milligrams of sodium is a large amount. In fact, it's nearly half of the recommended limit for sodium intake in an entire day. As a high-sodium food, soy sauce might be expected to be associated with increased risk of certain cardiovascular problems, including high blood pressure, since a certain percentage of individuals are salt-sensitive and experience blood pressure increases alongside of a high-salt diet. Yet, what's interesting is that recent research studies have suggested that soy sauce may be different than other high-salt foods with respect to our blood pressure and cardiovascular health. When soy sauce is fermented in the traditional way, many of the proteins found in the soybeans get broken down into smaller molecules called peptides. Some of these peptides act to inhibit the activity of angiotensin I-converting enzyme (ACE) that is needed to constrict our blood vessels. Our blood pressure tends to goes up when our blood vessels constrict because there is less room for our blood to flow through. By decreasing ACE activity, peptides in soy sauce may be able to help prevent this process from happening.

It's still too early in the research process to give soy sauce any kind of "green
light" in terms of its salt content, however. Anyone at risk of excessive salt intake or following a salt-restricted diet should still consult with a healthcare provider before including more soy sauce in a meal plan than would otherwise be allowed based on sodium content.

Since soybeans are one of the eight food types most commonly associated with food allergy in the U.S., many people assume that soy sauce is a food with greater-than-usual potential to cause allergy problems. However, new research in this area suggests that soy sauce may be a far less allergenic form of soy that may actually provide support to our immune and inflammatory systems, which are typically involved in an allergic response. Two factors are especially fascinating in this new research. First is the breakdown of key allergy-triggering proteins in soybeans during the soy sauce fermentation process. (For example, an allergy-triggering protein in soybeans called Gly m Bd 30K gets broken down during soy sauce fermentation, and once this protein has been broken down into smaller parts, it can no longer trigger an allergenic response.) Second are the immune and inflammatory system benefits provided by unique soy sauce polysaccharides. Some of these carbohydrate-family molecules can lessen the activity of an enzyme called hyaluronidase. Overactivity of this enzyme is associated with increased inflammation and also with increased likelihood of allergic reaction. By lowering its activity, soy sauce polysaccharides may be able to lower the chances of an allergic reaction.

In an equally fascinating twist, allergic reaction to the soy sauce itself might not be the only allergy risk that is lowered by these polysaccharides. In preliminary studies on small groups of students, supplementation with soy sauce polysaccharides has been found to lessen the occurrence of seasonal allergy symptoms. Students in the studies were given soy sauce polysaccharide supplements rather than soy sauce itself, with the polysaccharide content of the supplements being equivalent to approximately 2 ounces of soy sauce each day. We won't be able to know whether soy sauce itself will be equally effective without future studies. Still, the direction of this research is fascinating since it involves a food traditionally associated with heightened allergy risk. Important Note: persons with known or suspected soy allergy should still consult with a healthcare provider before making a decision about soy sauce in their meal plan.
WHFoods Recommendation

We highly recommend that you look for a soy sauce that is traditionally made (more details on what this means in the Description section). Also, it's important to find one that doesn't have artificial colors or flavors, including caramel coloring. Many supermarkets and Asian groceries now offer these additive-free varieties; natural food stores also are a very good source for them. If you are have a wheat sensitivity, wheat-free versions are available. These are sometimes labeled as "tamari." (Please note though that "tamari" is actually a broader class of soy sauce that reflects that it is made with either less or no wheat).

We recommend selection of certified organic soy sauce. For soy sauce produced within the U.S., one of the major reasons we like certified organic soy sauce is the widespread use of genetic modification in non-organic soybeans. Genetically modified (GM) soybeans have reached 90% market penetration in the U.S. For soy sauce produced in other countries like Japan, Korea, China, or Indonesia, even though the likelihood of genetic modification might be less, we still like certified organic soy sauce due to the lower risk of unwanted contaminants like pesticides. In the case of non-U.S. soy sauce, you may not find the USDA organic seal on the product, but you should still look for the words "certified organic" or "organic certified" on the product label.

An Important Message About Soy Sauce

We have placed soy foods (such as Soy Sauce) on our "10 Most Controversial WHFoods List." This list was created to let you know that even though some foods (like soy sauce) can make an outstanding contribution to your meal plan, they are definitely not for everyone. Soy foods can be difficult to find in high-quality form; can be more commonly associated with adverse reactions than other foods; and can present more challenges to our food supply in terms of sustainability.

Health Benefits

Overall Nutrient Benefits, Including Great Antioxidant Benefits
Thanks to the unique soy sauce fermentation process, this food is a rich mixture of nutrients not typically present in as concentrated amounts in other foods. Peptides from proteins (smaller and often bioactive protein "building blocks"), oligosaccharides and polysaccharides from carbohydrates (smaller starch-like components) and other fermentation-based nutrients are characteristically present in soy sauce. These breakdown components from protein and carbohydrate provide us with immune system, digestive system, and cardiovascular support.

Soy sauce also contains many different types of antioxidants. It is a good source of the mineral antioxidant manganese. It also contains valuable amounts of antioxidant phenolic acids including vanillic, syringic, coumaric, and ferulic acid. Isoflavonoid antioxidants in soy sauce include glycitein, daidzein, genistein, and genistin. (It's worth noting here, however, that the soy sauce production process may sometimes involve steps that lower the concentration of these isoflavonoids significantly and leave soy sauce with a much lesser concentration than other soyfoods.) Interestingly, some studies have shown more phytonutrient antioxidant density in soy sauce than red wine! In terms of its antioxidant benefits, soy sauce also appears to have a special ability for decreasing formation of hydrogen peroxide in the body. Since formation of hydrogen peroxide can be involved in unwanted oxidative stress, this special ability on the part of soy sauce may be an important antioxidant benefit. However, researchers have yet to determine exactly how soy sauce works to decrease hydrogen peroxide formation.

In our food rating system, we classify soy sauce as a "good" source of protein. But soy sauce actually deserves special mention in this protein category, since it ranks 9th among all of the World's Healthiest Foods in terms of protein density. In other words, if you obtain one gram of protein from soy sauce, it will cost you fewer calories than if you try to obtain one gram of protein from more than 100 other WHFoods. The protein density of soy sauce is actually greater than the protein density of animal foods like lamb, fish like salmon, or soybeans themselves!

**Possible Digestive Tract Benefits**

The unique fermentation process used to produce soy sauce may bring with it a long list of digestive tract benefits. First is the breakdown of large protein and carbohydrate molecules into smaller units, including dipeptides or polypeptides from proteins and oligosaccharides or polysaccharides from carbohydrates. This breakdown of proteins and carbohydrates would typically be carried out in our
digestive tract by chemicals, enzymes, and bacteria. By carrying out breakdown through food fermentation, there may be less work needed in our digestive tract and that decreased "workload" may be helpful to our digestive tract under various circumstances.

Fermentation of soy sauce is also known to produce higher concentrations of oligosaccharides which support the growth of "friendly" bacteria in our large intestine. Here's how that process works: some of the micro-organisms involved with soy sauce fermentation contain enzymes that can break apart unique fibers (hemicelluloses) found in soybeans. When these hemicelluloses are broken apart, oligosaccharides are produced, and these oligosaccharides can help support the growth of lactic acid bacteria including Lactobacillus bulgaricus and Streptococcus thermophilus. These bacteria in turn help us obtain nutrients from food and provide for chemical balance inside of our large intestine.

**Fermented Soy Foods and Vitamin K**

Even though soy sauce is often fermented with the help of bacteria, as a general rule, Bacillus bacteria are not used in soy sauce fermentation. An exception to this rule involves the production of some Korean-style soy sauces, which do make use of Bacillus bacteria to help with fermentation.

From a health standpoint, one of the reasons why Bacillus bacteria - and especially one species called Bacillus subtilis - are so interesting is their ability to create a form of vitamin K2 called menaquinone-7 (MK-7). Vitamin K (in all forms) is an important nutrient for bone health. Sufficient intake of vitamin K is associated with decreased risk of osteoporosis, since this vitamin is involved with maintenance of bone mineral density and also with shaping of bone structure (through gamma-carboxylation). In the case of MK-7 (the form of vitamin K produced by Bacillus bacteria, and a member of the vitamin K2 menaquinone family), we know that higher levels of MK-7 in the blood correspond to lower risk of hip fracture in older Japanese women, and that higher MK-7 levels correspond to increased intake of soy foods that have been fermented with Bacillus bacteria. One fascinating aspect of Bacillus-fermented soy foods is the potential ability of these bacteria to stay alive in our lower intestine after these foods are consumed. We've seen one study in which 1.6-20 million Bacillus bacteria (per gram of feces) were found to remain alive up to 6 days following consumption of natto (a sticky form of whole soybeans that have been fermented with Bacillus bacteria). If Bacillus bacteria from
fermented soy foods can remain alive in our digestive tract, they may keep providing us with vitamin K benefits many days after their consumption.

If vitamin K is a nutrient of special concern in your meal plan, you may want to consider Korean-style soy sauce as a preferred choice. However, we still recommend that you contact the manufacturer to determine what information is available about fermentation and vitamin K content, since Korean-style soy sauces are not always fermented with the help of Bacillus bacteria.

**Other Health Benefits**

Health benefits from soy sauce appear likely in several additional areas, even though these areas lack a large number of studies specific to soy sauce.

Immune and inflammatory system support from soy sauce is likely to come from its unique concentration of polysaccharides. Researchers have already identified at least one mechanism of action involved with this immune system support. Some polysaccharides within the carbohydrate family of molecules can lessen the activity of an enzyme called hyaluronidase. Overactivity of this enzyme is associated with increased inflammation and also with increased likelihood of allergic reaction. By lowering its activity, soy sauce polysaccharides may be able to lower the chances of an allergic reaction. The presence of unique polysaccharides in soy sauce appears to make soy sauce one of the least allergy-triggering forms of soy.

In this area of immune and inflammatory system support, preliminary studies suggest that soy sauce polysaccharides might be able to lower our risk of seasonal allergy symptoms. In these preliminary studies, small groups of students were given supplements containing soy sauce polysaccharides and were determined to experience fewer seasonal allergy symptoms following 4-8 weeks of supplementation. Students in the studies were given soy sauce polysaccharide supplements rather than soy sauce itself, with the polysaccharide content of the supplements being equivalent to approximately 2 ounces of soy sauce each day. Without additional studies involving soy sauce itself, we can't know if soy sauce will provide the same benefits as these polysaccharide supplements. Still, this research appears to point in the direction of immune and inflammatory system benefits from soy sauce as a food.
There has also been some preliminary research to suggest possible soy sauce benefits for prevention of type 2 diabetes. For soy foods in general, there is an association between dietary intake and risk of type 2 diabetes. This association makes sense because a major problem in the development of type 2 diabetes is loss of function in the beta cells of the pancreas which manufacture insulin. This loss of function is sometimes due to a process called "apoptosis" in which the cells undergo a type of pre-programmed shutdown. Intake of many different food phytonutrients can lower the risk of apoptosis in certain cells, and included in these phytonutrients are the isoflavonoids naturally present in soybeans. These interrelationships between soy isoflavonoids, pancreatic cell function, and type 2 diabetes make soybeans a logical choice for decreased risk of type 2 diabetes. However, in the specific case of soy sauce, these interrelationships don't make the same degree of sense because the soy sauce production process can sometimes lower the amount of isoflavonoids to a level far below the amount present in most other soyfoods. For this reason, the jury is still out in this area of potential health benefits.

**Description**

Soy sauce is a liquid made from soybeans (also known by the Latin name Glycine max) or a combination of soybeans and wheat. It can vary from light amber to dark brown in color (even though most of us are accustomed to seeing the dark brown versions). The thickness of soy sauce can also vary, because soy sauce is actually a liquid that gets pressed out of a semi-solid soybean "mash" consisting of soybeans that have been boiled, mashed, fermented, and aged over a lengthy period of time. One of the most popular types of soy sauce—tamari—actually gets its name from the Japanese verb "tamaru" which means to "accumulate" or "save" or "be stock" in Japanese. The liquid we call "soy sauce" is thus the fluid that accumulates when fermented soybean mash gets mechanically squeezed and pressed.

Due to the widespread popularity of soy sauce in Japan and the unique relationship between Japan and the United States, many of the Japanese names for soy sauce appear on product labels in U.S. groceries. The most general word for soy sauce in Japanese is shoyu, and you will often find this word on a product label. Within the shoyu family are three basic types of soy sauce. The deepest brown and most strongly aromatic type of shoyu is koikuchi shoyu. This product is also sometimes referred to as "dark soy sauce." It's relatively common for koikuchi to contain a mixture of 50% soybeans and 50% wheat in its composition. A very popular and common type of shoyu in the U.S. is somewhat less dark, less aromatic, and more viscous. It's made from a soybean-wheat mixture than contains only a small amount
of wheat. Tamari shoyu is the name for this second type of soy sauce. Finally is a type of soy sauce that contains the greatest amount of wheat, a much lower amount of soy, and is lighter in color. This type of soy sauce is shiro shoyu. Shiro is also sometimes referred to as "light soy sauce."

A fascinating set of steps is involved with the traditional fermentation of soy sauce. First, whole soybeans are soaked, drained, and then boiled. (In the case of some soy sauce varieties, including many Korean varieties, the beans are also allowed to germinate prior to boiling.) The boiled soybeans are then cooled and inoculated with mold spores. (Molds are a type of fungus. Other types of fungus include mushrooms and yeasts.) The two types of molds used to inoculate the soybeans are Aspergillus oryzae and Aspergillus sojae. The soybean-mold combination is then cultivated for several days at approximately room temperature or slightly above. The beans are then mashed and combined with a salt brine. This mixture will be aged for several months, or in some cases, several years. As a final step in the process, the liquid will then be squeezed out of the aged mash, and it's that liquid that we recognize as soy sauce.

During the cultivation and aging steps in soy sauce production, several unique micro-organisms become involved in fermentation. Already mentioned are the very important molds (fungi) Aspergillus oryzae and Aspergillus sojae. Foods that have been inoculated with these mold spores and cultured are sometimes referred to as "koji," regardless of whether the inoculated foods are plant foods (like soybeans and grains) or animal foods or fish. You'll sometimes see the phrase "koji starter" being used to describe steps in the soy sauce production process, and this phrase may refer to inoculated soybeans or inoculated grains (usually wheat). But in any case, the special value of "koji" in Asian cuisines definitely attests to the value of the Aspergillus mold.

Bacteria are also involved in soy sauce fermentation. Because the Aspergillus mold needs oxygen to thrive, the first soy sauce fermentation steps usually involve more shallow containers to provide plenty of oxygen access. But later on, deeper vats are used that create lower-oxygen conditions that are more conducive to the growth of certain bacteria and yeasts. In the case of most Japanese soy sauces, Tetragenococcus halophilus is the most important of these bacteria, but other lactic acid bacteria may be used in the fermentation process, including numerous species of Lactobacillus. Yeasts may also be used to assist with fermentation, including the yeast Saccharomyces cerevisiae.
In the case of some soy sauce production, Bacillus bacteria are also used to help with fermentation. Bacillus subtilis, for example, is sometimes used in the fermentation of Korean-style soy sauce. As discussed in our Health Benefits section above, the use of Bacillus bacteria can result in unique health benefits since these bacteria are able to make a form of vitamin K2 (called MK-7).

As you can see, the soy sauce fermentation process is truly amazing; it involves the participation of molds, yeasts, and bacteria, and can take months or years to complete. The many unique flavors found in different varieties of soy sauce reflect this complex interaction of micro-organisms, as well as the varying amounts of soy and wheat used in soy sauce production. Unfortunately, it is possible to find products in the marketplace that have not been produced according to traditional fermentation and cultivation methods, and do not provide the health benefits of genuine soy sauce. For this reason, we recommend that you purchase soy sauce that has been prepared in the traditional way. In some cases, you will find information on the product label about the production process, including details about the length of fermentation and aging. In other cases, you will need to contact the manufacturer to determine this information. Two additional pieces of labeling information can also be helpful in finding a traditionally fermented soy sauce. One is the phrase "naturally brewed" on the label. This phrase isn't a guarantee of traditional fermentation, but it's usually a helpful indicator. Another helpful indicator is the phrase "no artificial colors or flavors" or "made only from natural ingredients." Once again, this labeling information doesn't give you a guarantee, but makes it more likely that your soy sauce was traditionally prepared.

In today's marketplace, it is also worth noting that many types of soy sauce traditionally containing wheat are available in wheat-free versions, including tamari. Also available are reduced sodium versions of many soy sauce types.

No description of soy sauce would be complete with a celebration of umami. Many people would describe "umami" as the basic unique taste of soy sauce, but from a Western science standpoint, this word actually refers to a special taste perception that is experienced not only with soy sauce but with other foods, including fish sauce, shrimp paste, mushrooms, sea vegetables, aged meats and cheeses, and other foods. Relatively recent research has shown that humans have receptors on certain taste buds for the unique flavor referred to as "umami." Alongside of our taste bud receptors for sweet, salty, sour, and bitter, we have receptors for what is usually referred to as "savory" and umami is that savory fifth taste. Food scientists have determined the food chemistry that is needed to provoke this umami taste. What's required is the combination of an amino acid (usually glutamate, but
sometimes aspartate as well) with a nucleotide (usually inosine monophosphate or guanosine monophosphate). When coupled together, these particular molecules latch onto the receptors for "savoriness" on our taste buds. This chemical understanding of umami matches up extremely well with the actual food sensations experienced by humans. Sardines, tuna, bonito flakes (which are dried flakes made from a fish that is closely related to tuna), beef, and shrimp are all foods high in the nucleotide inosine, as well as being frequently high in glutamate. Mushrooms are high in the other umami-related nucleotide, guanosine, and can also contain substantial amounts of glutamate. It's worth noting that for many persons, the experience of soy sauce and other umami-rich foods extends beyond the mere chemistry of taste, and involves a much richer experience of these foods involving not only taste but also aroma as well as generalized satisfaction and pleasure that comes from consumption of these foods.

**History**

Like other soy foods, soy sauce has a long and wonderful history of use in many cuisines, especially cuisines in China, Japan, Korea, Vietnam, Thailand, Burma, Indonesia, and the Philippines. The Chinese character "sho" appeared in recipes as early as the 1st century AD in China and referred to a fermented food either made from vegetables or alternatively from flesh or fish. Over the course of several hundred years, the food fermentation process used to create "sho" became more popular both inside and outside of China. In Japan, the word "shoyu" began to be used in reference to soybean-based pastes that had been fermented in this way. "Shoyu" is still the correct word in Japanese for referring in general to soy sauce (rather than to particular types of soy sauce, for example, tamari, shiro, or koikuchi).

During the earliest periods of soy sauce use, it's very likely that this "sauce" was not consumed in the form of a liquid but rather in the form of an unrefined paste. (The word "moromi" was often used in Japanese cuisine to refer to this early paste-like form of soy sauce. Today, this paste-like form of soy would often simply be described as "miso."). It may have taken as many as 500-1,000 years for soy sauce to become popular in the form of a true liquid.

Today, several thousand different companies are involved in soy sauce production worldwide. The world's largest soy sauce producer (Kikkoman Corporation headquartered in Tokyo, Japan) sells over 500 million liters of soy sauce per year.
How to Select and Store

Soy sauce is generally sold in sealed glass bottles. Some stores also sell it in bulk containers. Check the label to make sure that no additives, such as MSG, have been added. Look for the phrase "contains no artificial colors or flavors" on the label, as well as the phrase "naturally brewed." These phrases do not guarantee soy sauce production according to traditional methods, but they increase the likelihood of such production. We also encourage you to look for certified organic soy sauce, which is very likely to lower your risk of exposure to unwanted synthetic pesticides or soy sauce made from genetically engineered soybeans or wheat.

One unexpected difficult with selection of soy sauce in today's marketplace, however, is the availability of products that have not been produced according to traditional fermentation and cultivation methods. As a result, these products may not provide the health benefits of genuine soy sauce. From a product labeling standpoint, however, it can be tricky to determine the difference between a traditionally fermented soy sauce and a lower quality soy sauce. In some cases, you will find information on the product label about the soy sauce production process, including details about the length of fermentation and aging. In other cases, you will need to contact the manufacturer to determine this information. Two additional pieces of soy sauce labeling information can also be helpful in finding a traditionally fermented soy sauce. One is the phrase "naturally brewed" on the label. This phrase isn't a guarantee of traditional fermentation, but it's usually a helpful indicator. Another helpful indicator is the phrase "no artificial colors or flavors" or "made only from natural ingredients." Once again, this labeling information doesn't give you a guarantee, but makes it more likely that your soy sauce was traditionally prepared.

While most certified organic soy sauces are produced in keeping with traditional methods, there is no requirement by the U.S. Department of Agriculture that traditional methods be adhered to - only that organic rules (like the avoidance of most synthetic pesticides, sewage sludge fertilizers, genetically modified ingredients, and irradiated ingredients) be followed. So we recommend that you go beyond the criterion of "certified organic" in the case of soy sauce and also try to select traditionally fermented products.

The growing popularity of soy sauce in the U.S. marketplace has also led to the increasingly widespread availability of wheat-free and reduced sodium versions of this food. For example, it has become relatively common to find "wheat-free tamari"
available in U.S. supermarkets, even though tamari is a type of soy sauce traditionally prepared with a small amount of wheat. You'll almost always find this information ("wheat-free" and/or "reduced sodium") prominently displayed on the product label.

Unopened soy sauce can be kept in a cool, dark place. Once the bottle is opened, soy sauce should be stored in the refrigerator.

How to Enjoy

A Few Quick Serving Ideas

- Use soy sauce as a seasoning when healthy sautéing vegetables.

- Combine soy sauce, garlic, and ginger and use as a marinade for baked tofu, tempeh, or chicken.

- Keep a container of soy sauce on the dinner table and use instead of table salt for seasoning foods.

- Serve brown rice with a Japanese flair by sprinkling some soy sauce, sesame seeds, and nori strips on top.
Soy Sauce and Salt

High salt content is perhaps the most common individual concern about intake of soy sauce. Technically, "high salt" in this case means "high in sodium," since table salt is formed from the elements sodium and chloride (and it's the sodium part of table salt that can increase blood pressure in sodium-sensitive individuals when consumed in excessive amounts). Since one tablespoon of soy sauce typically contains about 1,000 milligrams of sodium—nearly half of the recommended limit for sodium intake in an entire day—soy sauce is indeed a high-sodium food. As a high-sodium food, soy sauce might be expected to be associated with increased risk of high blood pressure. But interestingly, recent research studies have suggested that soy sauce may be different than other high-salt foods with respect to blood pressure and cardiovascular health. When soy sauce is fermented in the traditional way, many of the proteins found in the soybeans get broken down into smaller molecules called peptides. Some of these peptides act to inhibit the activity of angiotensin I-converting enzyme (ACE) that is needed to constrict our blood vessels. Our blood pressure tends to go up when our blood vessels constrict, because there is less room for our blood to flow through. By decreasing ACE activity, peptides in soy sauce may be able to help prevent this process from happening.

It's too early in the research process to give soy sauce any kind of "green light" in terms of its salt content, however. Anyone at risk of excessive salt intake or following a salt-restricted diet should still consult with a healthcare provider before including more soy sauce in a meal plan than would otherwise be allowed based on sodium content.

Allergic Reactions to Soy Sauce

Although allergic reactions can occur to virtually any food, research studies on food allergy consistently report more problems with some foods than with others. It's important to realize that the frequency of problems varies from country to country and can change significantly along with changes in the food supply or with other manufacturing practices. For example, in several part of the world, including Canada, Japan, and Israel, sesame seed allergy has risen to a level of major concern over the past 10 years.
In the United States, beginning in 2004 with the passage of the Food Allergen Labeling and Consumer Protection Act (FALCPA), food labels have been required to identify the presence of any major food allergens. Since 90% of food allergies in the U.S. have been associated with 8 food types as reported by the U.S. Centers for Disease Control, it is these 8 food types that are considered to be major food allergens in the U.S. and require identification on food labels. The 8 food types classified as major allergens are as follows: (1) wheat, (2) cow's milk, (3) hen's eggs, (4) fish, (5) crustacean shellfish (including shrimp, prawns, lobster and crab); (6) tree nuts (including cashews, almonds, walnuts, pecans, pistachios, Brazil nuts, hazelnuts and chestnuts); (7) peanuts; and (8) soy foods. Soy sauce, of course, would be included in this last category. (It's also important to remember that many types of soy sauce contain wheat, making it a food that those with allergies or sensitivities to wheat may need to avoid. Alternatively, if you cannot tolerate wheat, you can look for wheat-free soy sauce products.)

Alongside of this well-established and broad-based concern about the potential for allergic response to soy foods in general is recent research to suggest that soy sauce might be a much less allergy-triggering form of soy. In addition, this recent research suggests that soy sauce might provide support to our immune system, which is involved in an allergic response. Two factors are especially fascinating in this new research. A lower risk of allergic response to soy sauce may be related to the breakdown of key allergy-triggering proteins in soybeans during the soy sauce fermentation process. For example, an allergy-triggering protein in soybeans called Gly m Bd 30K gets broken down during soy sauce fermentation, and once this protein has been broken down into smaller parts, it can no longer trigger an allergic response.

In addition to this breakdown of allergy-triggering proteins during soy sauce fermentation, unique soy sauce polysaccharides may provide our immune system with special support. Some of these polysaccharides (which are carbohydrate-family molecules) can lessen the activity of an enzyme called hyaluronidase. Overactivity of this enzyme is associated with increased inflammation and also with increase likelihood of allergic reaction. By lowering its activity, soy sauce polysaccharides may be able to lower the chances of an allergic reaction. However, persons with known or suspected soy allergy should still consult with a healthcare provider before making a decision about soy sauce in their meal plan.

**Soy Sauce and "Chinese Restaurant Syndrome"**
Another concern that has been raised about soy sauce is its possible connection with what became known in the late 1960's as "Chinese restaurant syndrome." Chinese restaurant syndrome was the name given to symptoms of headache, lightheadedness, dizziness, or nausea experienced by some persons after consumption of meals in some restaurants that featured Asian-style cuisine. Early research into this phenomenon didn't provide any conclusive evidence about the reason for the symptoms, although many factors pointed to the very likely involvement of monosodium glutamate (MSG) used as a flavor enhancer during food preparation. Even though it is still not 100% clear whether MSG is the sole factor responsible for these post-meal symptoms, most current research has moved on from the idea of "Chinese restaurant syndrome" and has simply focused on adverse reactions to MSG (primarily nervous system changes). Since MSG is a chemical salt made from the amino acid glutamate, free glutamate is the main substance of concern when considering an MSG-related adverse food reaction. Furthermore, since glutamate is the primary free amino acid in soy sauce, it's logical to consider soy sauce as a potential trigger for MSG-type adverse reactions. However, most studies of soy sauce that we've seen show a very large difference between the amount of free glutamate present in MSG versus the amount of free glutamate present in soy sauce. For MSG, the amount is usually in the range of 700-750 milligrams per gram. That's about 70-75% free glutamate by weight. For soy sauce, the amount is usually in the range of 1-12 milligrams per gram—about 1-12% free glutamate by weight. This large difference may explain the reason why intake of soy sauce does not seem to be associated in research studies with symptoms like headache or lightheadedness in the same way as MSG. Still, persons with known or suspected sensitivity to MSG should consult with their healthcare provider when making a decision about the role of soy sauce in their diet.

**Nutritional Profile**

Soy sauce contains many different types of antioxidants. In fact, some studies have shown more phytonutrient antioxidant density in soy sauce than red wine. Soy sauce is a good source of the mineral antioxidant manganese. It also contains valuable amounts of antioxidant phenolic acids including vanillic, syringic, coumaric, and ferulic acid. Isoflavonoid antioxidants in soy sauce include glycitein, daidzein, genistein, and genistin. (However, depending on the exact production process being used, the concentration of these isoflavonoids may be quite low and far lower than the concentration in other soyfoods.) Soy sauce is a very good source of the amino acid tryptophan, a good source of vitamin B3 (niacin), and it is also a good source of protein. Soy sauce actually deserves special mention in the protein category, since it ranks 9th among all of the World’s Healthiest Foods in terms of protein density. In other words, if you obtain one gram of protein from soy sauce, it will cost you fewer calories than if you try to obtain one gram of protein from more than 100 other
WHFoods. The protein density of soy sauce is actually greater than the protein density of animal foods like lamb, fish like salmon, or soybeans themselves.

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