WORLD JOURNAL OF PHARMACEUTICAL RESEARCH

SJIF Impact Factor 8.453

Volume 13, Issue 12, 1167-1176. Review Article ISSN 2277–7105

SESAME (SESAMUM INDICUM L.): A REVIEW OF NUTRITIONAL VALUE, PHYTOCHEMICALCOMPOSITION AND HEALTH BENEFITS

[1]*Dr. Nandakishor B. Thatwale, [2]Yeshwant R. Patil and [3]S. A. Alde

[1]Ph.D. Scholar Swasthavritta G.A.C. Nanded.

[2]H.O.D. and Professor Department of Swasthvritta G.A.C. Nanded.

[3]Assi. Professor Department of Samhita G.A.C. Nanded.

Article Received on 06 May 2024,

Revised on 26 May 2024,
Accepted on 16 June 2024

DOI: 10.20959/wjpr202412-32848

***Corresponding Author**
Dr. Nandakishor B. Thatwale
Ph.D. Scholar Swasthavritta G.A.C. Nanded.

Sesame is distributed in countries such as India, China, and Malaysia. Chinese people have used sesame seeds from more than 5000 years.[1] India, Sudan, Myanmar, China, and Tanzania are the major producers of sesame. In current years, the production of sesame seeds in African countries has increased, Tanzania has replaced India as the leading producer of sesame seeds. Sesame is widely grown and popular because of its highly aromatic odour and mellow flavour. In people's lives, sesame seeds are often used to make a variety of foods, such as sesame oil, sesame paste, or to decorate other foods. The scientific nutritional value status of sesame seeds was establishedon a legal level in 2002 when they were included in the list of medicinal and food ingredients published by the former Chinese Ministry of Health. Other reviews are either about a certain chemical composition in the sesame seeds[2], on some of the pharmacological effects of sesame[3], or the technical aspects of its production.[4] This review will focus on not only the phytochemicaland pharmacological properties of sesame but also the economic-phytological and nutritional value of sesame.

Botanical Description Sesame, a genus of Sesamum, is a member of the Pedaliaceae family. According to the difference in germplasm color, sesame can be classified as white sesame, black sesame, and yellow sesame, among which black and white sesame are the more common and widely grown dominant species, Black sesame has strong growth ability, lodging resistance, anddrought resistance, while white sesame has high oil content and good quality and has the largestplanting area and distribution. For other variegated varieties such as yellow sesame, its plants aremostly branched. In general, the oil content decreases gradually as the color of the germplasm deepens.[4]

Morphology Sesame is an erect annual herb that grows 60–150 cm tall. The stem is hollow or has a white pith. The sesame leaves are 3–10 cm long, 2.5–4 cm wide, and rectangular or ovate in shape with a slightly hairy surface. They are borne singly or 2–3 together in the leaf axils. Thecalyx lobes of sesame are 5–8 mm long and 1.6–3.5 mm wide, lanceolate in shape, and have a pilose appearance. The corolla of sesame is 2.5–3 cm long in a tube shape about 1–1.5 cm in diameter. It is white, often with a purplish-red or yellow halo. The four stamens are hidden insidethe flower, the ovary is superior, 4-loculed and pilose outside, and flowering occurs in late summer and early autumn. The sesame capsule is rectangular in shape, 2–3 cm in length, and 6– 12 mm in diameter, with longitudinal ribs on the surface and microscopic hairs on the epidermis. Sesame seeds are black or white, the black ones are called black sesame and the white ones are called white sesame.[5-7]

Nutritional Components Sesame seeds are rich in fat, protein, minerals, vitamins, and dietaryfiber. Sesame oil, which is obtained through traditional oil production methods, is rich in unsaturated fatty acids, fat-soluble vitamins, amino acids, etc. Studies have found that sesame seeds contain 21.9% protein and 61.7% fat, and are rich in minerals such as Fe and Ca.[8]

Protein

The protein in sesame is a complete protein, of which the ratio of essential amino acid content is very similar to that of the human body.[9] Sesame protein is rich in variety, mainly including globulin, clear protein, alcoholic protein, and glutenin, of which globulin has the highest contentand alcoholic protein.

Lipids

The lipids in sesame are mainly found in the seeds and are an important component of sesame. Sesame has the highest oil content among the major oil crops, up to 45~57%, which is why it hasbeen known as the “Queen of Oil” since ancient times.[10] Sesame oil is reported to contain 80%unsaturated fatty acids and a small amount of saturated fatty acids.[11]

Vitamins

Vitamins also occupy a certain proportion in the nutrient composition of sesame, of whichvitamin E is the richest in sesame.[12]

Carbohydrates

Sesame seed hull is the major by-product of sesame seed oil extraction. It is mainly composed of 70–80% carbohydrate polymers (including hemicelluloses, cellulose, and pectic polysaccharides).[13]

Mineral Elements Sesame seeds have been reported to be a source of several minerals, such as K (525.9 mg/100 g), P (516 mg/100 g), Mg (349.9 mg/100 g), Na (15.28 mg/100 g), Fe (11.39 mg/100 g), Zn (8.87 mg/100 g), and Mn (3.46 mg/100 g).[14]

Antinutrients are substances that disrupt or prevent the digestion and absorption of nutrients, negatively affecting the health and growth of animals.[15] The main antinutritional factors in sesame seeds are oxalic and phytic acids and small amounts of tannins.[16] Until now, the range values of oxalic acid in sesame meal have been rarely reported, and Farran et al., detected 13% and 1.12% of oxalic acid and phytic acid in sesame hulls, respectively.[16]

Phytochemistry In addition to being rich in nutrients, sesame also contains many important functional components such as sesamin, sesamolin, sesamol, sesaminol, sesamolin, phenol, and other lignan-like active ingredients.[17] The content of each component in sesame varies depending on the extraction method and external growing conditions, e.g., hot-pressed sesame oil has a higher content of sesamol, sesamin, and total lignans than cold-pressed and refined sesame oil.[18] The lignan content in sesame can be affected by factors such as strain, genotype, growing location (soil and weather), and growing conditions (irrigation, fertilization, and harvesttime).[19]

Lignans

Sesame lignans are the main active ingredients in sesame seeds and have strong antioxidant activity.[20] Epidemiological studies have shown that sesame lignans have beneficial effects in regulating blood lipids and improving liver function. These properties are also responsible for the oxidative stability of sesame oil.[21]

Vitamins

Vitamins also occupy a certain proportion in the nutrient composition of sesame, of which vitamin E is the richest in sesame.[22] In particular, vitamin E can be present in black sesame seedsat levels up to 50.4 mg/100 g. Studies have shown that γ-tocopherol is the major form of vitamin E in sesame seeds, while there is relatively less α-tocopherol. In vitro experiments have shown that γ-tocopherol has a stronger antioxidant capacity than α-tocopherol, but the overall vitamin E has a stronger functional activity.[23] Vitamin A, thiamine, riboflavin niacin, pantothenic acid, folic acid, ascorbic acid, α-tocopherol, β-tocopherol, γ-tocopherol, δ-tocopherol, and tocotrienol, all the twelve vitamins have been reported to be isolated from sesame seeds.

Carbohydrates

Sesame seed hull is the major by-product of sesame seed oil extraction. It is mainly composed of 70–80% carbohydrate polymers (including hemicelluloses, cellulose, and pectic polysaccharides).[24] Seven carbohydrates have been found in the seeds: D-glucose, D-galactose, D-fructose, raffinose, stachyose, planteose, and sesamose.

Mineral Elements Sesame seeds have been reported to be a source of several minerals, such as K (525.9 mg/100 g), P (516 mg/100 g), Mg (349.9 mg/100 g), Na (15.28 mg/100 g), Fe (11.39 mg/100 g), Zn (8.87 mg/100 g), and Mn (3.46 mg/100 g).[25]

Antinutrients are substances that disrupt or prevent the digestion and absorption of nutrients, negatively affecting the health and growth of animals.[26] The main antinutritional factors in sesame seeds are oxalic and phytic acids and small amounts of tannins[27] Until now, the range values of oxalic acid in sesame meal have been rarely reported, et al., detected 13% and 1.12% of oxalic acid and phytic acid in sesame hulls, respectively.[27] According to relevant analysis, oxalic acid in sesame hulls can cause more than half of the calcium in sesame to exist in the formof calcium oxalate, so that it is not well digested and used by livestock and poultry animals, thus preventing the digestion and absorption of nutrients. In most cases, cooking techniques significantly reduce soluble oxalate, and should therefore enhance mineral availability. Aside from cooking, pairing high-oxalate foods with calcium-rich foods may offset soluble oxalate absorption. A normal calcium diet (800–1000 mg/day) should be able to offset potential inhibitory effects from dietary oxalates. Phytate, also known as phytic acid or myo-inositol hexa phosphate, is another commonly considered “anti-nutrient” widely distributed in amongst the plant kingdom. Structurally, phytate is made up of six phosphate groups, attached to an inositol ring, with the ability to bind up to 12 protons total. These phosphate groups act as strong chelators, readily binding to mineral cations, particularly

Cu2+, Ca2+, Zn2+, and Fe3+.[28] Thesecomplexes are insoluble at neutral pH (6–7) and cannot be digested by human enzymes, affecting the digestion and absorption of minerals in the animal intestine. In addition, phytic acid can also bind to proteins in the intestine to form calcium–magnesium phytate protein complexes, which cannot be digested by protein hydrolases, thereby reducing the utilization of proteins and minerals.[29] Processing techniques such as soaking, fermentation, sprouting, germinating, and cooking can significantly alter the phytic acid content of sesame seeds, resulting in improved mineral utilization. In addition, the addition of a certain amount of phytase to the actual production of sesame flour in livestock diets can also improve the digestive utilization of calcium, phosphorus, zinc, and other mineral nutrients.[26]

Phytochemistry In addition to being rich in nutrients, sesame also contains many important functional components such as sesamin, sesamolin, sesamol, sesaminol, sesamolin phenol, and other lignan-like active ingredients.[28] The content of each component in sesame varies depending on the extraction method and external growing conditions, e.g., hot-pressed sesame oil has a higher content of sesamol, sesamin, and total lignans than cold-pressed and refined sesame oil.[29] The lignan content in sesame can be affected by factors such as strain, genotype, growing location (soil and weather), and growing conditions (irrigation, fertilization, and harvest.

Sesamin Sesamin is one of the most abundant lignans in the composition of sesame seeds and has good physiological activity. Studies have found that sesamin has good antioxidant properties,cholesterol lowering, lipid metabolism regulation, blood pressure stabilization, and anti-tumor effects. Sesamin is metabolized in the body mainly by the action of cytochrome. The metabolites of sesamin exist in body fluids and tissues mainly as glucosinolates and sulfate-conjugated forms, the excretion of sesamin is via bile, urine and feces, and the elimination of sesamin is mainly achieved by metabolism.

Sesamolin is the second most abundant lignan in sesame. Since sesamolin does not contain phenolic hydroxyl groups, its antioxidant effect in the body is much weaker than that of sesamol. However, under certain heating conditions, sesamolin can gradually convert to sesamol. Takingadvantage of this conversion feature, the addition of sesamolin enhances the antioxidant properties of oils and fats under heating condition Sesamol Sesamol is present in low levels in sesame lignin, but it is the main flavor component and quality stabilizer of sesame oil, with good antibacterial and antioxidant properties. Sesaminol Sesaminol is an important fat-soluble lignan. It is found at low level in sesame seeds but demonstrates good antioxidant properties and thermalstability. Under acidic conditions, sesamolin can be readily converted to sesaminol Sesame Product Development In recent years, with the improvement of people's living standards and health consciousness, the consumption of sesame and its products is on the rise.

In the international market, the demand for sesame seeds has surged, with major consumer countries such as Japan, Korea, Turkey, Egypt, the United States, and Israel. In China, sesame oil is irreplaceable in the catering and cooking industry, with about 45% of sesame production used for sesame oil processing, 22% for sesame paste processing, 22% for peeled sesame processing, 5% for baked goods, and 6% for other uses Food Uses Sesame is one of the most popular foods among our consumers and is extremely versatile. In food production, sesame is a raw material for the production of traditional Chinese foods. The traditional foods in the market, including sesame oil, sesame paste, sesame candies, sesame cakes and other baked goods, as wellas sesame filled dumplings, can be bought. These foods are very popular among consumers. It can be said that the Chinese people are the best at using sesame to produce a variety of deliciousfoods. The variety of sesame products is the widest in the world. Sesame Oil.

Sesame oil is an aromatic oil extracted from sesame seeds and is a traditional product from the primary processing of sesame seeds, which can be used as edible oil. Sesame oil is rich in linoleicand linolenic acids as well as high amounts of biologically active substances such as lignans, natural vitamin E, and phytosterols. The quality and nutritional content of the oil obtained from sesame seeds by cold pressing is high. The main unsaturated fatty acid in sesame oil is linoleic acid (46.9%), followed by oleic acid (37.4%). These fatty acids are essential fatty acids, becausethey cannot be synthesized in the organism and must be obtained through the diet. In addition, sesame oil is rich in vitamin E, which is dominated by gamma-tocopherol (90.5%).

Antioxidants In daily life, the addition of antioxidant components to cooking oils is essential to slow down their oxidation. Refined sesame oil has antioxidant properties that extend its shelf lifein the food industry. This is because high temperature roasting is a necessary step in the refining of sesame oil. The Maillard reaction of reducing sugars with free amino acids during high temperature roasting not only enriches the flavor of sesame oil, but also increases the antioxidant activity. The sesamin and sesaminol content of sesame oil is also changed during the roasting Antioxidants In daily life, the addition of antioxidant components to cooking oils is essential to slow down their oxidation. Refined sesame oil has antioxidant properties that extend its shelf life in the food industry. This is because high temperature roasting is a necessary step in the refining of sesame oil. The Maillard reaction of reducing sugars with free amino acids during high temperature roasting not only enriches the flavor of sesame oil, but also increases the antioxidant activity. The sesamin and sesaminol content of sesame oil is also changed during the roasting process. Anti-Inflammatory Effect Studies have shown that sesamin has anti-inflammatoryeffects. TNF-α is known to play an important role in the formation of rheumatoid arthritis. Khansai et al., found that sesamin significantly reduced the mRNA expression of IL-6 and IL- 1 in human primary synovial fibroblast cell lines, indicating that sesamin inhibited TNF-α- induced pro inflammatory cytokine m RNA expression. Sesamin catechol conjugates are thought to Be the major metabolite so sesamin present in human plasma following oral administration of sesamin. Catechol glucuronides exert anti-inflammatory effects through demyelination in macrophage-like J774.1 cells, thereby inhibiting the expression of interferon beta and inducible nitric oxide synthase. It was found that SC1, one of the sesamin metabolites of CYP450, hadstrongeranti-inflammatory activity than sesamin itself inmurine macrophages like J774.1 cells Hypoglycemic Effect Type 2 diabetes mellitus, a chronic metabolic disorder characterized by altered fat, protein, and carbohydrate metabolism, is considered to be a global public health problem with increasing prevalence worldwide. Experimental studies have shownthat white sesame oil can help reduce the harmful effects of diabetes. The researchers randomized male Sprague Dawley rats into a standard diet group, a normal control group, and a diabetic control group, as well as a diabetic sesame oil group, which was fed a diet containing 12% white sesame oil, and blood samples were analyzed at 0, 30, and 60 days. Differences between groups and between days were assessed using two-way repeated measures ANOVA. In the beginning, fasting blood-glucose and insulin were similar in the two diabetic groups, with a mean of 248.4±2.8 mg/dL and a mean of 23.4±0.4 µU/mL, respectively. After 60 days, fasting blood-glucose was significantly higher in the diabetic control rats (298.0±2.3 mg/dL) than in the diabetic sesame oil group (202.1±1.0 mg/dL) ($p<0.05$). The results showed that consumption **of white sesame oil significantly reduced hyperglycaemia and other biomarkers** of liver stress, as well as protecting heart and kidney health. In an 8-week open- label randomized dietary intervention study, Devarajan et al., found significantly lower fasting and postprandial glucose at weeks 4 and 8 in patients with type 2 diabetes treated with a sesame oil mixture, glibenclamide, or a combination of glibenclamide and sesame oil mixture ($p < 0.001$).

HbA1c, total cholesterol, triglycerides, LDL cholesterol, and non-HDL cholesterol were significantly lower ($p < 0.001$), whereas HDL cholesterol increased significantly at week 8 ($p<0.001$). This result also demonstrated that sesame oil can reduce the symptoms of hyperglycaemia in type 2 diabetic patients and improve lipid profile. Studies have shown that a diet rich in polyunsaturated fatty acids and vitamin E would be beneficial in reducing hypertension and cardiovascular morbidity. Sesame seeds are rich in polyunsaturated fatty acids,phytosterols, lignans, and vitamin E, which have a beneficial effect on blood pressure

Conclusions and Perspectives

Sesame, one of the oldest oil crops available, is a versatile plant that contains a high Nutritional value. In addition to making oil, sesame seeds are often sesame paste, sesame milk, sesame paste, and other foods. Currently, with the continuous research on sesame, more bioactive components are being explored and applied, effectively promoting the development of the sesame processing industry. People have shown great interest in exploring this high economic value and nutritious crop.

REFERENCES

1. Zech-Matterne, V.; Tengberg, M.; Van Andringa, W. Sesamumindicum L. (Sesame) in 2nd Century BC Pompeii, Southwest Italy, and a Review of Early Sesame Finds in Asia and Europe. Veg. Hist. Archaeobotany, 2015; 24: 673–681.
2. Andargie, M.; Vinas, M.; Rathgeb, A.; Möller, E.; Karlovsky, P. Lignans of Sesame(Sesamum indicumL.): A. Comprehensive Review. Molecules, 2021; 26: 883.
3. Myint, D.; Gilani, S.A.; Kawase, M.; Watanabe, K.N. Sustainable Sesame (Sesamum indicum L.) Production through Improved Technology: An Overview of Production, Challenges, and Opportunities in Myanmar. Sustainability, 2020; 12: 3515.
4. Myint, D.; Gilani, S.A.; Kawase, M.; Watanabe, K.N. Sustainable Sesame (Sesamum indicum L.) Production through Improved Technology: An Overview of Production, Challenges, and Opportunities in Myanmar. Sustainability, 2020; 12: 3515.
5. Dar, A.A.; Kancharla, P.K.; Chandra, K.; Sodhi, Y.S.; Arumugam, N. Assessment of Variability in Lignan and Fatty Acid Content in the Germplasm of Sesamum indicum L. J. Food Sci. Technol., 2019; 56: 976–986.
6. Dar, A.A.; Kancharla, P.K.; Chandra, K.; Sodhi, Y.S.; Arumugam, N. Assessment of Variability in Lignan and Fatty Acid Content in the Germplasm of Sesamum indicum L. J. Food Sci. Technol, 2019; 56: 976–986.

7. Akhila, H.; Suhara Beevy, S. Palynological Characterization of Species of Sesamum (Pedaliaceae) from Kerala: A Systematic Approach. Plant Syst. Evol., 2015; 301: 2179–2188.
8. Gloaguen, R.M.; Couch, A.; Rowland, D.L.; Bennett, J.; Hochmuth, G.; Langham, D.R.; Brym, Z.T. Root Life History of NonDehiscent Sesame (Sesamum indicum L.) Cultivars and the Relationship with Canopy Development. Field Crops Res., 2019; 241: 107560.
9. Rout, K.; Yadav, B.G.; Yadava, S.K.; Mukhopadhyay, A.; Gupta, V.; Pental, D.; Pradhan, A.K. QTL Landscape for Oil Content in Brassica Juncea: Analysis in MultipleBi-Parental Populations in High and "0" Erucic Background. Front. Plant Sci., 2018; 9: 1448.
10. Hu, Y.-M.; Ye, W.-C.; Yin, Z.-Q.; Zhao, S.-X.Chemicalconstituents from flos Sesamumindicum L. YaoXueXue Bao., 2007; 42: 286–291.
11. Ozdemir, I.S.; Karaoglu, O.; Dag, C.; Bekiroglu, S. Assessment of Sesame Oil Fatty Acid and Sterol Composition with FT-NIR Spectroscopy and Chemometrics. Turk. J. Agric. For., 2018; 42: 444–452.
12. Mili, A.; Das, S.; Nandakumar, K.; Lobo, R. A Comprehensive Review on Sesamumindicum L.: Botanical, Ethnopharmacological, Phytochemical, and Pharmacological Aspects. J. Ethnopharmacol, 2021; 281: 114503.
13. Liu, H.-M.; He, M.-K.; Yao, Y.-G.; Qin, Z.; Cai, X.-S.; Wang, X.-D. Pectic Polysaccharides Extracted from Sesame Seed Hull: Physicochemical and Functional Properties. Int. J. Biol. Macromol, 2021; 192: 1075–1083.
14. Elleuch, M.; Besbes, S.; Roiseux, O.; Blecker, C.; Attia, H. Quality Characteristics of Sesame Seeds and By-Products. Food Chem., 2007; 103: 641–650.
15. Petroski, W.; Minich, D.M. Is There Such a Thing as "Anti-Nutrients"? A Narrative Review of Perceived Problematic Plant Compounds. Nutrients, 2020; 12: 2929.
16. Farran, M.T.; Uwayjan, M.G.; Miski, A.M.A.; Akhdar, N.M.; Ashkarian, V.M. Performance of Broilers and Layers Fed Graded Levels of Sesame Hull. J. Appl. Poult. Res., 2000; 9: 453–459.
17. Pathak, N.; Rai, A.K.; Kumari, R.; Bhat, K.V. Value Addition in Sesame: A Perspectiveon Bioactive Components for Enhancing Utility and Profitability. Pharmacogn. Rev., 2014; 8: 147–155.
18. Khuimphukhieo, I.; Khaengkhan, P. Combining Ability and Heterosis of Sesamin and Sesamolin Content in Sesame. SABRAO J. Breed. Genet., 2018; 50: 180–191.
19. Xu, F.; Zhou, R.; Dossou, S.S.K.; Song, S.; Wang, L. Fine Mapping of a Major Pleiotropic QTL Associated with Sesamin and Sesamolin Variation in Sesame (Sesamum

indicum L.). Plants., 2021; 10: 1343.

20. Dar, A.A.; Verma, N.K.; Arumugam, N. An Updated Method for Isolation, Purificationand Characterization of Clinically Important Antioxidant Lignans—Sesamin and Sesamolin, from Sesame Oil. Ind. Crops Prod., 2015; 64: 201–208.
21. Ma, F.; Fang, W. Research progress of active ingredients and product development of sesame. Anhui Agron. Bull., 2019; 25: 46–48+61.
22. Hegde, D.M. Sesame. In Handbook of Herbs and Spices, 2nd ed.; Elsevier: Amsterdam, The Netherlands, 2012; 2: 449–486
23. Mili, A.; Das, S.; Nandakumar, K.; Lobo, R. A Comprehensive Review on Sesamumindicum L.: Botanical, Ethnopharmacological, Phytochemical, and Pharmacological Aspects. J. Ethnopharmacol, 2021; 281: 114503.
24. Liu, H.-M.; He, M.-K.; Yao, Y.-G.; Qin, Z.; Cai, X.-S.; Wang, X.-D. Pectic Polysaccharides Extracted from Sesame Seed Hull: Physicochemical and Functional Properties. Int. J. Biol. Macromol, 2021; 192: 1075–1083.
25. Elleuch, M.; Besbes, S.; Roiseux, O.; Blecker, C.; Attia, H. Quality Characteristics of Sesame Seeds and By-Products. Food Chem., 2007; 103: 641–650
26. Petroski, W.; Minich, D.M. Is There Such a Thing as "Anti-Nutrients"? A Narrative Review of Perceived Problematic Plant Compounds. Nutrients, 2020; 12: 2929.
27. Farran, M.T.; Uwayjan, M.G.; Miski, A.M.A.; Akhdar, N.M.; Ashkarian, V.M. Performance of Broilers and Layers Fed Graded Levels of Sesame Hull. J. Appl. Poult. Res., 2000; 9: 453–459.
28. Humer, E.; Schwarz, C.; Schedle, K. Phytate in Pig and Poultry Nutrition. J. Anim. Physiol. Anim. Nutr., 2015; 99: 605–625.
29. Farran, M.T.; Uwayjan, M.G.; Miski, A.M.A.; Akhdar, N.M.; Ashkarian, V.M. Performance of Broilers and Layers Fed Graded Levels of Sesame Hull. J. Appl. Poult. Res., 2000; 9: 453–459.
30. Pathak, N.; Rai, A.K.; Kumari, R.; Bhat, K.V. Value Addition in Sesame: A Perspective on Bioactive Components for Enhancing Utility and Profitability. Pharmacogn. Rev., 2014; 8: 147–155.