Clinical Study Support for the Health Benefits of Fermented Foods

Diet shapes the gut microbiome which in turn affects the immune system and overall health. Low gut-microbiome diversity has been linked to obesity and diabetes.

The health benefits of fermented foods have popular support, but the few clinical studies undertaken attempting to detail how benefits flow through the gut-microbiome have had qualified conclusions. [1, ,2]

Part of the research challenge is the diversity and complexity of the over 5,000 varieties of traditional fermented foods and beverages worldwide. There are over 50 main types of microorganisms used in global food and beverage fermentation, Fig.1.

Examples of sub-microorganisms are noted in Fig.2, 3 & 4.

Fig.1 Main Types of Microorganisms in Global Food and Beverage Fermentation
Bacteria:
1) Acetobacter, 2) Arthrobacter, 3) Bacillus, 4) Bifidobacterium, 5) Brachybacterium, 6) Brevibacterium, 7) Carnobacterium, 8) Corynebacterium, 9) Enterobacter, 10) Enterococcus, 11) Gluconacetobacter, 12) Hafnia, 13) Halomonas, 14 Klebsiella, 15) Kocuria, 16) Lactobacillus, 17) Lactococcus, 18) Leuconostoc, 19) Macrococcus, 20) Microbacterium, 21) Micrococcus, 22) Oenococcus, 23) Pediococcus, 24) Propionibacterium, 25) Staphylococcus, 26) Streptococcus, 27) Streptomyces, 28) Tetragenococcus, 29) Weisaella, 30) Zymomonas
Fungi:
1) Actinomucor, 2) Aspergillus, 3) Fusarium, 4) Lecanicillium, 5) Mucor, 6) Neurospora, 7) Penicillium, 8) Rhizopus, 9) Scopulariopis, 10) Sperendonema
Yeasts:
1) Candida, 2) Cyberlindnera, 3) Cystofilobasidium, 4) Debaryomyces, 5) Dekkera, 6) Hanseniaspora, 7) Kazachstania, 8) Galactomyces, 9) Geotrichum, 10) Guehomuces, 11) Kluyveromyces, 12) Lachancea, 13) Metschnikowia, 14) Pichia, 15) Saccharomyces, 16) Schizosaccharomyces, 17) Schwanniomyces, 18) Starmerella, 19) Torulaspora, 20) Trigonopsis, 21) Wickerhamomyces, 22) Yarrowia, 23) Zygosaccharomyces, 24) Zygotorulaspora
Source: *Health Benefits of Fermented Foods and Beverages,* [3] Conceptasia, September 2021

Studies of individual fermented products have been more encouraging.

For example, the traditional Japanese fermented sticky soybean food *Natto*, and its enzyme Nattokinase, is associated with reduced blood pressure and lower cardiovascular risk. [4] The process of making *Natto* involves the use of *Bacillus natto* to ferment soybeans. *Bacillus natto* has been found to be a potential probiotic for the prevention of obesity and metabolic disorders. [5]

More recently, the July 2021 Stanford School of Medicine paper *Gut-microbiota-targeted diets modulate human immune status,* [6] was able to come to the strong conclusion that a fermented-food diet increases microbiome diversity and decreases markers of inflammation.

In a clinical trial, 36 healthy adults were randomly assigned to a 10-week diet that included either fermented or high-fiber foods. The two diets resulted in different effects on the gut microbiome and the immune system. The fermented food diet led to an increase in overall microbial diversity, with stronger effects from larger servings. In addition, four types of immune cells showed less activation in the fermented-food group. The levels of 19 inflammatory proteins measured in blood samples also decreased. One of these proteins, interleukin 6, has been linked to conditions such as rheumatoid arthritis, Type 2 diabetes, and chronic stress. [(7)]

In contrast, the high-fiber diet did not lead to any of the 19 inflammatory proteins decreasing, and the diversity of the gut microbes also remained stable.

Justin Sonnenburg, one of the authors, said: *This is a stunning finding, it provides one of the first examples of how a simple change in diet can reproducibly remodel the microbiota across a cohort of healthy adults.* [(7)]

Fermented Foods in the Japanese Diet

Fermentation is an ancient technique of preserving food, which adds nutritive value in the process, as well as allowing new flavors, textures, tastes and appearances. Implied by its roots, no chemical additives are involved.

In scientific terms, microbes produce enzymes which make amino acids, glutamic acid (glutamate), and aspartic acid. Glutamate enhances flavor, especially the savory taste known as umami.

Natto arrived in Japan during the Nara period (710-794 AD) with Buddhist priests from China. *Shoyu* and *Miso* date back to 1000 BC in China, with production knowledge arriving in Japan in around 600 AD. [(3)]

Fig.2, 3, & 4 note research studies on Japanese fermented foods.

Koji - an amylolytic starter culture specific to Japan, Fig.4

Japan's warm and humid climate is ideal for the bacteria and mold used for fermentation. For example, *koji* is an edible mold that lives in grains such as rice plants, barley, and soybeans. It was harvested in the wild, from the heads of rice plants for example, 800 years ago. In the fungi family, a sub microorganism of Aspergillus, Fig.1, aspergillus oryzae. Over the subsequent years, koji has been mass produced and refined. The fungal spores can be produced on cooked rice, and other grains, in warm, moist environment: rice koji, barley koji, bean koji. There are an estimated 200 plus flavors and fragrances available in Japan based on Aspergillus oryzae. [(20)]

The three most famous resulting products are:

1) **Miso:** Barley or Rice koji (barley or rice and aspergillus oryzae) and Brine (sea salt and water) and soybeans.
2) **Shoyu (soy sauce):** Wheat and aspergillus oryzae, and Brine, and soybeans.
3) **Mirin seasoning (a cooking wine):** Rice koji (rice and aspergillus oryzae) and shochu spirit and mochi rice

Fig.2 Research studies (*) on Japanese Fermented Foods: 1. Legume (Soybeans and Non-Soybean) Products				
(*)	**Product**	**Substrate**	**Properties**	**Microorganisms**
8.	Hishiho-Miso	Soybean, barley or wheat, salt, vegetables, Mizuame, sugar, Shoyu	Sweetened Miso	Asp. Oryzae, Ped. Halophilus, Sacch. Rouxii, Streptococcus sp.
8.	Koikuchi Shoyu	Defatted soybean flake, wheat, brine, tane-koji	Soy sauce	Aspergillus sojae, Asp. Oryzae, Sacch. Rouxii, Tor. Versatilis, Tor. Echellsii, Ped. Halophilus, Sacch. Halomembransis, Ent. Faecalis, Bacillus sp.
9.	Miso	Soybean	Alkaline, paste	Ped. Acidilactici, Leuc. Paramesenteroides, micrococcus halobios, Zygosaccharomyces rouxii, Asp. oryzae
8.	Miso (Kome Ama)	Rice, soybean, salt, tane-koji,	Sweet rice miso	Asp. Oryzae, Streptococcus sp., Pediococcus sp., Sacch. rouxii
8.	Miso (Kome Kara)	Rice, Soybean, salt, tane-koji, salt	Salt rice miso	Asp. Oryzae, Sacch. Rouxii, Ped. Halophilus, Tor. Versalis, Tot. echellsii, Bacillus sp.
8.	Miso (Mame)	Cereal, soybean, salt		Asp. Oryzae, Asp. Sojae, Ent. Faecalis, Tor. Versatilis, Bacillus sp.
8.	Miso (Mugi)	Barley, soybean, salt, koji	Barley miso	Asp. Oryzae, Sacch. Rouxii, Ped. Halophilus, Ent. Faecalis, Tor. Versatilis, Tor. Echellsii, Bacillus sp.
10.	Moromi	Soybean		Aspergillus sp., Sacch. rouxii
11.	Natto	Soybean	Alkaline, sticky	B.subtilis (natto)
8.	Soy sauce	Soybean	Alkaline, liquid	Asp. Oryzae, Asp. Niger, Sacch. Riuxii, Ped. Acidilactis, Ped. Cerevisae, Ped. Halophilus, Lb. delbrueckii
8.	Shoyu	Soybean	Alkaline, liquid, seasoning	Asp. oryzae or asp. Sojae, Z. Rouxii, C. versatilis
12.	Tamari Shoyu	Defatted soybean, salt, water, wheat	Soybean rich Shoyu	Asp. Sojae, Asp. Oryzae, Sacch. Rouxii, Tor. Versaltilis, Tor. Echellsii, Ped. Halophilus, Ent. Faecalis, Bacillus sp.
13.	Tofu (stinky tofu)	Soybean	Alkaline, liquid	Bacillus sp., Ent. hermanniensis, Lib. Agilis, Lb. brevis, Lb. buchneri, Lb. crispatus, Lb. curvatus, Lb. delbrueckii, Lb. farciminis, Lb. fermentum, Lb. pantheris, Lb. salivarius, Lb. vaccinostercus, Lc. Lactis, Lactococcus sp., Leuc. Camosum, Leuc. Citreum, Leuc. Fallax, Leuc. Lactis, Leuc. Mesenteroides, Leuc. Pseudomesenteroides, Ped. Acidilactici, Strep. Bovis, Strep. Macedonicus, W. cibaria, W. confuse, W. paramesenteroides, W. soli
12.	Usukuchi Shoyu	Soybean, wheat, Tane-koji, Amasake	Soy sauce, seasoning	Asp. Oryzae, Sacch. Rouxii, Tor. Versatilis, Tor. Echellsii, Ped. Halophilus, Sacch. Halomembransis, Ent. faecalis, Bacillus sp.
(*): please see references at the end of this article				
Source: Health Benefits of Fermented Foods and Beverages, [3] Conceptasia, September 2021				

Fig.3 Research studies (*) on Japanese Fermented Foods: 2. Vegetable Products				
(*)	Product	Substrate	Properties	Microorganisms
14. 15.	Sunki	Turnip	Acidic, sour, wet	Lb. plantarum, Lb. fermentum, Lb. delbrueckii, Lb. parabuchneri, Lb. kisonensis, Lb. otakiensis, Lb. rapi, Lb. sunkii
12.	Takuanzuke	Japanese radish, salt, sugar, *Shochu*	Pickle radish	Lb. plantarum, Lb. brevis, Leuc. Mesenteroides, Streptococcus sp., Pediococcus sp., yeasts
12.	Takanazuke	Broad leaved mustard, red pepper, salt, turmeric	Vegetable pickle Takuanzuke	Ped. Halophilus, Lb. plantarum, Lb. brevis
(*): please see references at the end of this article				
Source: Health Benefits of Fermented Foods and Beverages, [3] Conceptasia, September 2021				

Fig.4 Research studies (*) on Japanese Fermented Foods: 3. Other (**)				
(*)	Product	Substrate	Properties	Microorganisms
12.	Ika-shiokara	Squid, salt	Fermented squid	Micrococcus sp., Staphylococcus sp., Debaryomyces
12.	Kusaya	Horse mackerel, salt	Fermented dry fish	Corynebacterium kusaya, Spirillum sp., C. bifermentans, Penicillium sp.
12.	Nazezushi	Sea water fish, cooked millet, salt	Fermented fish-rice	Leuc. Mesenteroides, Lb. plantarum
16.	Shottsuru	Anchovy, opossum, shrimp, salt	Fish sauce, condiment	Halobacterium sp., Aerococcus viridians (Ped. Homari), halotolerant and halophilic yeasts
17.	Shiokara	Squid	Fermented side-dish	LAB
18. 19.	Koji (***)	Rice, Wheat	Dry, black-yellow colored, mold-culture to produce sake, miso, shoyu	Asp. awamori, Asp. kawachii, Asp. oryzae, Asp. shirousamii, Asp. sojae, yeasts
(*): please see references at the end of this article, (**): there are no examples yet for Japanese fermented Fruit or Meat Products, (***) Kojin is an Amylolytic Starter Culture specific to Japan				
Source: Health Benefits of Fermented Foods and Beverages, [3] Conceptasia, September 2021				

Unami

There are five tastes: sweet, sour, bitter, salty and umami (meaty, savory). Umami taste buds on the human tongue were first identified in 2002. Umami is the taste of glutamate, an amino acid, one of the building blocks of protein. Glutamate occurs naturally in the human body and many foods. Like salt, glutamate enhances all flavors.

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