An overview of Tofu: History, Types, manufacturing process and Health benefits

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Abstract

Soy tofu is widely used in plenty of culinary dishes for its health benefits and nutrition. it is often called as the poor man's meat. It replaces dairy products because of its relatively low cost and rich source of protein, iron, calcium and other minerals. Quality of tofu varies based on the methodology, addition of coagulant and diversity in bean. The tofu making procedure is still at its preliminary stage and the production is limited to cottage level.Tofu is made of condensed soymilk that is pressed into solid blocks. It is buttery, fine textured and palatable. This cheese-like food is made from fresh hot soymilk with one or more coagulants by curdling process. Tofu originated in China and it is a traditional ingredient of the cuisines of Indonesia, Japan, Korea, Vietnam, Singapore and Thailand. It is a rich source of protein and excellent source of essential amino acids calcium, iron, and some minerals. Tofu is made from other bean curd also, however, chick pea tofu is an easy alternative to soy-based tofu and India is the largest producer for chick pea in the world. Hence, this article reviews the historical aspects and characteristics of traditional tofu and more focus on fortified tofu from chick pea milk, manufacturing processes, types and health benefits to create its significance in the world market.This review article also mentioned about the alternative resources for the preparation of tofu.

Keywords: *Tofu, Chick pea milk, Quality of tofu*

Introduction to traditional tofu

Animal products have not been consumed by the majority of non-vegetarian people on a regular basis in adequate quantities to provide the recommended amount of protein. Very few plants provide high quantity of protein, fiber, vitamins, minerals and essential amino acids in the amounts needed for human health. Beans families are one of the rich sources of protein and also provide several therapeutic benefits [1].

Tofu is a traditional product that has been made mainly from soybeans in China over 2000 years ago. Dried soybeans are soaked at lower temperature (22ºC) for 9-10 hours at higher temperatures (32ºC) for 4-6 hours, and then it is followed by the grinding of soybeans [2]. Soybean hulls can also be removed before grinding. Soft, rotating rubber rollers are used to remove the hulls. This is done to improve the color and reduce the beany flavor of the tofu [3].

In addition to this, soybeans can be pretreated with sodium bicarbonate which decreases beany flavor and increases smoothness of the final tofu [4]. Ground slurry is separated into solid pulp (*okara*) and soy milk. The soy milk is cooked at 100°C - 110°C for 3–10 min [5]. Due to cooking, denaturation of the protein occurs thereby eliminating the beany flavor. The curd of soymilk is separated from whey by the addition of salt coagulants such as calcium and magnesium chlorides and sulfates. In some cases, citric acid or gluons delta-lactone can be added as

acid coagulants. The resulting bean curd turns into white blocks of varying softness. It was then preserved for further use. The texture of the tofu maybe firm or tight firm and softened [6].

Tofu consists of relatively high content of proteins, lipids, vitamins, minerals and isoflavones. It is also a major source of protein and contains all nine essential amino acids (histidine, isoleucine, leucine, lysine, methionine, phenylalanine, threonine, tryptophan and valine). Vitamin $B_{1,}$ copper, magnesium and zinc are also present in it. Tofu is found to be very low in calories and it as also free from gluten. It contains no cholesterol so that many people can make use of it. Tofu can be seasoned with spices and flavored with onion and ginger [7].

In the recent years, initiatives are taken to produce varieties of tofu such as silken tofu, firm tofu, dried tofu, fermented tofu and low fat tofu [8]. Firm tofu is also called as “Cotton tofu” which is prepared from soymilk. Both synthetic and natural coagulants are used for processing of soymilk. Partial coagulation takes place by this process and excess water, moisture is removed by pressing and filtering through cheese cloth [9]. Silken tofu/ soft tofu is fine and has a smooth texture. Generally, the curd generally obtained for the soy milk is irregular and coarse [10]. Dried tofu has moisture content below 76%. This is the firmest tofu among all the types. Excess water is removed in multiple stages of pressing. Low fat tofu is apt for the people of the modern era who are indulged in healthy foods. Tofu reduces the consumption of fat and is also a major source of protein [11].

However, it is an inexpensive and nourishing protein rich food. During production of the tofu, coagulant forms a soy protein gel matrix which helps in entrapping water, lipids and constituents present in the matrix to form curd, further pressurized to form solids [12]. Tofu products are classified based on various aspects such as the heating time, coagulants used etc. Therefore, inclusion of tofu as part of a routine diet reduces the risk of various diseases which includes diabetes, hypertension, cardiovascular diseases and others [13, 14].

India is the largest producer of chickpea than soybean in the world, accounting for 65% of the total production. Chickpea is also called as garbanzo beans and also part of a legume family [15]. They are grown in Middle Eastern countries for thousands of years. Chickpeas may offer several health benefits as they are rich in proteins, minerals, and fibers. In addition, they are an excellent replacement for meat in vegetarian’s diet.

Tofu is made from bean curd; however, Burmese tofu is made from chick pea milk and has a fairly neutral flavor similar to regular tofu. It is more firm than traditional tofu and also mixed up with other dishes [16]. Chick pea tofu is rich sources of protein, iron, calcium and other minerals. They also provide a protein alternative to the vegetarians as their diet lacks sufficient amount of protein. Chickpea have an impressive nutrient profile like providing 46 calories per 1-ounce serving approximately 67% of those calories from crabs, while the rest comes proteins and small amount of fat. The protein in chickpea may satisfy the nutritional requirement and keep our appetite in control. Some studies have suggested that the protein quality is high in chickpea other than other types of legumes and contains all amino acids except methionine [17].

Historical aspects of Tofu

It is said that soybeans originated from China almost 2000 years ago. It was used as a common commodity in Chinese cuisine [18]. China was the world's biggest soybean producer and its exports until 1954, when the United States replaced them. Hence China is considered as the birth country of tofu [19, 20].

The word tofu was named in early 1182 A.D by the Japanese. Japanese people gave different nicknames such as shirakabe, shirokabe and okabe. While soybean is technically not a grain, among the five sacred grains including rice, wheat, barley and millet, soybean was one of the important grains according to Chinese culture [21].

The creator of tofu is said to be Liu An, who was a Han-dynasty prince of the Anhui province, prepared soybeans similar to grains followed by drying, mashing and boiling with addition of sea salt. The salt, hence acted as a seasoning agent as well as a solidifying agent to attain the curd form. Since then, sea salts were used to process the tofu from soybeans in 200 B.C. [22, 23].

According to various studies, tofu was originated from a country referred to as Shouxian within the Province of Anhui located in Southeast China. Shouxian civilization was once referred to as Shouchun or Shouyang at the time of Chow dynasty 203 B.C. Shouxin was awarded the title of historical and cultural town of China. In Shouxin, tofu was prepared by coagulating smashed soybean with water and placed into the curdling box. Major consumption of the tofu began in the early 1980s in America [24].

Characteristics of tofu

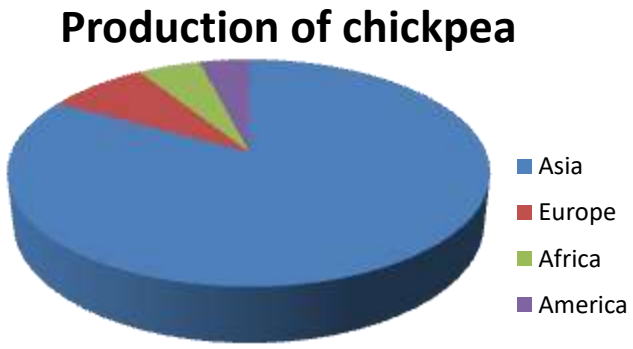
The textural property of the tofu is the most necessary quality that attributes for evaluation of the acceptance of tofu. Higher physical properties and chewiness are sometimes observed in tofu, making it tougher to eat [25]. Hence, factors those are responsible for the three-dimensional network structure is related to the textural characteristics of the tofu. The contents of glycinin (11S) and β-conglycinin (7S), content magnitude relation (11S/7S) and their fractional monetary unit profiles directly impact the formation of network structure and consequently the textural properties. [26]

In general, there is an enhancement in the property of texture by the 11S proteins. Nevertheless, 7S proteins have the alternative result. Thus, gels made of 11S proteins have finer network structure, leading to higher hardness, gel strength and breaking stress than gels made of 7S proteins [27, 28].

The hardness, elasticity, cohesiveness, and chewiness of tofu have a considerably positive relationship with the 11S/7S protein [29]. In order to form the network structure of the tofu, denaturation of soybean proteins by heating of soy milk is mandatory. The hardness, cohesiveness, and chewiness are negatively associated with the heating time in $CaSO_4$-induced tofu. For MTGase-induced tofu, a lot of continuous and uniform coral-like structure and better hardness were observed within the tofu by heating soy milk at 75 °C for thirty minutes [26].

Production and benefits of chickpea tofu

India is the largest producer of chickpea in the world, accounting for 65% (9.075 million tonnes) of the total production [30]. In India, Andhra Pradesh contributes the highest chickpeas yield of an average of 1.4 metric tons /ha [31]. The overall increase in the yield of chickpea per annum is 6kg/ha. Studies suggest that the yields are progressively increasing globally [32].



Average Annual production share of Chick peas by region from 2008 to 2017. Source: [33]

It is also stated that Chickpea (Cicer arietinum L.) is an ancient pulse crop and major consumption of chickpea is due to its high nutritional value [34]. It is also reported the presence of rich dietary protein in chickpea and also insisted that it is used as a supplement for protein in various countries including India, Pakistan and many other western countries [35].

Chickpea is considered to be highly valued crop and it also plays a major role in covering the deficiency of protein in the daily diet [36]. A tofu can also be prepared from both chickpea and chickpea flour. Similar to soybeans, chickpeas are good sources of nutrients and phenolic compounds, especially isoflavones [37].

Cooked chickpea is found to be higher in calories and Soy tofu has fewer calories than chickpea. Soy tofu has 76kcal per hundred grams and chickpeas have 164kcal per 100 grams [38]. Hence it has a high supply of dietary fibers. While soy tofu has 3g of dietary fiber per hundred grams, chickpea has 6g of dietary fibers per hundred grams [39].

Types of chickpea

There are two distinct types of chickpea. The prominent and largely consumed type is called the "Desi". It is relatively a small seed that has a colour variation from light tan to black. Variations in the anthocyanin pigmentation are also observed in this type. They are characterized by yellow cotyledons and have a thick seed coat. The seed coats are often removed from the seeds and "Dal" is obtained when the seeds are split. "Dal" is commonly used in South Asia. It can be made from most of the pulse crops [40].

The other type is called the "Kabuli" type. It is characterized by large seeds that measure up to 22mm in diameter. This type is thin and lightly tanned in color due to the lack of pigmentation. This type is mostly consumed by the population outside of South Asia. This type is less expensive and is produced in an easy manner. Overall, 80% of the world production of chickpea is the "desi" type whereas the remaining 20% is the "Kabuli" type [41].

Benefits

The protein percentage of the chickpea ranges from 15% to 30% depending upon the variety and the physiological factors. Chickpea is an essential source of protein, minerals and vitamins [19].

The Desi and Kabuli types are consumed in various forms all across the globe. They are boiled, roasted, dehulled to make dal, eaten freshly as raw fresh seeds or processed into flour that can be used for the preparation of bread. The amino acids which contain sulfur compensates for the ones that limit the cereals [42]. Chickpea also contains bioactive substances in addition to carbohydrates, protein, fibers, minerals and vitamins. Both the soluble and insoluble-bound forms consist of the phenolic compounds [43].

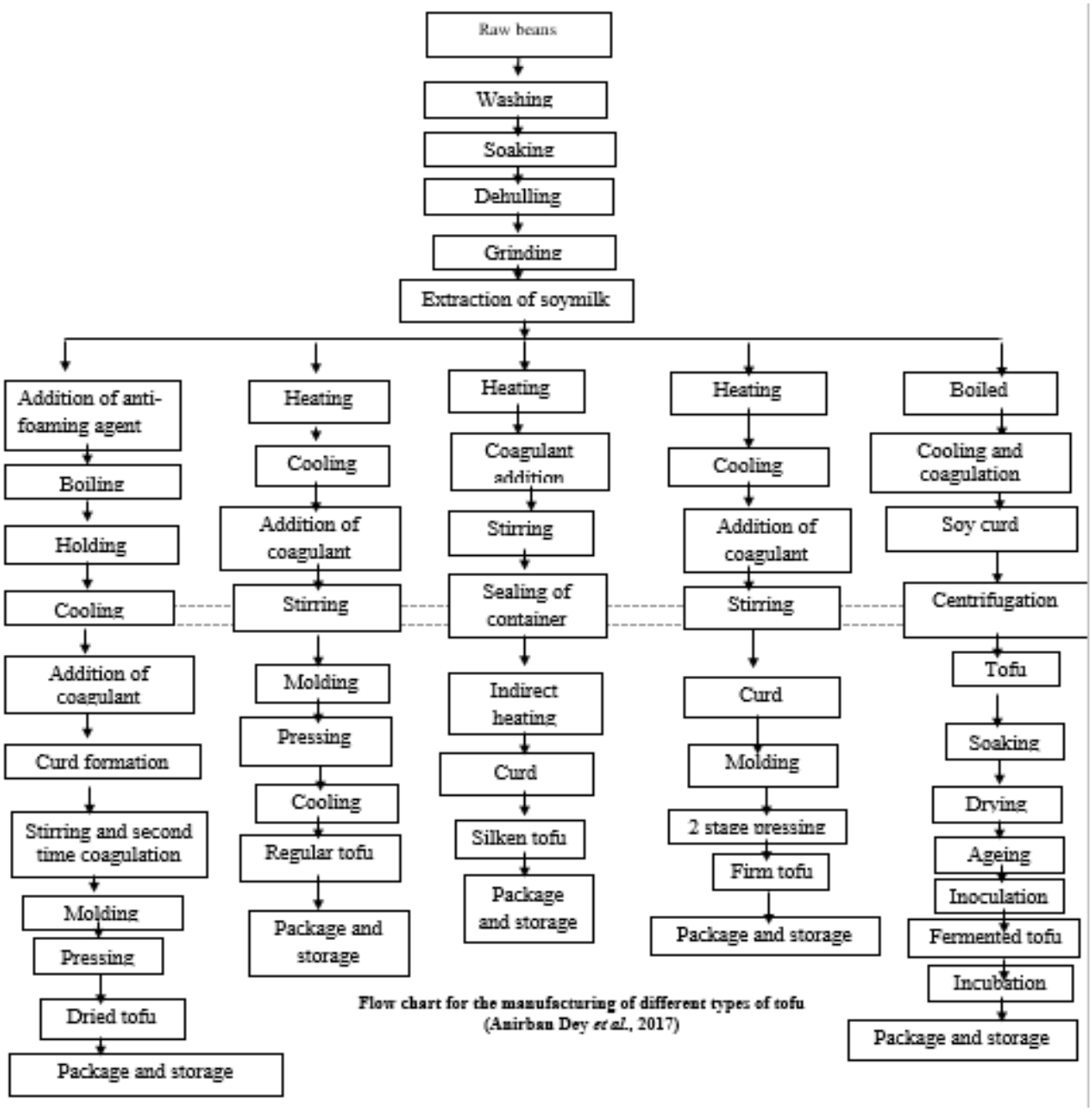
Chickpea consists of significant amounts of flavonoids, especially isoflavones. According to the literature, the TIC (total isoflavone content) varies from 153 to 340 mg/100 g of chickpea [44]. The major isoflavones found in chickpeas were biochanin A and formononetin while trace amounts of genistein and daidzein were also noted [45]. Due to its lower lipid content (up to twenty-one-fold less) compared to that of soybean, chickpea stands out as a good option in weight management [42].

Furthermore, the fiber content of chickpea is higher when compared to soybean content. Due to their high contents of insoluble fiber, consumption of chickpea and soybean may promote regular bowel movement, thus preventing constipation [46]. Consuming large amount of fiber may lower the risk of developing various diseases such as diabetes, colorectal cancer cardiovascular diseases [47].

Different compounds of chickpea display various activities that include are antioxidant, antihypertensive, hypocholesterolemic, and anticancer activities. They are consumed as an alternative for the prevention of chronic degenerative diseases owing to the presence of phenolic compounds in it. The discovery of new anticancer agents from natural sources like the chickpea seed could be an alternative for the prevention and treatment of cancer. Bioactive compounds in the chickpea are found to decrease the level of lipids in the blood. It also reduces the blood lipid concentration. It is a high source of dietary fiber and consists of a very low amount of lipid in it [48]. Chickpea

seeds also consist of molecules that have the capacity to inhibit inflammatory process my means of various mechanisms [49].

Various methods of production



Flow chart for the manufacturing of different types of tofu (Anirban Dey *et al.*, 2017)

Alternative resources for the preparation of tofu

Quinoa (Seemathinai):

The tiny seedof quinoa contains protein, potassium, iron, magnesium fiber, manganese, calcium and riboflavin. Cooked quinoa contains eight grams of protein. It is one of the non-meat options that provide the nine essential amino acids to our body which is essential for tissue growth and repair [50, 51].

Kidney beans

It is a great source of fiber, vitamin and minerals and rich in protein. Sprouted red bean is significantly contributed to an increase in GABA (Gamma Amino Butyric acid) production. They are composed of high amount of protein and low amount of carbohydrates. The GABA content in tofu was 0.55 mg/g, which was lower than that in soybean milk (0.65 mg/g) [52].

Though kidney beans are delicious, studies suggest that they exhibit toxicity. Kidney bean toxicity may be divided into two subcategories: toxicity caused by lectins, sapanins, phytates and protease inhibitors or allergenicity induced by its allergenic proteins [53]. Autoclaving the kidney beans for 30 minutes considerably improved weight gains and eliminated the pancreatic enlargement. Supplementing the diet containing 50% red kidney beans with the deficient essential amino acids did not results in growth performance equivalent to that with the control corn soybean meal type diet. [54]

Seitan(wheat meat):

It is a best tofu alternative, made from wheat gluten. It is a popular protein source for many vegetarians. It is rich in proteins and a good source of minerals like selenium and iron. Seitan was found to have 20%protein content higher than fried tofu. [55]

Lupin (lupini beans):

It has comparable nutritional functional properties to soybean. Lupin can be used to replace soybean in number of food products including tofu. Lupin has very low fat content. The fat content of tofu can be reduced by lupin substitution without affecting sensory acceptability. Lupin is a suitable substitution for tofu with low fat and high protein content in it. It is also an economic alternative to tofu in comparison with the cost and production [56].

Conclusion

Due to environmental, health and ethical reasons, many consumers are avoiding the number of animal products. Tofu consumption is accelerated by its nutritional values for vegetarian and also recommended as hypocaloric diets for disease person and health-conscious people. Hence, to meet the demand of consumers, high quality and excellent flavored tofu products must be produced commercially. The quality of final tofu products depends on nutritional values, major ingredients, making process, coagulant type, Temperature, shelf life and packing material. This review clearly discussed the different types, characteristic and different production methods. Also provided the alternative resources for the preparation of tofu.

Reference:

1. Raja.J, Hillal A Punoo, Farooq A.M (2014). Comparitive study of soy paneer prepared from soymilk, blends of soymilk and skimmed milk; Journal of Food processing and Technology, 5(2); 378-391.

2. Purcell, Larry C. Salmeron, Montserrat, Ashlock, Lanny (2000). "Chapter 19: Soybean Facts" (PDF). Arkansas Soybean Production Handbook – MP197. Little Rock, AR: University of Arkansas Cooperative Extension Service.

3. Snyder. H.E and Wilson.L.A; Soy beans: Processing for the food industry; Encyclopedia of Food Sciences and Nutrition; Edition 2; 2003.

4. Kellor R L. (1974). Defatted soy flour and grits. Journal of the American Oil Chemists' Society 51: 77-80.
5. Beddows C G and Wong J (1987) Optimization of yield and properties of silken tofu from soybeans. I. The water: bean ratio. International Journal of Food Science and Technology 22: 15-21.

6. Tara McHugh (2016), How Tofu is processed; Food Technology Magazine; 176-180.

7. Li Zheng, Joe M. Regenstein, Fei Teng, Yang Li. (2020), Tofu products: A review of their raw materials, processing conditions, and packaging; Comprehensive reviews in food science and food safety; 19:3683–3714.

8. Rekha C R and Vijayalakshmi G (2010). Influence of natural coagulants on isoflavones and antioxidant activity of tofu. Journal of Food Science and Technology 47(4): 387-393.

9. Wallace TC, Murray R, Zelman KM, (2016), The nutritional value and health benefits of chickpeas and hummus; Nutrients, 08, 766-776.
10. Yang A, James A.T. (2016). Comparison of two small scale processing methods for testing silken tofu quality; Food Analytical Methods, 9, 385-392.
11. Rizzo G and Baroni L, (2018), Soy, Soy Foods and Their Role in Vegetarian Diets, Nutrients.,10(1): 43.

12. DeMan J M, deMan L and Gupta S (1986) Texture and microstructure of soybean curd (tofu) as affected by different coagulants. Food Microstructure 5: 83-89.

13. Anderson, E. J., Ali, M. L., Beavis, W. D., Chen, P., Clemente, T. E., Diers, B. W., ... McHale, L. K. (2019). Soybean [Glycine max (L.) Merr.] breeding: History, improvement, production and future opportunities. In J. M. Al-Khayri, S. M. Jain, & D. V. Johnson (Eds.), Advances in plant breeding strategies: Legumes, 431–516.

14. Voora, V., Larrea, C., and Bermudez, S. (2020). Global Market Report: Soybeans. State of Sustainability Initiatives.

15. Hulse, J. H. (1994). Nature, composition, and utilization of food legumes. In F. J. Muehlbauer& W. J. Kaiser (Eds.), Expanding the production and use of cool season food legumes,. 77–97.

16. Potter S (1998). Soy protein and cardiovascular disease: the impact of bioactive components in soy. Nutrition Reviews 56(8): 231-235.

17. Key T.J., Davey G.K. (1999). Appleby P.N. Health benefits of a vegetarian diet. *Proc. Nutr. Soc.* 58:271–275.

18. Watanabe T (1997). Science of Tofu. Food Journal Co. Ltd, Kyoto, Japan.

19. Buell, P. D. (2018). Tofu. In K. Christensen (Ed.), Asian cuisines: Food culture from east Asia to Turkey and Afghanistan (pp. 124–127). Great Barrington, MA: Berkshire Publishing Group LLC.

20. Shurtleff, William; Aoyagi, Akiko (2015). History of Soybeans and Soyfoods in Sweden, Norway, Denmark and Finland (1735–2015): Extensively Annotated Bibliography and Sourcebook. Lafayette, CA: SoyinfoCenter. 490.

21. Hong Fan, (2014), Branding a place through its historical and cultural heritage: The branding project of Tofu Village in China; Place Branding and Public Diplomacy, 10, 279–287.

22. Adriano Costa de Camargo, Bruno TrevenzoliFavero, MaressaCaldeiraMorzelle, Marcelo Franchin, Emilio Alvarez-Parrilla, Laura A. de la Rosa, Marina VilarGeraldi, Mário Roberto Maróstica Júnior, Fereidoon Shahidi and Andrés R. Schwember (2019). Is Chickpea a Potential Substitute for Soybean? Phenolic Bioactives and Potential Health Benefits; International Journal of Molecular Sciences, 20, 2644; 1-42.

23. Sung Won Knag, M. Shafiur Rahman, Sung Gil Choi. (2018). Yield and physiochemical properties of low fat tofu prepared using super critical carbon dioxide treated soya flours with different fat levels; Journal of food science and technology, 55; 2712-2720.

24. Anirban Dey, Rasane Prasad1, Sawinder Kaur, Jyoti Singh, M.D. Luwang (2017). Tofu: technological and nutritional potential; Indian Food Industry Magazine, 3 (36).

25. Cai T D and Chang K C. (1997). Dry tofu characteristics affected by soymilk solid content and coagulation time. Journal of Food Quality 20: 391-402.

26. Qing Zhang, Wen Qin, in Encyclopedia of Food Chemistry, 2019

27. Carroll K. (1991). Review of clinical studies on cholesterol-lowering response to soy protein. Journal of the American Dietetic Association 91: 820-827s.

28. James AT,Yang A.(2016), Interaction of protein content and globulin subunit composition of soybean protein in relation to tofu gel properties, food chemistry,194,284-289.

29. Penaranda A V. (1999) Effect of the use of lipoxygenase-free soybean line on the sensory attributes of soymilk and tofu. Retrospective Theses and Dissertation. Iowa State University.

30. Bulti Merga&Jema Haji. (2019). Economic importance of chickpea: Production, value, and world trade; Cogent Food & Agriculture, 5, 1-12.

31. Nedumaran, S., Abinaya, P., Jyosthnaa, P., Shraavya, B., Rao, P., &Bantilan, C. (2015). Grain legumes production, consumption and trade trends in developing countries. Working Paper Series No. 60.

32. Akibode, C. S and Maredia, M. K. (2012). Global and regional trends in production, trade and consumption of food legume crops (No. 1099-2016-89132).

33. Food and Agriculture Organization (FAO). (2019). FAOSTAT Statistical Database of the United Nation Food and Agriculture Organization (FAO) statistical division. Rome

34. Kumara Charyulu, D., & Deb, U. (2014, October 15–17). Proceedings of the "8th International Conference viability of small farmers in Asia". International Conference on Targeting of Grain Legumes for Income and Nutritional Security in South Asia, Savar, Bangladesh.
35. Latham, M. C. (1997). Human nutrition in the developing world (No. 29). Rome: Food & Agriculture Organization of the United Nations.

36. R. Cai, A. Mccurdy, and B.-K. Baik (, 2002). Textural Property of 6 Legume Curds in Relation to their Protein Constituents; JFS: Food Chemistry and Toxicology; 67. 5; 1725-1730.

37. De Camargo AC, Favero BT, Morzelle MC, Franchin M, Alvarez-Parrilla E, de la Rosa LA, Geraldi MV, Maróstica Júnior MR, Shahidi F, Schwember AR.(2019). Is Chickpea a Potential Substitute for Soybean? Phenolic Bioactives and Potential Health Benefits. Int J Mol Sci. 20(11):2644-2659.

38. Nemecek, T.; Poore, J. (2018). "Reducing food's environmental impacts through producers and consumers". Science. 360 (6392): 987–992.

39. Kan L, Nie S, Hu J, Wang S, Bai Z, Wang J, Zhou Y, Jiang J, Zeng Q, Song K. (2018). Comparitive study on the chemical composition, anthocyanins, tocopherols and carotenoids of selected legumes, Food Chemistry, 260; 317-326.

40. Malunga, L. N., Bar-El, S. D., Zinal, E., Berkovich, Z., Abbo, S., &Reifen, R. (2014). The potential use of chickpeas in development of infant follow-on formula. Nutrition Journal, 13(1).

41. Wood, J. A., &Grusak, M. A. (2007). Nutritional value of chickpea. Chickpea Breeding and Management, 101–142.
42. Singh, B.; Singh, J.P.; Kaur, A.; Singh, N. (2017), Phenolic composition and antioxidant potential of grain legume seeds: A review. Food Res. Int. 101, 1–16.

43. https://www.soupersage.com/compare-nutrition/tofu-vs-chickpeas

44. Cantelli, K.C.; Schmitd, J.T.; Oliveira, M.A.D.; Steffens, J.; Steffens, C.; Leite, R.S.; Carrão-Panizzi, M.C. (2017), Brotos de linhagensgenéticas de soja: Avaliação das propriedadesfísico-químicas. Brazilian Journa; of Food Technology, 20.

45. Alajaji, S.A.and El-Adawy, T.A. (2006). Nutritional composition of chickpea (Cicer arietinum L.) as affected by microwave cooking and other traditional cooking methods. Journal of Food Composition and Analysis, 19, 806–812.

46. Gao, Y.; Yao, Y.; Zhu, Y.; Ren, G. (2015), Isoflavone content and composition in chickpea (Cicer arietinum L.) sprouts germinated under different conditions. J. Agric. Food Chem., 63, 2701–2707.

47. Hiwot Abebe Haileslassie, Carol J. Henry & Robert T. Tyler (2019). Impact of pre-treatment (soaking or germination) on nutrient and anti-nutrient contents, cooking time and acceptability of cooked red dry bean (Phaseolus vulgaris L.) and chickpea (Cicer arietinum L.) grown in Ethiopia; International Journal of Food Science and Technology, 1-13.

48. Jukanti A, Gaur P, Gowda I, Chibbar N.(2012). Nutritional quality And health benefits of chickpea (Cicer arietinum L.): a review; British Journal of Nutrition. 108:S11–S26.

49. Iqbal S, Zia-Ul-Haq M, Ahmad S; (2007). Nutritional and Compositional study of Desi chickpea (*Cicer arietinum* L.) cultivars grown in Punjab, Pakistan; Food Chemistry. 105; 1357-1363.

50. GS Ranhotra, BK Glaser et.al., (1993). Composition and protein nutritional quality of quinoa, cereal chemistry,70, 303-303.
51. KJ Lorenz, GS Ranhotra, JA Gelroth, BK Glaser, DL Johnson; Composition in protein, nutritional quality of Quinoa; Cereal Chemistry; 1993;70; 303.
52. Atiya Techaparin, Kimroeun, Vann. (2020). Beans germination as potential tool for GABA – enriched tofu production, Food science and technology, 57(11), 3947- 3954.

53. Sandeep Kumar, Mukul Das, (2013), Clinical complications of kidney bean consumption, Nutrition 29(6) ,821- 827.
54. PV Wagh, IE Liener. (1963). Nutritive value of red kidney bean for chicks, The journal of nutrition 80 (2), 191-195.
55. Dina anwar, el- chaghaby Ghadir , (2019). Nutritional quality, amino acid profiles , protein digestibility corrected amino acid and anti-oxidant properties of fried tofu and seitan , Food and environment safety journal, 18 (3).
56. Vijay Jayasena, WS Khu, et.al, (2010). The development and sensory acceptability of lupin based tofu, The journal of food quality, 33 (1), 85-97.