IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

A Comprehensive Review On Lentils: Nutritional Composition, Functional Properties And Health Benefits

Vaishnavi Singh 1, Prarthana Tiwari 2

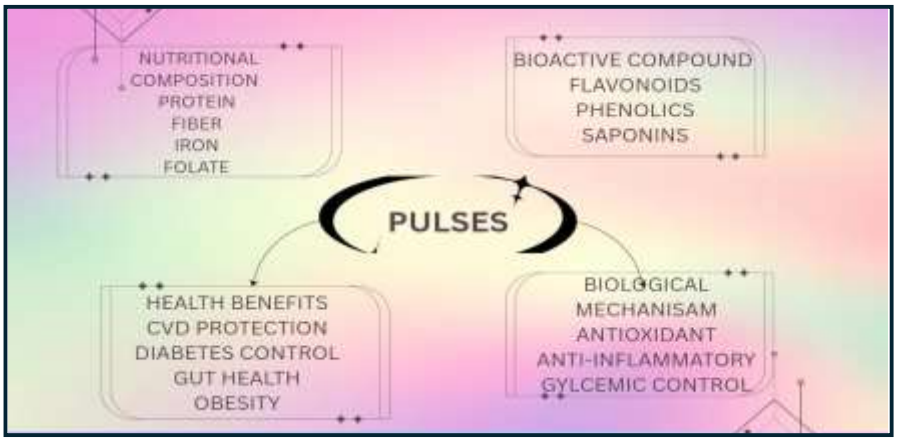
1. PG Student of Allied Health Sciences, Jaipur National University, Jaipur, Rajasthan, 302017.
2. Assistant Professor, School of Allied Health Sciences, Jaipur National University, Jaipur, Rajasthan, 302017

ABSTRACT

One of the world's first cultivated crops is the lentil. Legumes are a cool-season food that are important to humans. A variety of agroecological locations, including Asia, North and South America, Africa, and Oceania, grow lentils. The global output of lentils grew by 107% between 2001 and 2020, from 3.15 to 6.54 million metric tons. With 44% of the world's production, Canada is the top producer of lentils, followed by Australia and India with 18% and 8%, respectively. Typically, lentil crops are planted in the fall and harvested at moisture levels of 16–18% for green lentils and 14–16% for red lentils toward the conclusion of a very hot and dry summer. Lentils are regarded as a nutritious food since they are high in protein, complex carbs, dietary fibre, and folic acid. Numerous bioactive phytochemicals, including flavonoids, total phenolics, phytate, saponins, and tannins, are also found in lentils. An overview of lentil production and trade, consumption patterns, nutritional profile, health advantages, and the contribution of lentil production to environmental sustainability is given in this review article.

KEY WORDS- Lentil, Health Benefits, Functional Food, Bioactive Compound, Antioxidant

GRAPHICAL ABSTRACT



INTRODUCTION

The lentil (Lens culinaris Medik.) is among the first domesticated agricultural species, if not the first. It began at least 12,000 years ago in the Fertile Crescent region of the Middle East (Stefaniak & McPhee,2015). The stem and pod of the lentil plant contain carbohydrates (50%), protein (4.4%), oil (1.8%), moisture (10.2%), ash (12.2%) and cellulose (21.4%). The dried grains of the lentil plant contain protein rich in amino acids and vitamins A, B, C, K and iron. The high levels of thiamine and niacin in the grain increase the quality of the protein contained in red lentils (ERDEN & TOPRAK.,2022). Typically, lentil crops are planted in the fall and harvested at moisture levels of 16–18% for green lentils and 14–16% for red lentils toward the conclusion of a very hot and dry summer. To prevent both quantity and quality losses, lentils should be kept at 14% or below (Chelladurai & Erkinbaev,2020).

One of the major issues with collecting and processing grains and seeds, like lentil seeds, after harvest is mechanical damage to the seeds. In the export market, damaged lentils are less valuable and more susceptible to mould and insect attacks (Shahbazi *et al*.,2017). Compared to plant-based diets, animal-based foods usually require more resources and have a greater environmental impact. The least significant is a vegan diet. FAO and WHO (2019) also note that dietary shifts toward healthier diets can lessen the food system's environmental effect because research so far has shown the advantages of moving toward a diet higher in fruits, vegetables, nuts, legumes, and wholegrains (Lignicka *et al*.,2022). According to Amin and Borchgrevink (2022), edible legumes, such as lentils, are a good choice for creating pasta and other wheat flour products due to their compositional and techno-functional qualities. In comparison to conventional 100% wheat-based goods, the amount of protein and dietary fibre in such items can be greatly boosted by substituting wheat flour with that from pulse flours or flour blends (Kaale *et al*.,2022).

Due to their high nutritional content, capacity to fix nitrogen, and ability to improve soil fertility, lentils (Lens culinaris) play a significant role in agriculture. In lentil farming, appropriate fertilisation techniques are essential for both soil health and increased output (TUNÇ & RUFAİOĞLU). Abiotic stressors that limit crop

growth and yield include high temperatures and moisture stress. Climate change has made unfavourable crop conditions worse, leading to large financial losses for horticulture and crops (Venugopalan *et al*.,2022). The second-most significant rabi pulse crop in India, lentils are a rich source of vital amino acids and protein. In India, marginal farmers are the primary producers of lentils, which are known for their poor yields and significant unpredictability. According to research, replacing outdated lentil varieties and changing the crop sequence's planting timing might increase production and increase the area in promising locations (Mukherjee et al.,2023). Lentils (Lens culinaris Medik.) and peas (Pisum sativum L.) are examples of pulse crops that can enhance the sustainability of cropping systems in the Northern Great Plains, primarily through biological N fixation. Increased N fixation can assist farmers in boosting production while lowering N fertiliser inputs for the subsequent crop (Baber *et al*.,2023). Because pulses use symbiosis to fix atmospheric N2, they are important to the nitrogen cycle. It's unclear, nevertheless, if different pulse species and cultivars have varying capacities for biological nitrogen fixation (BNF) (Hossain *et al*.,2016).

One of the first domesticated crops in the world is the lentil (Lens culinaris Medik.). Lentils, often referred to as split peas, masur, or red dhal, are a staple meal that is frequently consumed alongside cereal grains. One of the three most popular pulses, lentils are grown in 53 countries worldwide, with yields ranging from 227 kg/ha in Israel to 2567 kg/ha in China in 2018. According to FAOSTAT 2019, there are an estimated 6.10 million hectares of lentils grown worldwide, with an annual output and yield of 6.33 million tonnes (MT) and 1038 kg/ha, respectively. Recent years have seen a considerable increase in global lentil output, with North American and Asian nations accounting for the majority of this growth. The world's lentil consumption is predicted to rise to 5.50 MT by 2030, implying a 2.0 MT increase in output. In 2017, Canada, Australia, the United States, and Turkey accounted for 87.02% of global export commerce (3.49MT), making them the top exporting nations (MALIK *et al*.,2021). Only 44% of the produce is sent to the world market, with the majority—roughly 56%—being eaten domestically. India is the country that consumes and produces the most lentils, whereas Canada is the top exporter (Reda,2015).

As the world's second-largest producer of lentils, India is a net importer. Production of lentils has become more expensive over time. Lentils have lower net returns than other crops that compete with them (Varghese et al.,2019). Period II (2013–22) saw the highest compound annual growth rate of lentil output (3.06%) and yield (2.19%) in India, along with a 0.84% increase in the country's lentil cultivation area. The worldwide lentil region, on the other hand, saw the largest growth rate (2.94%) during that time, while the yield level growth rate saw an annual fall of 0.71% (SAH *et al*.,2024).

PRODUCTION AND TRADE DYNAMICS OF LENTIL IN INDIA

	Area (Mha)	Production (Mt)	Yield (t/ha)
TE 2003	1.44	0.92	0.62
TE 2012	1.54	1.01	0.65
TE 2022	1.41	1.26	0.89
CAGR (%)			
Period 1 (2003-2012)	1.02	0.70	-0.312
Period 2 (2013-2022)	0.84	3.06	2.19
Overall Period (2003-2022)	0.09	2.18	2.08
CDVI			
Period 1 (2003-2012)	5.29	7.93	7.08
Period 2 (2013-2022)	8.99	14.72	9.47
Overall Period (2003-2022)	7.38	14.64	11.96

Table 1: Growth and Instability in area, production and yield of lentil at the national level

BOTANICAL DESCRIPTION AND DISTRIBUTION

Because of their low cost of production, lentils (Lens culinaris Med.) stand out among the many species that make up the Fabaceae family as one of the most significant sources of protein, particularly in poor nations. Lentils often lose fewer nutrients than pulses with a hard seed coat since they are regarded as soft-seeded pulses that require less boiling time (Plaza *et al*.,2021). There are two varieties of lentil seeds: Chilean/large-seeded seeds, which weigh more than 50 grams per 1,000 seeds, and Persian/small-seeded seeds, which weigh 45 grams or less (Shahbazi *et al*.,2017). One of the most important economic characteristics in the red lentil industry is efficient milling. It's interesting to note that the colour and composition of the seed coat are known to affect the thickness of the seed coat; genotypes with homozygous tan seeds have significantly lower polyphenol content, and their seed coats are almost 20% thinner and lighter than those with normal seed coat colour (Mishra *et al*.,2022). The lentil is a 20–45 cm long, bushy, semi-erect, branching, or single-stemmed plant. It yields several tiny pods, each of which typically contains one or two seeds. Morphological characterisation has been used to enhance crop breeding programs and characterise the germplasm of many plant species (Kefelegn *et al*.,2025). This accession was shown to have a very distinctive and conspicuous funiculus on the seed coat, a greater rate of water uptake, and nutritional features (rich in sugar, starch, protein, and minerals) based on a comparison study with chosen accessions for seed shape, quality attributes, and physiology (Tripathi *et al*.,2019).

NUTRITIONAL COMPOSITION

The lentil (Lens culinaris) is a very nutritious crop that is cultivated and eaten all over the world because it contains a lot of macro and micronutrients, including minerals. There are several positive effects of minerals on human health. Therefore, especially in low-income nations, lentils are crucial to food security. The average

daily dietary intake amount that is sufficient to fulfil the nutritional requirements of almost all (97%–98%) healthy people of a specific age, sex, life stage, or physiological condition (pregnancy or breastfeeding) is known as the recommended dietary allowance (RDA). By definition, the RDA surpasses everyone's real needs, except around 2% to 3% (Benayad & Aboussaleh, 2021). Lentils, both raw and cooked, are composed of around 25% protein, 63% carbs, and approximately 1% fat. Between 11% to 31% of dietary fibre is found in lentils (Dhull *et al*.,2022). Protein content was greater in lentils (25.8–28.6%) than in peas (22.2–27.6%). However, compared to lentils (17.8–21.8%), peas have a greater fibre content (19.8–31.4%). Lentils and peas both have low fat content (<1.6%) and comparable starch contents (41.5–52.3 and 43.5–50.0%, respectively) (Li & Ganjyal 2017).

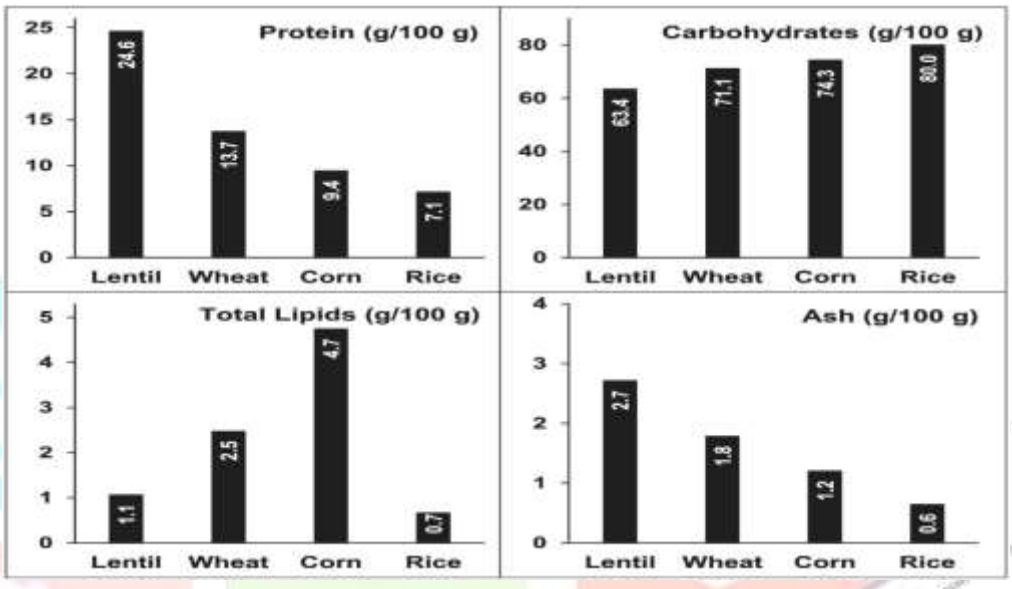


Table 2: Protein, carbohydrate, total lipids, and ash content of lentil compared with selected cereal grains.

Source: Based on data from USDA (**2022**).

Additionally, beans are high in nutrients, including zinc, magnesium, and B vitamins. Water-soluble B group vitamins participate as coenzymes in a significant portion of enzymatic reactions that support cellular physiological activities. The body cannot store these vitamins, thus they must be consumed every day. B vitamins are essential for energy metabolism (Ozturk *et al*.,2022).

The fibre content of lentil seeds is usually substantial, with soluble fibre making up the remainder portion and insoluble fibre making up between one-third and three-quarters (Singh *et al*.,2016). B1 (thiamine), B2 (riboflavin), B3 (niacin), B5 (pantothenic acid), B6 (pyridoxine), B8 (biotin), B9 (folic acid), and B12 (cyanocobalamin) make up the B vitamin complex. Neural tube abnormalities in the fetus (B9), anaemia (B2), and beriberi (B1) are only a few of the acute and chronic disorders that can result from a B vitamin shortage. All of the necessary B vitamins, with the exception of B12 (which is lacking in higher plants), may be obtained via plant-based diets (Zhang *et al*.,2021). Polyphenols (flavonols, tannins, phenolic compounds), phytate, phytosterols, minerals, vitamins, oligosaccharides, resistant starch, proteins, bioactive peptides, and saponins are among the bioactive components of lentils that have positive health benefits. With 16.7% saturated fatty acids (SFA), 23.7% monounsaturated fatty acids (MUFA), and 58.8% polyunsaturated fatty acids (PUFA),

lentils have a comparatively low fat content (Paucean *et al*.,2018). Both crude and neutral-detergent fibre levels decreased during germination, but total phenolic and flavonoid contents, antioxidant activity, and digestibility increased. Digestibility increased after cooking, but antioxidant activity, crude and neutral detergent fibre contents, and total phenolic and flavonoid contents decreased (Bubelová et al., 2018).

Antioxidants found in lentils are also abundant and are mostly linked to polyphenolic substances such as flavonols, flavones, flavan-3-ols, proanthocyanidins, anthocyanidins, hydroxybenzoic, hydroxycinnamic acids, and isoflavones (Rico et al.,2021). Because lentils contain phytochemicals that may have antioxidant and anti-inflammatory properties, eating lentils has been linked to a lower risk of several illnesses (Zhang *et al*.,2018).

HEALTH BENEFITS

In both developed and developing countries, lentils have grown in popularity as a crop and food item. From early infancy to old age, lifestyle decisions—including diet—have a significant impact on preserving human health. A normal biological process, inflammation aids in tissue repair and protects the body. It may eventually lead to the formation of diseases, including cancer, autoimmune disorders, neurological illnesses, or cardiovascular disease (CVD) if it lasts for a long time and forces the use of anti-inflammatory medications. Alternative medicines based on natural products have grown in popularity in recent years (Dewan *et al*.,2024). Red lentils contain soluble fibre that binds to "bad" cholesterol and aids in its excretion via bile acids. By lowering the chance of atherosclerotic plaque, this lowers cholesterol and maintains heart health (BBQ Box *et al*.,2022).

In both healthy individuals and those with diabetes, lentils can enhance the metabolism of lipids, lipoproteins, and blood sugar. When 50 g of cooked lentils are regularly consumed by diabetic patients, the glycemic load, glycemic index, and fasting blood sugar (FBS) of animals with streptozotocin (STZ)-induced diabetes significantly decrease (Ganesan & Xu 2017). The low glycemic index of several pulses is crucial for both diabetes prevention and therapy. Pulses include α-amylase and α-glucosidase inhibitors, which lessen the absorption of glucose from the gastrointestinal system, in addition to their high fibre content and low glycemic index. These substances have anti-inflammatory and antidiabetic properties (Grden & jakubczyk 2023).

Dietary pulses may lower the risk of CVD by helping to control postprandial blood glucose, which is crucial for managing and preventing type 2 diabetes, a risk factor for CVD. Dietary pulses are slow to digest due to their high soluble fibre content (Padhi & Ramdath, 2017). Dietary modifications are a crucial part in managing and preventing diabetes and CVD (Lukus *et al*.,2020).

The anticancer and hemopreventive effects are caused by the abundance of polyphenolics. Lectins, saponins, glycosides, bioactive peptides such as defensin proteins and protease inhibitors, fermentable fibres, and prebiotic oligosaccharides are other components of lentils that have been shown to have anticarcinogenic potential. Understanding the chemopreventive and anticancer properties of lentil seeds may be aided by the notably high polyphenolic content of lentils and the mechanisms they activate (E. Faris *et al*.,2020).

Numerous studies show how lentils can help reduce obesity. Among them, epidemiological research shows how lentil polyphenols can lower the prevalence of obesity. A human study also demonstrated a link between eating lentil seeds with pasta and sauce and lowering body weight, waist circumference, and food consumption. Colon, thyroid, liver, breast, and prostate cancers are all lessened by lentil seeds (M. Mustafa et al.,2022).

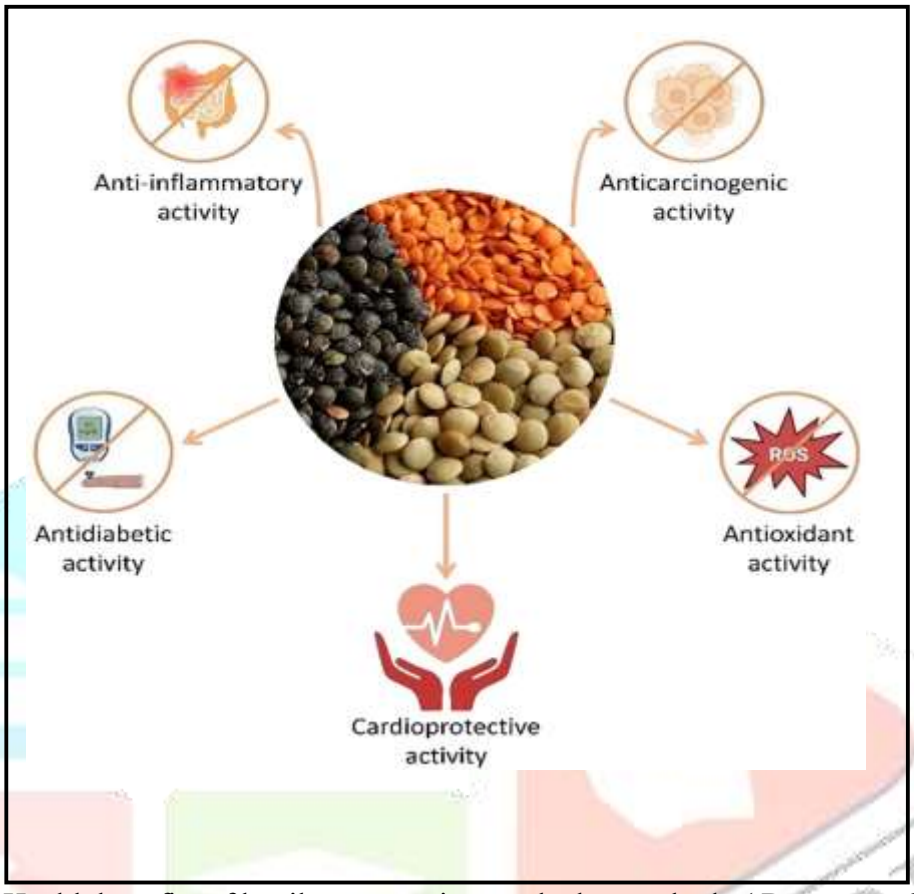


Table 3: Health benefits of lentil consumption on the human body (Dewan *et al*.,2024)

FUTURE SCOPE

The search for novel protein sources to substitute animal proteins is becoming more popular due to concerns about food security and environmental sustainability (Day, Trends in Food Science and Technology, 32, 2016, 25). Lentil proteins (LP) and other pulse proteins show promise as suitable replacements due to their diverse range of functional characteristics (Jarpa-Parra,2018). For use in functional food products, lentil components such as flour, protein isolates, starch, and fibre have important nutritional and technological qualities. Their usefulness is greatly improved by processing methods, especially germination, which permits their usage in a variety of food systems, such as encapsulation and edible/biodegradable materials (O. Keskin & Summu,2023).

climate change, Food insecurity, substantial livestock production (a major source of greenhouse gas emissions and a contributing factor to climate change), and daily dietary habits that are more nutritionally adequate and healthful (low-sodium, low-fat, high-protein, cholesterol-free, bioactive, and meat-free) as a result of growing consumer health and wellness awareness. These consist of gluten-free (GF), vegan, and plant-based functional

food items (Keskin & Summu,2024). Consumer trends are shifting toward plant-based products due to concerns about animal welfare, health, and the environment, among other things. In addition to the high cost and lack of taste and texture of analogues, the market's limited selection of plant-based products remains a significant obstacle to this trend. It is anticipated that expanding the variety of plant-based goods will benefit customer choice, which is partly motivated by human curiosity (Badia-Olmos et al.,2024).

Lentils' bioactive substances are essential for preventing degenerative illnesses in humans and for enhancing overall health. The current thorough review, which is based on exploratory investigations, attempts to give information on the nutritional contents, bioactive chemicals, and health-promoting effects of polyphenol-rich lentils and investigates their therapeutic benefits for upcoming clinical trials (Ganesan & Xu,2017).

CONCLUSION

Numerous studies have emphasised this legume's nutritional value, mostly because of its high protein content. Lentils are typically used in soups and rotis. Due to their enhanced nutritious properties, baked goods fortified with pulse flour and extruded items like spaghetti made with pinto bean, navy bean, and lentil flour are becoming more and more popular among customers. Due to consumers' desire for pleasant and healthful snacks and baked goods, the use of lentil flour in conjunction with cereal-based flours is growing daily. Human nutritional deficiencies, including protein malnutrition, are brought on by a lack of food and a diet low in macronutrients such as proteins, lipids, vitamins, and minerals. Prebiotics, or low-digestible carbohydrates, are substrates that bacteria in the host's digestive system use to improve health. Additionally, it has been demonstrated that lentils contain hepatoprotective, antiviral, and anti-inflammatory properties, creating a new avenue for research into the potential uses of this legume. Legumes, like lentils, are also of considerable importance because of their capacity to fix atmospheric nitrogen through rhizobia-legume interactions through the creation of nodules. This makes it easier to intercrop lentils with other economically significant plants to increase their health and output. Herbicide removal is another way that lentils contribute to soil phytoremediation. Protecting the agrobiodiversity of landraces and Lens species is crucial in light of climate change, as germplasm is required to improve lentils' resistance to drought and high temperatures.

RERERENCE

1. Abraham, R. (2015). Lentil (Lens culinaris Medikus) Current status and prospects of production in Ethiopia. Adv Plant Agric Res, 2(0004).
2. Andac-Ozturk, S., Garipoğlu, G., Çatak, J., & Yaman, M. (2022). Investigation of the bioaccessibility of vitamins B1, B2, and B6 vitamers in canned, dried legumes after in vitro gastrointestinal digestion. Food Research International, 160, 111671.
3. Baber, K., Jones, C., McPhee, K., Miller, P. R., & Lamb, P. (2023). Nitrogen fixation among pea and lentil varieties in the Northern Great Plains. Agronomy Journal, 115(5), 2325-2338.
4. Badia-Olmos, C., Sánchez-García, J., Laguna, L., Zúñiga, E., Haros, C. M., Andrés, A. M., & Tarrega, A. (2024). Flours from fermented lentil and quinoa grains as ingredients with new techno-functional properties. *Food Research International*, *177*, 113915.

5. Benayad, A., & Aboussaleh, Y. (2021). Mineral composition of lentils: Physiological functions, antinutritional effects, and bioavailability enhancement. Journal of Food Quality, 2021(1), 5515654.
6. Box, B. B. Q., Classic, T. O., Twins, S., Sauces, B., Sauces, C., Hurry, C. I. A., ... & Blog, R. (2022). The Top 5 Health Benefits of Red Lentils. Red.
7. Bubelova, Z., Sumczynski, D., & Salek, R. N. (2018). Effect of cooking and germination on antioxidant activity, total polyphenols and flavonoids, fibre content, and digestibility of lentils (Lens culinaris L.). Journal of Food Processing and Preservation, 42(1), e13388.
8. Chelladurai, V., & Erkinbaev, C. (2020). Lentils. In Pulses: Processing and product development (pp. 129-143). Cham: Springer International Publishing.
9. Dewan, M. F., Shams, S. N. U., & Haque, M. A. (2024). A review of the health benefits of processed lentils (Lens culinaris L.). Legume Science, 6(2), e232.
10. Dhull, S. B., Kinabo, J., & Uebersax, M. A. (2023). Nutrient profile and effect of processing methods on the composition and functional properties of lentils (Lens culinaris Medik): A review. Legume Science, 5(1), e156.
11. ERDEN, P. S. Z. (2022). Red Lentil Growing, its status and problems in Siirt province. Agriculture: Current challenges and solution suggests.
12. Faris, M. E. A. I. E., Mohammad, M. G., & Soliman, S. (2020). Lentils (Lens culinaris L.): A candidate chemopreventive and antitumor functional food. Functional foods in cancer prevention and therapy, 99-120.
13. Ganesan, K., & Xu, B. (2017). Polyphenol-rich lentils and their health-promoting effects. International journal of molecular sciences, 18(11), 2390.
14. Grdeń, P., & Jakubczyk, A. (2023). Health benefits of legume seeds. Journal of the Science of Food and Agriculture, 103(11), 5213-5220.
15. Hossain, Z., Wang, X., Hamel, C., Knight, J. D., Morrison, M. J., & Gan, Y. (2016). Biological nitrogen fixation by pulse crops on semiarid Canadian prairies. Canadian journal of plant science, 97(1), 119-131.
16. Jarpa-Parra, M. (2018). Lentil protein: A review of functional properties and food application. An overview of lentil protein functionality. *International Journal of Food Science and Technology*, *53*(4), 892-903.
17. Kaale, L. D., Siddiq, M., & Hooper, S. (2023). Lentil (Lens culinaris Medik) as a nutrient-rich and versatile food legume: A review. Legume Science, 5(2), e169.
18. Kefelegn, N., Benor, S., Haile, G., Fikre, A., & Barbetti, M. J. (2025). Agro-morphological characterisation and comparative performance of Ethiopian and exotic lentil (Lens culinaris Medik) germplasm. Genetic Resources and Crop Evolution, 72(4), 4491-4506.
19. Keskin, S. O., & Sumnu, G. (2023). Functional Properties of Lentils and Their Ingredients in Natural or Processed Form. *Lentils: Production, Processing Technologies, Products, and Nutritional Profile*, 115-142.
20. Keskin, S. O., & Sumnu, G. (2024). Versatile Functions of Raw and Modified Lentils/Lentil Components in Food Applications: A Review. *Legume Science*, *6*(3), e70000.
21. Li, C., & Ganjyal, G. M. (2017). Chemical composition, pasting, and thermal properties of 22 different varieties of peas and lentils. Cereal Chemistry, 94(3), 392-399.
22. Lignicka, I., & Zīdere-Laizāne, A. M. (2022). Nutritious lentil and rice meal for a sustainable vegan and pescatarian diet.
23. Malik, D. P., Devi, M., & Reddy, A. A. (2022). Global status of lentil production with special reference to India. Indian J Agric Sci, 92(4), 474-479.
24. Mishra, G. P., Ankita, Aski, M. S., Tontang, M. T., Choudhary, P., Tripathi, K., ... & Dikshit, H. K. (2022). Morphological, molecular, and biochemical characterisation of a unique lentil (Lens culinaris medik.) genotype showing seed-coat colour anomalies due to altered anthocyanin pathway. Plants, 11(14), 1815.

25. Mukherjee, B., Kumar Naskar, M., Nath, R., Atta, K., Visha Kumari, V., Banerjee, P., ... & Hossain, A. (2023). Growth, nodulation, yield, nitrogen uptake, and economics of lentil as influenced by sowing time, tillage, and management practices. Frontiers in Sustainable Food Systems, 7, 1151111.
26. Murat, T. U. N. Ç., & RUFAİOĞLU, S. B. (2024). Fertilisation strategies and practices: a study on lentil. MAS Journal of Applied Sciences, 9(3), 537-551.
27. Mustafa, A. M., Abouelenein, D., Acquaticci, L., Alessandroni, L., Angeloni, S., Borsetta, G., ... & Vittori, S. (2022). Polyphenols, saponins and phytosterols in lentils and their health benefits: an overview. Pharmaceuticals, 15(10), 1225.
28. Padhi, E. M., & Ramdath, D. D. (2017). A review of the relationship between pulse consumption and the reduction of cardiovascular disease risk factors. Journal of Functional Foods, 38, 635-643.
29. Paucean, A., Moldovan, O. P., Mureșan, V., Socaci, S. A., Dulf, F. V., Alexa, E., ... & Muste, S. (2018). Folic acid, minerals, amino acids, fatty acids and volatile compounds of green and red lentils. Folic acid content optimisation in wheat-lentil composite flours. Chemistry Central Journal, 12(1), 88.
30. Plaza, J., Morales-Corts, M. R., Pérez-Sánchez, R., Revilla, I., & Vivar-Quintana, A. M. (2021). Morphometric and nutritional characterisation of the main Spanish lentil cultivars. Agriculture, 11(8), 741.
31. Rico, D., Peñas, E., del Carmen García, M., Rai, D. K., Martínez-Villaluenga, C., Frias, J., & Martín-Diana, A. B. (2021). Development of antioxidant and nutritious lentil (Lens culinaris) flour using controlled optimised germination as a bioprocess. Foods, 10(12), 2924.
32. Sah, U., Rani, R., Kumar, H., OJHA, J., SINGH, V., DUBEY, S., & DIXIT, G. (2024). Dynamics of lentil (Lens culinaris) production and trade: Global scenario and Indian interdependence. The Indian Journal of Agricultural Sciences, 94(3-1), 102-108.
33. Shahbazi, F., Valizade, S., & Dowlatshah, A. (2017). Mechanical damage to green and red lentil seeds. Food science & nutrition, 5(4), 943-947.
34. Shahbazi, F., Valizade, S., & Dowlatshah, A. (2017). Mechanical damage to green and red lentil seeds. Food science & nutrition, 5(4), 943-947.
35. Singh, J., Srivastava, R. P., Gupta, S., Basu, P. S., & Kumar, J. (2016). Genetic variability for vitamin B9 and total dietary fibre in lentil (Lens culinaris L.) cultivars. International Journal of Food Properties, 19(4), 936-943.
36. Stefaniak, T. R., & McPhee, K. E. (2015). Lentil. In Grain Legumes (pp. 111-140). New York, NY: Springer New York.
37. Tripathi, K., Gore, P. G., Pandey, A., Bhardwaj, R., Singh, N., Chawla, G., & Kumar, A. (2019). Seed morphology, quality traits and imbibition behaviour study of atypical lentil (Lens culinaris Medik.) from Rajasthan, India.
38. Varghese, N., Dogra, A., Sarker, A., & Hassan, A. A. (2019). The lentil economy in India. In Lentils (pp. 203-219). Academic Press.
39. Venugopalan, V. K., Nath, R., Sengupta, K., Pal, A. K., Banerjee, S., Banerjee, P., ... & Siddique, K. H. (2022). Foliar spray of micronutrients alleviates heat and moisture stress in lentil (Lens culinaris Medik) grown under rainfed field conditions. Frontiers in Plant Science, 13, 847743.
40. Zhang, B., Peng, H., Deng, Z., & Tsao, R. (2018). Phytochemicals of lentil (Lens culinaris) and their antioxidant and anti-inflammatory effects. Journal of Food Bioactives, 1, 93-103.
41. Zhang, H., De Silva, D., Dissanayaka, D., Warkentin, T. D., & Vandenberg, A. (2021). Validated B vitamin quantification from lentils by selected reaction monitoring mass spectrometry. Food Chemistry, 359, 129810.