

Review Article

Different Trends of World & Ethiopian Local Soybean Based Recipes and Their Health Benefits: A Review

Kasahun Wale*

Ethiopian Institute of Agricultural Research, Jimma Agricultural Research Center, Jimma, Ethiopia

Abstract

Soybean (*Glycine max* L.) accounts for 25% of global vegetable oil production. It is a high-protein, high-nutritional-value food that is beneficial for chronic disease prevention and treatment, alleviates depressive symptoms, and improves skin health, fiber, high in calcium and magnesium, essential amino acids, anthocyanin, saponins, lipids, and oligosaccharides. According to epidemiological studies, consumption of soybean based foods provides the advantages of lowering the prevalence of heart disease, reducing the chance of an ischemic stroke, and lowering cholesterol, which reduces the likelihood of atherosclerosis. It is effective against a wide range of malignancies, including breast, prostate, colorectal, ovarian, and endometrial cancers. Soybean recipe have antioxidant properties and helps to ease menopausal symptoms in women as well as lower the risk of type 2 diabetes. Isoflavones, a phytochemical present in soybeans, have numerous health benefits. Soybean recipes (dishes) are created in varied ways and composite ratios in different countries. Soy milk, bread, enjera, tofu and kukis are a few examples in Ethiopia. In all types of the recipes prepared, their nutritional compositions are outstanding and delicious in their tastes. The large population of Ethiopian Orthodoxy Christianity followers are not allowed during seasons of fasting, to consume proteins derived from animals. Hence soybean foods are good alternatives during those fasting days for the problem of protein malnutrition and vitamin A absorption. Ethiopian traditional unique foods like enjera, bread, wot, kitta, biscuit, kukis etc. can be prepared from soybean mixed flour. Owing to its superior nutritional value as a well-balanced diet and several health advantages, we advise making greater use of soybean-based recipes, oils, and products.

Keywords

Bread, Enjera, Ethiopia, Protein, Recipe, Soybean, Soymilk, Wot, Health Benefits

1. Introduction

Soybean (*Glycine max* L.) is the most farmed plant on the planet in addition to having a high protein level. Among modern agricultural commodities, soybean stands emerge as the most significant seed legume in the world, accounting for 25% of worldwide vegetable oil production. It is currently farmed on 103 million hectares worldwide, with an annual production of 261 million tones and an average productivity

of 2533 kg per hectares [1, 2]. Ethiopia's prospective arable land suited for soybean cultivation makes up the great bulk of the country's low- to mid-land agro-ecosystem. In Ethiopia, the number of small holders (177,940.0), the area covered (83,797.2 hectares), and the annual soybean production (208,676.4 tons) with its productivity (2.5 tons/ha) have all improved over the previous trend [3, 4]. Soybean is a high

*Corresponding author: kasahun322@gmail.com (Kasahun Wale)

Received: 16 January 2024; **Accepted:** 8 February 2024; **Published:** 28 February 2024



Copyright: © The Author(s), 2023. Published by Science Publishing Group. This is an **Open Access** article, distributed under the terms of the Creative Commons Attribution 4.0 License (<http://creativecommons.org/licenses/by/4.0/>), which permits unrestricted use, distribution and reproduction in any medium, provided the original work is properly cited.

value and profitable oil seed crop due to its versatile uses. With almost 60% of the world's oil seed crop produced there, it is the most significant oil seed crop globally [5]. Consuming soybean grain can increase one's intake of high-quality protein (35–40%) and vegetable oil (18–22%) [6]. And [7] reported protein content of (38–40%) and oil content of (19–21%). In both studies, protein content was greater than 35% and oil content was greater than 19%.

Because of a significant proportion of the Ethiopian population is Orthodox Christian, they are unable to consume animal-source proteins during To address the issue of protein malnutrition during these days, fasting for 200–250 days and consuming soy products is highly suggested. It could be an excellent interaction for the absorption of vitamin A [8].

1.1. Importance of Soybean for Sustainable Production in the Farming Community

Nowadays, Soybean is emerging as the most important strategic crop for small holder farmers' in terms of reducing malnutrition, improving soil fertility and as a source of income. It is a crop that is perfect for low input farming systems since it fixes nitrogen in the soil, breaks the lifecycles of pests and diseases, and rotates cereal crops. Monoculture which neglects pulse crops; causes negative impacts on the environment and ecosystem services through reduction of soil fertility and aggravating incidence of pests and diseases pressures [9]. Considering the current societal problems, such as malnutrition and soil fertility problem faced due to frequent cultivation of cereals, the adoption of crop rotation of soybean is good alternative option [9].

1.2. Soy Bean Nutrition and Its Importance for Human Health

While, cereal can serve as a major source of the daily calorie intake of the large majority of rural community, soybean need to be integrated in the cropping system to meet their It also provides a good supply of important micronutrients to the diet, including folic acid, zinc, iron, magnesium, and calcium, as well as all the key amino acids that kids need to thrive. Soybeans are high-nutritional-value foods which have a lot of fiber. It has high in unsaturated fats and low in saturated fats, which should be avoided [10].

Soybean has the compositions of 8.5g of water, 36.5g of protein (which is very high compared to other plant-based protein sources), 19.9g of total fat, 30.2g of carbohydrates, and 9.3g of fiber per 100g. It also had 1797 mg of potassium, 704 mg of phosphorus; 277 mg of calcium, 200 mg of isoflavones, and 15.7 mg of iron [11].

Many epidemiological studies pointed to a number of health benefits linked to consuming soybeans and fermented products derived from soybeans, such as a decreased risk of ischemic stroke, a decreased incidence of cardiovascular disease, and a decrease in cholesterol levels, which lower the

incidence of atherosclerosis [12]. They are also high in isoflavones, anthocyanin, saponins, lipids, and oligosaccharides [13]. Isoflavones, a type of phytochemical found in soybeans, have a variety of health benefits [14]. Soybean phytochemicals have also been shown to be effective against numerous types of cancer, encompassing endometrial, colorectal, ovarian, breast, and prostate cancers [15].

Soybean is also helpful for chronic diseases prevention and treatments. Additionally, it lessens the chance of developing coronary heart disease, breast and prostate cancer, reduces hot flashes and may positively impact renal function, lessens feelings of depression, and enhances skin health [2]. Additionally, it has long been known that soybeans reduce the prevalence of type 2 diabetes and help women with menopausal symptoms [16]. It has long been known that soybeans contain antioxidants.

1.3. Importance of Soybean by-Product for Animal Feed and Soil Fertility

The primary source of protein for farm animal and aquaculture feeds is also the by-product of soy meal or cake [17]. Due to its high crude protein and oil content, which is necessary for animal diets, soybean meal is frequently utilized in the feed industries [8].

With its capacity to break the life cycles of pests and diseases in cereal rotation systems, as well as its ability to fix nitrogen in the soil, this crop is perfect for low-input farming systems [9].

2. Most Common Soybean Recipe

Soybean based foods are most preferred for their balanced diets for pregnant women. As well as also used as an excellent complementary food values for infants [18]. In different countries soybean recipes prepared in different ways with different composite flour.

2.1. Most Common Soybean Recipe in the World

Depending on the nature of the dishes, different proportion of soybean mixed with other inputs and soybean recipes prepared. Some of them are; soymilk, tofu, tempeh, miso, natto, okara and etc. their preparation procedure is also differ from each other.

2.1.1. Soymilk

To make soymilk, soybeans are traditionally soaked in a ratio of one to ten for an entire night before being ground in a mill with additional water added while the beans are grinding.

Slurry is heated and stirred for 15 to 30 minutes. The process improves the milk's flavor by volatilizing some of the off-tasting compounds that develop during grinding and inactivating lipoxygenase, which also boosts the milk's nutri-

tional content. Lowering the microbiological load (critical control point) of milk with heating also increases its shelf life. To separate the soymilk from the residual of insoluble fiber, okara, the heated slurry is filtered through a cloth or nylon bag [19]. Omega-3 fatty acids, or "healthy" fats that your body is unable to manufacture on its own, are abundant in soy milk. Consuming omega-3 fatty acids has been linked to a decreased risk of Alzheimer's disease and dementia. Although research on the effects of soy milk on various ailments is ongoing, soy is generally one of the most important non-animal sources of omega-3 fatty acids [20].

2.1.2. Tofu

Tofu commonly referred to as bean curd, a soft, flavourless soybean food product. Tofu is an essential source of protein in Chinese, Japanese, Korean, and other cuisines. Dry soybeans are soaked in water, crushed, and then boiled to make tofu. The mixture is separated into two sections: "soy milk" and solid pulp (okara). Salt coagulants, such as calcium and magnesium chlorides and sulphates, are added to the soy milk in order to separate the curds from the whey. In some situations, acid coagulants such citric acid or glucono delta-lactone may be used. Poured into molds, the soy milk allows the carbohydrate-rich whey to escape.

Depending on the manufacturing process, tofu can be created exceptionally firm, firm, soft, or silky. There is also tofu that is sold that doesn't need to be refrigerated [19]. All nine essential amino acids are present in tofu, making it a high-protein food. It's also a good source of calcium, iron, and the minerals phosphorus and manganese. Tofu's main ingredient, soy protein, has been shown to help reduce LDL, or bad cholesterol. Tofu comprises a class of chemicals called isoflavones, which are phytoestrogens found in plant-based diets. Because of their structural resemblance to the female hormone oestrogen, they mimic the effects of oestrogen on the body. They attach to human cells' oestrogen receptor sites, particularly in breast cells, and may lower the risk of breast cancer [21].

2.1.3. Tempeh

Originating in Indonesia, tempeh is a fermented whole soybean product that has gained popularity in Malaysia as well. To make tempeh, soak soybeans for a whole night and then boil them for thirty minutes, either with or without the hulls (Malaysian). After draining the extra water, the beans are put on a tray to be inoculated with either *Rhizopus oligosporus* or a piece of tempeh. After that, the beans are allowed to ferment for one to two days at ambient temperature or for twenty hours at 30 to 32 °C (86 to 90 °F). White mold mycelium envelops the beans during fermentation, solidifying them into a film. Since tempeh is a perishable food, it is then sliced into smaller pieces and sold the same day. It is often blanched, sun-dried, or frozen if it is to be stored for later use. Tempeh is often cooked just before consumption. The product is frequently cooked through baking, deep-frying, or frying. It

is commonly used as a meat substitute in major dishes and added to soups and quick snacks [19]. Prebiotic fibers, which encourage the growth of beneficial bacteria in your digestive system, seem to be abundant in tempeh. Prebiotics have been shown to improve the colon's ability to synthesize short-chain fatty acids. The primary energy source for the cells lining your colon is butyrate. Research indicates that taking prebiotic supplements can lead to positive modifications in the gut microbiota, or the bacteria that reside in your digestive system. Studies have shown mixed results, however some have linked prebiotic ingestion to improved memory, decreased inflammation, and more frequent stools [22].

2.1.4. Miso

Cooked soybeans, koji (a starting culture, often fermented rice), and salt water are combined to make miso. The material is then fermented for a few months after that. The kind of koji utilized in the fermentation process varies throughout miso products. For the manufacturing of rice miso, barley miso, and soybean miso, koji from rice, barley, and soybeans are used individually. A miso with a higher ratio of rice or barley to soybeans has a brighter color and is sweeter. Higher concentrations of wheat or barley in miso often ferment more quickly than miso with a higher percentage of soybeans. "Soybean miso" has the longest fermenting time—between one and two years—before it reaches a flavor that is acceptable. The salt content of miso is about 10% [19]. Soybean miso is made exclusively from soybeans. To encourage the growth of *Aspergillus oryzae*, cooked soybeans are mashed, formed into balls, covered with powdered koji starter, and then incubated in a koji room. Soybean koji has completed germination after four days. Subsequently, the mash is combined with water and salt and let to mature in barrels. Since this miso was aged, a year has gone by.

It is clear how the many elements interact intricately to give miso its distinct sensory qualities (such as color, texture, flavor, taste, and scent). The enzymatic action of the microorganisms and how they alter the substrate's composition (rice, barley, soybeans, rice and barley, rice and soybeans, barley) play a major role in the end product's quality. Soybean miso is made exclusively from soybeans. To encourage the growth of *Aspergillus oryzae*, cooked soybeans are mashed, formed into balls, covered with powdered koji starter, and then incubated in a koji room. Soybean koji has completed germination after four days. Subsequently, the mash is combined with water and salt and let to mature in barrels. Since this miso was aged, a year has gone by.

It is clear how the many elements interact intricately to give miso its distinct sensory qualities (such as color, texture, flavor, taste, and scent). The enzymatic action of the microorganisms and how they alter the substrate's composition (rice, barley, soybeans, rice and barley, rice and soybeans, barley) play a major role in the end product's quality [23].

Miso is rich in essential minerals and a potent source of folic acid, B, E, and K vitamins. As a fermented food, miso

fills the gut with excellent bacteria that keep us vibrant, healthy, and content; overall mental and physical fitness have been linked to gut health [24].

2.1.5. Natto

It is a whole soybean meal that has been fermented and cooked using *Bacillus natto*. You can find comparable products in the Thai and Indonesian markets, but not in China. At first, *B. natto* grown in rice straw was used to make natto. Modern production is not too complicated. To soften, soybeans are soaked in water for the entire night before cooking. The chilled mash is infected with a commercial *B. Natto* culture (a powder that resembles starch or liquid suspension) in a rotating barrel. To create fresh packs, the mash is then covered with a thin layer of perforated polyethylene film or arranged in shallow trays made of wood or polystyrene. These are left in the fermentation room for a full day, or until a sticky, white glutamic acid polymer covers the whole surface of the soybeans. After that, the product is either sold or kept in a cold room [25]. Trillions of microbes more than ten times the amount of cells in your body are found in our gut. A healthy gut flora, which is produced by having the right bacteria in your stomach, has been connected to several health advantages, including better digestion. Probiotics from Natto can work as your gut's first line of protection against harmful bacteria and toxins. Studies have shown that probiotics can lessen a variety of symptoms related to inflammatory bowel disease (IBD), including gas, constipation, diarrhea brought on by antibiotics, and bloating. A portion of most probiotic-rich foods and supplements contains 5–10 billion colony-forming units (CFUs). Conversely, natto has the ability to hold anywhere from one million to one billion colony-forming units (CFUs) per gram. It's interesting to note that natto fermentation lessens the amounts of anti-nutrients typically present in soybeans, improving their digestibility [26].

2.2. Most Common Soybean Recipe in Ethiopia

Ethiopians first began to cultivate and introduce soybeans in the 1950s with the intention of substituting imported soybean flour, incorporating the product into the country's current farming system, and enhancing Ethiopians' diets [27]. Since then, Ethiopians have started to use and consume more meals based on soybeans. Some of them; Enjera, bread, yoghurt, porridge, kukis, biscuit and soymilk are becoming popular in Ethiopia [28].

For the past few decades, a nearby food processing plant has been using soybeans to make balanced diet, especially for mothers and children [29]. Currently, Ethiopia is home to several oil processing firms that employ soybeans as a row crop. To accommodate domestic demand, the nation imports edible oil at a high cost [30].

Jimma Agricultural Research Centre developed soybean recipe with various crops and ratios, which were validated by sensory and nutritional quality tests. The nutritious benefits of

the meals make them highly appealing. Farmers, customers, and end users were included in the demonstration and popularization. Now a day farmers are interested to enjoy soybean recipe. Enjera, bread, soy milk, yoghurt, soup (wot), porridge, tofu, biscuits, kukis, etc. are some of formulated recipe with recommended ratio by Jimma Agricultural Research Center. Procedure of some of the recipe preparation has described below.

2.3. Soybean Grain Sample Preparation for Enjera and Bread

Crash the soybean grain sample with stone (mortar & pestle). Heat the crashed soybean with pan. Mix the crashed soybean with other crops with appropriate ratio (20 soybeans: and 80 other crop types like teff, wheat, sorghum, etc.), (means that if the other crop is 80 kilo grams, soybeans will be 20 kilo grams). Grind the mixed crops with grinding mill. This step is similar for enjera and bread preparation.

2.4. Some of Soybean Recipe Preparation Procedures

2.4.1. Enjera

Enjera is Ethiopian favorite common food item. It is prepared from different crop types with different ratios. In this section we are concerned on soybean enjera preparation. Soybean enjera can be prepared in different compositions. Jimma Agricultural Research center has formulated Soybean mixed enjera with the following ratios.

Sample of soybeans processed according to the above-described method, followed by the addition and digestion of 20% of the crushed soybeans with 80% harvested crops like as wheat, sorghum, and teff. This results in 20 kilograms of soybeans for every 80 kilograms of crop. After adding two cans of water to three cans of soybean mixed flour with yeast, let it wait for three days. Dilute it with three liters of hot water on the third day. Three days later, bake it an enjera.



Figure 1. Enjera.

2.4.2. Bread

When 20% of crushed soybeans is combined and digested with 80% harvested wheat, the resulting product is 20% soybean of the 80 kg of wheat. After adding two cans of water to three cans of soybean mixed flour with yeast, let it wait for 12 hours. After a full day, bake the bread.



Figure 2. Bread.

2.4.3. Yoghurt

Soybean grain will be danced into water overnight/for 24 hours. The soybean grain will be grinded with local grinder (stone) or juicer machine. Lemon juice will be added to the soybean sample and cover it up. Extract with smoother and cleaner clothes. Keep the extract in refrigerator for overnight. Finally you get soybean yoghurt. Similarly soy milk also prepared with this procedure, the difference is in the absence of lemon juice for soy milk preparation.

2.4.4. Wot

Wot is Ethiopian common traditional recipe usually eaten by immersing with enjera.

First onion will be cooked with edible oil. Red pepper will be added on the onion which is called in Amharic word "qeyi wot" and without red pepper is called in Amharic word "alicha wot". Then 2 kilo grams of cooked lentile and 1 kilo gram of soybean by product (Okara) will be added. Spices and salt will be added for good taste. Wait it until cooking gets enough. Finally eat by immersing it with enjera.



Figure 3. Wot.

2.4.5. Kitta

Kitta is traditional Ethiopian popular recipe prepared from composite of soybean and maize flour. 80% of maize flour and 20% of soybean flour will be mixed. It will be danced with proper ratio of water. Salt will be added, and then it will be baked soon. The baked recipe is called in Amharic word kitta. Then break up in to smaller. Pretend/danced it with red pepper and butter. Finally feed the recipe.

2.4.6. Biscuit and Kukis

Biscuit and kukis prepared from byproduct (Okara) of soybean with different ratios.

Biscuit

Prepare some onion and chill cook it by adding edible oil with hot plate or traditional fire wood. Then add 100% soybean Okara and some wheat flour for making bond with each other. Finally you get Ethiopian interesting traditional biscuit.

Kukis

Mix 80% wheat flour and 20% soybean flour. Add baking powder and oil. Mix it well and make smoother. Cut it with appropriate and needed shape. Finally cook it with edible oil.



Figure 4. Biscuit.

3. Conclusion

Soybean based foods are source of high-quality protein, and all important nutrients in the diet for human. Soybean recipes are popular diets throughout the world and in Ethiopia. They prepared in different ratios with other flours according to their culture and nature of recipe types. Tofu, soy milk, tempeh, miso, natto are few of soybean recipes in the World and Bread, Enjera, kukus, soy milk are popular in Ethiopia. From this review paper we found that soybean has multiple advantages. Some of them are; they are important for muscle growth, chronic illness prevention and treatment, helps against the risk of coronary heart disease, breast and prostate cancer, improve renal function, reduce depressed symptoms and skin health. It is also helpful for complementary food for infants. Soybean, has gained prominence as a result of these qualities. Hence we advise to consume soybean based products for its better nutritional values and health benefits.

Acknowledgments

The author acknowledges Mrs. Alemitu Mohammed for guiding the recipe preparation procedure, Mr. Masreshaw Yirga and Mr. Behailu Atero for technical support.

Conflicts of Interest

The author declares no conflicts of interest.

References

- [1] Nair, R. M., Boddepalli, V. N., Yan, M. R., Kumar, V., Gill, B., Pan, R. S., ... & Somta, P. (2023). Global status of vegetable soybean. *Plants*, 12(3), 609. <https://www.mdpi.com/2223-7747/12/3/609#>
- [2] Kamble RE, Pawar VS and Veer SJ. (2021). Health benefits of soybean and soybean based food products: A study. <http://www.thepharmajournal.com>
- [3] Kemboi, N., Ng'eno, E. K., & Rotich, J. K. (2021). Effects of Adoption of CSA Interventions on Maize Productivity among Small Scale Farmer Households in Moiben Sub-County, Kenya. <http://ir-library.kabianga.ac.ke/handle/123456789/718>
- [4] Hagos, A., & Bekele, A. (2018). Cost and returns of soybean production in Assosa Zone of Benishangul Gumuz Region of Ethiopia. *Journal of Development and Agricultural Economics*, 10(11), 377-383. <https://doi.org/10.5897/JDAE2018.0952>
- [5] Adeleke, B. S., & Babalola, O. O. (2020). Oilseed crop sunflower (*Helianthus annuus*) as a source of food: Nutritional and health benefits. *Food Science & Nutrition*, 8(9), 4666-4684. <https://doi.org/10.1002/fsn3.1783>
- [6] Barman, A., Marak, C. M., Barman, R. M., & Sangma, C. S. (2018). Nutraceutical properties of legume seeds and their impact on human health. In *Legume seed nutraceutical research*. <https://doi.org/10.5772/IntechOpen.78799>
- [7] Qin, P., Wang, T., & Luo, Y. (2022). A review on plant-based proteins from soybean: Health benefits and soy product development. *Journal of Agriculture and Food Research*, 7, 100265. <https://doi.org/10.1016/j.jafr.2021.100265>
- [8] Takele Atnafu Delele. (2021). Review on the Role of Soybean on Animal Feed and Human Nutrition in Ethiopia. *American Journal of Zoology*. Vol. 4, No. 3, pp. 25-31. <https://doi.org/10.11648/j.ajz.20210403.11>
- [9] Kumar, S., Meena, R. S., Datta, R., Verma, S. K., Yadav, G. S., Pradhan, G., & Mashuk, H. A. (2020). Legumes for carbon and nitrogen cycling: an organic approach. *Carbon and nitrogen cycling in soil*, 337-375. <https://link.springer.com/book/10.1007/978-981-13-7264-3>
- [10] Anderson JW, Johnstone BM, Cook-Newel ME. (1995). Metaanalysis of the effects of soy protein intake on serum lipids. *N Engl J Med*. <https://doi.org/10.1056/NEJM199508033330502>
- [11] Jayachandran, M., & Xu, B. (2019). An insight into the health benefits of fermented soyproducts. *Food chemistry*, 271, 362-371. <https://doi.org/10.1016/j.foodchem.2018.07.158>
- [12] Belardo, D., Michos, E. D., Blankstein, R., Blumenthal, R. S., Ferdinand, K. C., Hall, K., ... & Gulati, M. (2022). Practical, evidence-based approaches to nutritional modifications to reduce atherosclerotic cardiovascular disease: an American society for preventive cardiology clinical practice statement. *American Journal of Preventive Cardiology*, 10, 100323. <https://doi.org/10.1016/j.ajpc.2022.100323>
- [13] Stephen Barnes. (2010). the Biochemistry, Chemistry and Physiology of the Isoflavones in Soybeans and their Food Products; Lymphatic Research and Biology. <https://doi.org/10.1089/lrb.2009.0030>
- [14] LEE C. (2005). Relative antioxidant activity of soybean ~ 1138 ~The Pharma Innovation Journal [http://www.thepharmajournal.com/isoflavones and their glycosides](http://www.thepharmajournal.com/isoflavones%20and%20their%20glycosides). Food Chemistry. <https://doi.org/10.1016/j.foodchem.2004.04.034>
- [15] Fisk ID, Gray DA. (2011). Soybean (*Glycine max*) Oil Bodies and Their Associated Phytochemicals. *Journal of Food Science*. <https://doi.org/10.1111/j.1750-3841.2011.02428.x>
- [16] Messina, M. (2016). Soy and health update: evaluation of the clinical and epidemiologic literature. *Nutrients*, 8(12),7(54). <https://doi.org/10.3390/nu8120754>.
- [17] Wadhwa, M., & Bakshi, M. P. S. (2016). Application of waste-derived proteins in the animal feed industry. In *Protein byproducts* (pp. 161-192). Academic press. <https://doi.org/10.1016/B978-0-12-802391-4.00010-0>
- [18] Michaelsen, K. F., Dewey, K. G., Perez - Exposito, A. B., Nurhasan, M., Lauritzen, L., & Roos, N. (2011). Food sources and intake of n - 6 and n - 3 fatty acids in low - income countries with emphasis on infants, young children (6–24 months), and pregnant and lactating women. *Maternal & Child Nutrition*, 7, 124-140. <https://doi.org/10.1111/j.1740-8709.2011.00302.x>
- [19] Wilson, L. A. (1995). Soy foods. In *Practical handbook of soybean processing and utilization* (pp. 428-459). AOCS Press
- [20] Angela Saunders V, Brenda Davis C, ManoharGarg L. (2013). Omega-3 polyunsaturated fatty acids and vegetarian diets. The Medical Journal of Australia. <https://doi.org/10.5694/mja11.11507>
- [21] Eze NM, Okwume UG, Eseadi C, Udentia EA, Onyeke NG, Ugwu EN et al. (2018). Acceptability and consumption of tofu as a meat alternative among secondary school boarders in Enugu State, Nigeria. <https://doi.org/10.1097%2FMD.00000000000013155>
- [22] Tjasa Subandi, Stephanie, Kartawidjajaputra, Felicia, Silo W, Yogiara Yogi et al. (2018). Tempeh consumption enhanced beneficial bacteria in the human gut. *Food Research*
- [23] Abiose SH, Allan MC, Wood BJB. (1982). Microbiology and Biochemistry of Miso (Soy Paste) Fermentation. *Advances in Applied Microbiology*. [https://doi.org/10.1016/S0065-2164\(08\)70237-5](https://doi.org/10.1016/S0065-2164(08)70237-5)

- [24] Ito K. (2020) Review of the health benefits of habitual consumption of miso soup: focus on the effects on sympathetic nerve activity, blood pressure, and heart rate. *Environmental Health and Preventive Medicine*.
<https://doi.org/10.1186/s12199-020-00883-4>
- [25] Pradhananga M. (2018). Effect of processing and soybean cultivar on natto quality using response surface methodology. *Food Science & Nutrition*. <https://doi.org/10.1002/fsn3.848>
- [26] Nagai T. (2015). Health Benefits of Natto. *Health Benefits of Fermented Foods and Beverages*.
- [27] Arega Woldemariam, A. (2016). Genetic Progress for Yield and Yield Components of Soybean Varieties [Glycine Max (L.) Merrill] At Bako, Western Ethiopia (Doctoral dissertation, HaramayaUniversity).
<http://localhost:8080/xmlui/handle/123456789/3423>
- [28] Yirga M., Sileshi Y., Tesfaye A., & Hailemariam, M. (2022). Genetic Variability and Association of Traits in Soybean (Glycine max (L.) Genotypes in Ethiopia. *Ethiopian Journal of Crop Science*, 9(2).
- [29] Chen, K. I., Erh, M. H., Su, N. W., Liu, W. H., Chou, C. C., & Cheng, K. C. (2012). Soyfoods and soybean products: from traditional use to modern applications. *Applied microbiology and biotechnology*, 96, 9-22.
- [30] Alemaw, G., & Gurmu, F. (2023). Towards edible oil self-sufficiency in Ethiopia: Lessons and prospects. *Cogent Food & Agriculture*, 9(1), 2198742.
<https://doi.org/10.1080/23311932.2023.2198742>