

## Case Report

# A comprehensive review on Tukhme Kunjud (*Sesamum indicum* Linn.) with special reference to Unani System of Medicine.

Rizwana Khatoon<sup>1</sup>, Hana Abbasi<sup>1</sup>, Mohammad Aslam<sup>2</sup>, Shahid Shah Chaudhary<sup>3</sup>

*M.D. Scholar<sup>1</sup>, Professor and Head, D/O Ilmul Advia<sup>2</sup>, Assistant Professor D/O Ilmul Saidla<sup>3</sup> School of Unani Medical Education & Research (SUMER) Jamia Hamdard, New Delhi, India.*

## ABSTRACT

Sesame (*Sesamum indicum* L.) is a rich source of edible oil most commonly it is used as a food product mainly in bakeries and also use as a common source of oil in daily kitchen needs. Due to the presence of some special phytochemicals like proteins, fibers, oil, minerals and antioxidants it is highly used for medicinal and therapeutic purposes. It is a good source of energy and act as an antiaging agent. Its seeds are used as Anti-helminthic, antihypertensive, antimicrobial, cytotoxic and Hepatoprotective but its seed coat which is a byproduct of sesame and a cherished source of fibers is normally use for animal feedstuff. In Unani system of medicine it is used both as drug & diet (dawa wa ghida). In classical Unani literature it is indicated in various disorders like Asthma, Dry Cough, Gastritis (due to any drug, excessive use of alcohol), Dryness of Intestine, Dryness in throat, Renal Stone, Bleeding Piles, Amenorrhea, Retention of urine, Dysuria, Orchitis, Sexual Debility, Anorexia. The present review article, an attempt have been made to compile all the pharmacological and Pharmacognostical characters of *Sesamum indicum* with special reference to Unani literature.

**Keywords** Tukhme Kunjud, *Sesamum indicum*, Phytochemistry

## INTRODUCTION

*Sesamum indicum* is an annual oldest oilseed crop belongs to the family Pedaliaceae (Nagendra Prasad MN, 2012), (Bilmez Ozcinar A, 2017) which is erect and herbaceous. The arrangement of leaves are opposite which are broad and lanceolate. It has large, cylindrical and bell-shaped (two lipped) flowers, which are about 4-5 cm long having pink or white corolla. The fruit is called capsule which is oblong in shape having a small seeds (Sandeep D, 2013). From thousand year ago through Hardpan and Anatolian eras, India was the home place for the growth and development of the *Sesamum indicum* (BEDIGIAN, et al., 1985), (BEDIGIAN, 2003). However at this time *Sesamum indicum* is cultivated throughout the world, but at this time Asia is annoying for cultivation of *Sesamum indicum*. It is a high potential crop, cultivated for finding palatable seeds, oil and saporous (Pathak N, 2014). Sesame herb is an erect & growing annually, it has simple or splitting stems its seed are teardrop-shaped, minor, & uniform having very high amount of fixed oil called as seed oil. Both seeds and oil contain a valuable price in the field of medical and pharmaceutical science that's why both are used in many health cure inventions. A lots of researches has been done for proving the medicinal value of Sesame seeds (Tukhm e Kunjud), it has anti hyper lipidemic & hypocholesterolemic activity (Kita S, 1995), (Hemalatha S, 2004), antihypertensive activity (MATSUMURA Y, 1995), (Matsumura Y, 1998), (Nagendra Prasad MN, 2012),

(W, 1996), Neural differentiation activity (W, 1996), (Miyahara, 2001), Anticancer Effect (Miyahara, 2001), Hypoglycemic Action. The main constituent of the *Sesamum indicum* seed are oil (50-60%), protein (25%), 13.5% carbohydrate and 5% ash due to this oil contains high degree of antioxidant and rancidity property (Ali GM, 2007), (Elleuch M). Protein present in *Sesamum indicum* (Tukhm e Kunjud) contains lignan like sesamol, sesamin which are responsible for anti-oxidation (FUKUDA, et al., 1996). It is a very good source of iron, magnesium, manganese, copper & calcium and also contains vitamin B1 (thiamine), vitamin E (tocopherol) and vitamin K. High amounts of unsaturated fatty acids such as oleic and linoleic acids are present in sesame seeds which saturated fatty acids such as palmitic and stearic acids are also found in low amounts which makes it beneficial for human healthy (Chakraborty GS, 2008), (Chattopadhyaya B, 2010), (Al-Shafey AF, 2011). The sesame crop takes at least three to four month for growth after sowing the seeds while flowers starts to come at thirty to forty days. Harvesting of sesame seeds cannot be done by mechanically because budding continues till ripeness & suddenly scattering the seeds from the capsule, it demonstrated like a magic words "open sesame" (Fukuda, 1986).

## BOTANICAL DESCRIPTION

### Geographical distribution

Sesame (Tukhme Kunjud) belongs to family Pedaliaceae and have its place in the genus *Sesamum*, out of sixteen genera of this family the genus *Sesamum* has 36 species, most of species

\*Correspondence: Rizwana Khatoon

E-mail: dr.rizwanakhatoon1992m@gmail.com

Received Jul 04, 2019; Accepted Aug 01, 2019; Published Aug 31, 2019

doi: <http://dx.doi.org/10.5667/tang.2019.0010>

©2019 by Association of Humanitas Medicine

This is an open access article under the CC BY-NC license.

(<http://creativecommons.org/licenses/by-nc/3.0/>)

are wild. On the basis of the color of seed there are 3 varieties of sesam seeds are found which are called as white, black, red (Khan, YNM) Mostly, it is cultivated in the African savanna, India, the East Indies, and Australia (Namiki, `1989), (Weiss, 1983) (Josh, 1961). Originally Sesame seeds (Tukhme Kunjud) thriven in tropic African savanna plains, but nowadays, worldwide cultivation has been started, it is also cultivated such a tropical and subtropical regions (between the north and south parallels of about 45°). *Sesamum indicum* L (Tukhme Kunjud), is the main source of sesam used as at commercial level which is primarily grown in India, China, Mexico, and Sudan.

Kingdom	Plantae
Subkingdom	Viridiplantae
Infrakingdom	Streptophyta
Superdivision	Embryophyta
Division	Tracheophyta
Subdivision	Spermatophyta
Class	Magnoliopsid
Superorder	Asteranae
Order	Lamiales
English	Gingeli oil plants
Family	Gingeliasae
Gujrat	Tal
Arabic	Sesamum
Hindi	Kash and Ben-Til, Tal
Kannada	Bhanguru, Tili
Persian	<i>Sesamum indicum</i>
Punjab	Til, Tili
Sanskrit	Tau, Snehphala
Sindh	Thirr
Telugu	Nuvvulu, guvvulu
Tamil	Ellu, com-ure-ellu

2005);

### Cultivation and collection

Sesame seed (Tukhme Kunjud) is an annual herb which attends its height of about 100-120 cm. It has branched or simple stems and having an opposite or alternate type of leaves at every node (Bentley, 1991). It has large, cylindrical and bell-shaped (two lipped) flowers, which are about 4-5 cm long having pink or white corolla (Fig.2a). A frost-free germinating period is required the cultivation of Sesame seed (Tukhme Kunjud). Sesam Plant grown from seed sown broadcast. Soil should be sandy loam for the growth and development of the sesam plant. Around 25°C temperature is promising for growth and fruiting sesam plant (M.I., 1995). Germination of seeds also affected by soil temperatures below than 20°C (Oplinger, 1990). It can also grow in those parts where adequate rainfall has occurred because it is fully drought resistant as well as having a well-built tap root which can reach subversive water sources (MI, 2006). About 30-40days of seed sowing, flowering starts while blooming continues till maturity (Fig. 2). The seed pods (capsules) which are developed from the 1-3 beautiful flowers, borne in each axis (Fig.2) (Anonymous, YNM). It get fully ripped in about five months' time period sesam seeds (Tukhme Kunjud) have been fully ripe. The vertical capsules fragmented and open at the top. The seeds are ejected forcefully after splitting the sutures. About 70- 100 seeds are present in each capsule. Nearby 70-140 days are required for complete maturation of the plant. After maturation of the seeds, plants have been cuts down. Stocks of the plants have been made for drying and seeds have dazed from the capsule (M.I., 1995), (T.E.Wallis, YNM).

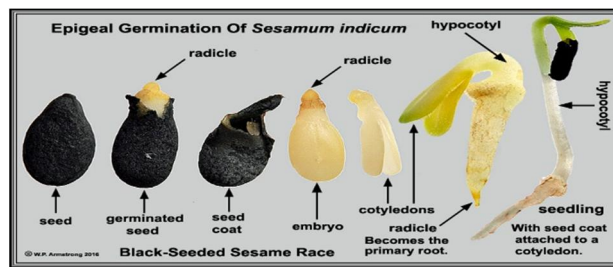


Fig. 1 Germination of seed

### Morphological character of the seed

Sesame seeds (Tukhme Kunjud) is very small in size about 3-4 mm long, 2 mm broad & 1 mm thick and also a very low in weight approximately 2-3.5 g/1000 seeds. Seeds are compressed ovoid in shape. They also vary in their color, size, and surface of the seed coat. The color of the seeds varies in shades like brown, gold, gray, violet, and black other than white (Fig.2b). The texture of the seed coat some time may be rough or smooth. (M.I., 1995), (T.E.Wallis, YNM) Seeds are finely punctate having four elusive longitudinal ridges at the edges of the flat faces; the hilum is at the pointed end, from which the raphe extends as a line along the Centre of one flat face to the broader end (Fig.3).

### Microscopic features of the seed

Epidermis of the sesame seeds made up of thin-walled palisade, the anticlinal walls with more or less curvy. The cells of epidermis are 18- 30µ wide and 50-95µ long. Each cell has a spherical mass of calcium oxalate crystals with 12- 40µ diameter in its apex. The spherical mass is not present in those cells which have four ridges in their constituent. The collapsed cells with a yellowish membrane (inner side) are present on the remaining parts of the testa. The cellulosic polygonal parenchymatous cells having fixed oil and small aleurone grains (about 2-10µ) are also present in the tissue of endosperm and cotyledons. Starch is not present in the cells (T.E.Wallis, YNM).

### UNANI DESCRIPTION

#### Temperament (Mizaj)

According to Shaikh it is hot and wet in first degree. (Khan, YNM). Some scholar said it: hot and dry in second or third degree (Khan, YNM).

**Important function (Nafa-e-khas):** Musammine badan (Adipogenous), Muqawwie Baah (Aphrodisiac) (Khan, YNM), (Kabiruddin, YNM)

**Toxic (Muzir):** it is very slow in digestion (Kabiruddin, YNM)

**Correctives (Musleh):** Kunjud Biryani (Roasted seeds), Shahad (Honey), qand safaid (Sugur) (Kabiruddin, YNM)

**Badal (Alternative):** Alsi or Tukhme Katan (Linseed) (Kabiruddin, YNM)

**Dose (Miqdar-e-Khurak):** 7-10 gm (Khan, YNM), (Kabiruddin, YNM)



Fig. 2a. Plant of sesame with flower



Fig. 2b. Morphology of the seed

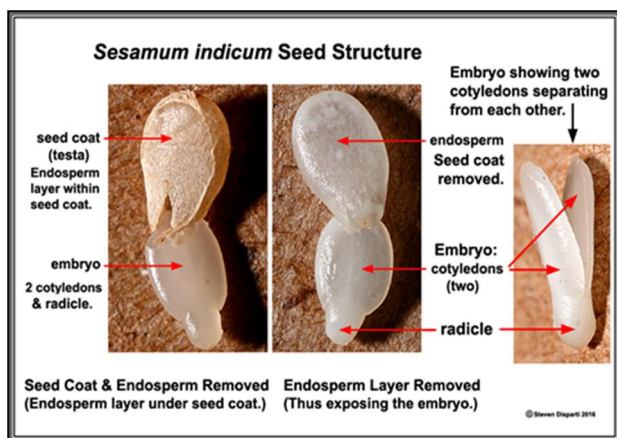


Fig. 3 Seed Structure

**Pharmacological activities (Af'aa):** (Kabiruddin, YNM), (Lakhanawi, 2011), (Khan, YNM)

1. Adipogenous (Musammine badan)
2. Aphrodisiac (Muqawwie Baah)
3. Agglutinant (Mugharri)
4. Anti-Inflammatory (Muhallile awram)
5. Styptic (Habise Dam)
6. Deobstruent (Mufatteh)
7. Diuretic & Mennorrhagic (Mudire Baul wa Haiz)
8. Cicatrizant (Mudammile qurooh)
9. Anti-Achne (Da'fe Basoore lbana)
10. Anti-Pyretic (Da'fe Humma)

11. Analgesic (Muskine Alam)
12. Appetizer (Mushtahi)
13. Lithotripter (Mufattite Hisate Kulliya)
14. Abortified (Qatile Musqite Janeen)

**Therapeutic Uses (Mawaqe Istemal):** (Kabiruddin, YNM), (Lakhanawi, 2011), (Khan, YNM)

1. Asthama (Zeequn Nafas)
2. Dry Cough (Suale Yabis)
3. Gastritis (Sojishe Maida) due to any drug, excessive use of alcohol
4. Asthama (Zeequn Nafas)
5. Dry Cough (Suale Yabis)
6. Gastritis (Sojishe Maida) due to any drug, excessive use of alcohol
7. Dryness of Intestine (Khashoonate Maivi)
8. Dryness in throat (Khashoonate Halaq)
9. Renal Stone (Hisate Kulliya)
10. Bleeding Piles (Bawasire Damvi)
11. Amenorrhoea (Etebase Haiz)
12. Retantion of urine (Etebase Baul)
13. Dysuria (Usare Baul)
14. Termination of pregnancy (Isqate Hamal)
15. Dryness of Skin (Khashoonate Jild)
16. Orchitis (Warama Unsayain)
17. Colitis (Warme qoolanj)
18. Pain in lower abdomen (Darde Shikam)
19. Sexual Debility (Zaufe Baah)
20. Anorexia (Zaufe Ishtiha)
21. Achne (Busoore laban)

**Chemical Constituent:** Fixed oil (50%), protein (approximately 20%), and carbohydrate (18-20%) are the Chief constituents of sesame.

#### Fixed oil

Approximately 50% fixed oil is present in the seasam seed which is full with high energy. The oil droplets are present in the cells of the cotyledon and endosperm. The following components are present in the composition of fatty acid of seasam oil are (Namiki, '1989);

- ▶ Oleic
- ▶ Linoleic acids
- ▶ Palmitic (small amounts)
- ▶ Stearic acids (small amounts)
- ▶ Linolenic acid (in trace)

**Fatty Acid Composition of sesame seed oil in g/100 g of seed (M.I., 1995);**

- a) Saturated 15.2
- b) Unsaturated (mono) 39.99
- c) Unsaturated (poly) 40.46

#### Protein

Approximately 20% protein is present in the seasam seed, lignan like sesamol, sesamin is the main constituent of protein. Amino acids are also found in the protein described as follows ((D. ash A. Dak C. N. Fail, 1993), such as; Isoleucine, Leucine, Lysine, Methionine, Cystine, Met + Cys, Phenylalanine, Tyrosine, Phe + Tyr, Threonine, Tryptophan, Valine, Histidine, Arginine, Alanine, Aspartic acid, Glutamic acid, Glycine, Proline, Serine etc

Pharmacological Activity	References (New Researches)	References (Unani System of Medicine)
Anti-Alzheimer's activity	(W, 1996)	
Antioxidant activity	(Dzoyem JP, 2014), (Visavadiya NP, 2010), (Wang, 2007) (Park SH, 2010) (Elleuch M, 2007), (Fukuda Y, 1985)	(Khan, YNM)
Acetylcholinesterase inhibitory activity	(Sharififar, 2012)	
Anti-hyperlipidemic activity	(Asgary, 2013), (Visavadiya NP, 2008)	
Anti-hypertensive activity	(Costa FT, 2007) (Chavali SR, 1998), (htt2)	
Anti-helmintic activity	(Kamal AT, 2015), (R. Sireesha, 2013)	
Anti-inflammation and wound healing	(Kiran K, 2008), (Sharif MR, 2013), (Wang, 2007)	(Kabiruddin, YNM), (Khan, YNM)
Antimicrobial activity	(Sharma S, 2014)	
Anti-peptic ulcer activity and Gastro-protective effect	(Kuo PC, 2011), (Ravi K. Sori1, 2018 ), (Okwuosa CN, 2011)	(Khan, YNM)
Anti-obesity,	(JB., 2002), (Hu, 2007), (George P, 2012)	(Khan, YNM)
Cytotoxicity/Toxicity	(Sharififar, 2012), (Abushama MF, 2014), (Amara AA, 2008), (Wang, 2007)	
Cholesterol Regulation	(Kita S, 1995), (S., 2004), (Yamada Y, 2008)	
Hepatoprotective activity	(Kumar M, 2011), (Sharif MR, 2013), (Nahar, 2009), (Wang, 2007)	

**Table 1.** Reported Pharmacological Activity

### Carbohydrate

Carbohydrate is present about 18-20% in composition of the sesam seed. The glucose and fructose are present in low amounts, an oligo sugar planteose [0-a-D-galactopyranosyl-(1, 6)-/3-D-fructofuranosyl-a-D-glucopyranoside] has also been reported in small amount (D. B. Wankhede and R. N. Tharanathan, 1976).

### Vitamin

A significant amounts of the vitamin B complex are also present in the sesam seed. Thiamin (Vitamin. B1) is 0.95 mg %, Riboflavin (vitamin B2) 0.25 mg %), and niacin 5.1 mg % present in per100g of sesam seeds. The complete loss of vitamin B.

Complex is shown in hulled seeds (Slover HT, 1983). Sesam seeds also have a high amount of tocopherol (vitamin E), the tocopherol present in sesame is  $\gamma$ -tocopherol in more amount, while  $\alpha$ -tocopherol content is found in very small amount (Fukuda, 1986), (Kamal-Eldin A, 1994), (Speck AJ, 1985).

### Minerals

The sesam seeds are the rich sources of minerals such as Ca (1200 mg) P (540 mg) Fe (9.6 mg) Na 2mg) K (400 mg) in per 100g of seed. Magnesium, zinc, and selenium are also present in very low amount while iron and calcium are present in high amount in sesam seeds (Brito OJ, 1982).

### CONCLUSION

*Sesamum indicum* (Tukhme Kunjud) has a valuable properties, used as medicine as well as diet. It is very good source of natural antioxidant due to presence of lignan like sesamol and sesamin which are the main constituents of protein present in Tukhme Kunjud. The prominent Unani physician were very well aware of medicinal properties of seed and their uses in various disorders. Various pharmacological studies performed as mentioned above, proves the fact of its use by prominent Unani physician and further researches in this area are necessary to validate its therapeutic uses mentioned in classical Unani literature.

### ACKNOWLEDGEMENTS

The authors have no conflicting financial interests.

### CONFLICT OF INTEREST

No conflict of interest is involved in writing of this article

### REFERENCES

- Abushama MF, Hilmi YI, AbdAlgadir HM, Fadul E, Khalid HE. Lethality and antioxidant activity of some Sudanese medicinal plants' fixed oils. *European Journal of Medicinal Plants*. 2014; 4(5):563-70.
- Al-Shafeay AF, Ibrahim AS, Nesiem MR, Tawfik MS. Establishment of regeneration and transformation system in Egyptian sesame (*Sesamum indicum* L.) cv Sohag 1. *GM crops*. 2011; 2(3):182-92.
- Ali ML, Rajewski JF, Baenziger PS, Gill KS, Eskridge KM, Dweikat I. Assessment of genetic diversity and relationship among a collection of US sweet sorghum germplasm by SSR markers. *Molecular Breeding*. 2008; 21(4):497-509.
- Amara AA, El-Masry MH, Bogdady HH. Plant crude extracts could be the solution: extracts showing in vivo antitumorigenic activity. *Pakistan journal of pharmaceutical sciences*. 2008;21(2):159-71.
- Asgary S, Rafieian-Kopaei M, Najafi S, Heidarian E, Sahebkar A. Antihyperlipidemic effects of *Sesamum indicum* L. in rabbits fed a high-fat diet. *Scientific World Journal*. 2013.
- Baitar, Ibn e. *Aljamai ul Mufradat Al Aghdhiya wal Advia*. (New Delhi, India: CCRUM), pp. 113-14, YNM.
- Bedigian D, Seigler DS, Harlan JR. Sesamin, sesamol and the origin of sesame. *Biochemical Systematics and Ecology*. 1985;13(2):133-9.
- Bedigian D. Evolution of sesame revisited: domestication, diversity and prospects. *Genetic resources and crop evolution*. 2003;50(7):779-87.
- Brito OJ, Nunez N. Evaluation of sesame flour as a complementary protein source for combinations with soy and corn flours. *Journal of Food Science*. 1982;47(2): 457-60.
- Cagirgan MI. Selection and morphological characterization of induced determinate mutants in sesame. *Field crops research*. 2006;96(1):19-24.
- Chakraborty GS, Sharma G, Kaushik KN. *Sesamum indicum*: A review. *J herb med toxicol*. 2008; 2(2):15-9.
- Chattopadhyaya B, Banerjee J, Basu A, Sen SK, Maiti MK. Shoot induction and regeneration using internodal transverse thin cell layer culture in *Sesamum indicum* L. *Plant Biotechnology Reports*. 2010; 4(2):173-8.
- Chavali SR, Zhong WW, Forse RA. Dietary  $\alpha$ -linolenic acid increases TNF- $\alpha$ , and decreases IL-6, IL-10 in response to LPS: effects of sesamin on the  $\Delta$ -5 desaturation of  $\omega$ 6 and  $\omega$ 3 fatty acids in mice. *Prostaglandins, leukotrienes and essential fatty acids*. 1998;58(3):185-91.
- Collinge W. *The American Holistic Health Association Complete Guide to Alternative Medicine*. (New York, USA: Grand Central Publishing), 1996.
- Costa FT, Neto SM, Bloch C, Franco OL. Susceptibility of human pathogenic bacteria to antimicrobial peptides from sesame kernels. *Current microbiology*. 2007;55(2):162-6.
- Elleuch M, Besbes S, Roiseux O, Blecker C, Attia H. Quality characteristics of sesame seeds and by-products. *Food chemistry*. 2007;103(2):641-50.
- Fukuda Y, Nagata M., Osawa T., Namiki, M. Contribution of lignan analogues to antioxidative activity of refined unroasted sesame seed oil. *Journal of the American Oil Chemists' Society*. 1996;63(8): 1027-1031.
- George P, Paduchuri P. A Review on Antiobesity Properties of Some Medicinal Plants. *Pharma Science Monitor*. 2012;3(4).
- Ghani MN. *Khazainul Advia Vol.2<sup>nd</sup>*, (Lahore, Pakistan: Diamond Publisher Lahore), pp. 180-183, YNM
- Hakeem M. *Bustan ul Mufradat*. (New Delhi, India: Aijjaz Publishing house), pp. 209, YNM.
- Hakim LM. *Bustanul Mufredat*, (New Delhi, India: Aijjaz Publishing House New Delhi), pp.125, 2011.
- Hemalatha S. Lignans and tocopherols in Indian sesame cultivars. *Journal of the American Oil Chemists' Society*. 2004;81(5):467.
- Hu YM, Wang H, Ye WC, Zhao SX. Flavones from flowers of *Sesamum indicum*. *Zhongguo Zhong yao za zhi*. 2007;32(7):603-5.
- Integrated Taxonomic Information System (ITIS). Govt. of Canada. Available at: <http://www.itis.gov> (accessed on 24<sup>th</sup> April 2019).
- Josh A. B. *Sesame*. 1st ed. (London, UK: Collier-Macmillan), pp.109, 1961.
- Kabiruddin HM. *Mukhzan ul Mufradat*, (New Delhi, India: Aijjaz Publishing House New Delhi), pp.347-48, YNM.
- Kabiruddin HM. *Mukhzanul Mufredat Al ma'roof Khuasul Advia*, (Lahore, Pakistan: Shikh Mohammad Bashir Industries), pp.198, YNM.
- Kamal-Eldin A, Appelqvist LA. Variations in the composition of sterols, tocopherols and lignans in seed oils from four *Sesamum* species. *Journal of the American Oil Chemists' Society*. 1994;71(2): 149.
- Khan A. Muhit e Azam. Vol.3<sup>rd</sup>, (New Delhi, India: CCRUM) pp. 283-85, 2014.

- Kita S, Matsumura Y, Morimoto S, Akimoto K, Furuya M. Antihypertensive effect of sesamin. II. Protection against two-kidney, one-clip renal hypertension and cardiovascular hypertrophy. *Biol Pharm Bull*, 1995;8(1):1283-1285.
- Kumar M, Anjoo K, Sidhraj S. Hepatoprotective activity of *Sesamum indicum* Linn. against Ccl4-induced hepatic damage in rats. *International Journal of Pharmaceutical and Biological Archives*.2011;2:710-15.
- Kuo PC, Lin MC, Chen GF, Yiu TJ, Tzen JT. Identification of methanol-soluble compounds in sesame and evaluation of antioxidant potential of its lignans. *J Agric Food Chem*. 2011;59(7): 3214-9.
- Matsumura Y, Kita S, Morimoto S, Akimoto K, Furuya M, Oka N, Tanaka T. Antihypertensive effect of sesamin. I. Protection against deoxycorticosterone acetate-salt-induced hypertension and cardiovascular hypertrophy. *Biological and Pharmaceutical Bulletin*. 1995;18(7): 1016-19.
- Matsumura Y, Kita S, Tanida Y, Taguchi Y, Morimoto S. Antihypertensive effect of sesamin. III. Protection against development and maintenance of hypertension in stroke-prone spontaneously hypertensive rats. *Biol Pharm Bull*. 1998;21(5): 469-473.
- Medical Economics Company. PDR of Herbal medicine. (New Jersey, USA: Medical Economics company), pp.688-689, 1998-2007.
- Miyahara Y, Hibasami H, Katsuzaki H, Imai K, Osawa T, Ina K, Komiya T. Sesaminol from sesame seed induces apoptosis in human lymphoid leukemia Molt 4B cells. *International journal of molecular medicine*. 2001;7(5):485-8.
- Morris JB. Food, industrial, nutraceutical, and pharmaceutical uses of sesame genetic resources. *Trends in new crops and new uses*. 2002:153-6.
- Nagendra PMN, Sanjay KR, Prasad DS, Vijay N, Kothari R, Nanjunda Swamy S. A review on nutritional and nutraceutical properties of sesame. *J Nutr Food Sci*. 2012; 2(127):2.
- Namiki M. *Goma no Kagaku (Sesame Science)*. (Fukuoka, Japan: Asakura Shoten Co), pp. 246, 1989.
- Namiki M. The chemistry and physiological functions of sesame. *Food reviews international*. 1995;11(2):281-329.
- Okwuosa CN, Okoi-Ewa R, Achukwu PU, Onuba AC, Azubuike NC. Gastro-protective effect of crude hexane leaf extract of *Sesamum indicum* in Rabbits. *Nigerian Journal of Physiological Sciences*. 2011;26(1).
- Oplinger ES, Putnam DH, Kaminski AR, Hanson CV, Oelke EA, Schulte EE, Doll JD. *Sesame, alternative field crops manual*, 1990.
- Ozcinar AB. Analysis of sesame (*Sesamum indicum* L.) accessions collected from different parts of Turkey based on qualitative and quantitative traits. *Ekin Journal of Crop Breeding and Genetics*. 2017;3(1):45-51.
- Park SH, Ryu SN, Bu Y, Kim H, Simon JE, Kim KS. Antioxidant components as potential neuroprotective agents in sesame (*Sesamum indicum* L.). *Food reviews international*. 2010; 26(2):103-21.
- Pathak N, Rai AK, Kumari R, Thapa A, Bhat KV. Sesame crop: an underexploited oilseed holds tremendous potential for enhanced food value. *Agricultural Sciences*. 2014;5(6):519.
- Ravi KS, Balaji O, Adiga S, Thomas H. Evaluation of the antipeptic ulcer activity of the seed extract of sesame (*Sesamum indicum*) in stress induced peptic ulcers in rats. *International Journal of Basic & Clinical Pharmacology*. 2018; 7(6): 1131-1135.
- Robert B. *Medicinal plants*. (London, UK: J & A Churchill), pp. 198, 1991
- Sharif MR, Alizargar J, Sharif A. Evaluation of the wound healing activity of sesame oil extract in rats. *World Journal of Medical Sciences*. 2013;9(2):74-8.
- Sharififar F, Moshafi MH, Shafazand E, Koohpayeh A. Acetyl cholinesterase inhibitory, antioxidant and cytotoxic activity of three dietary medicinal plants. *Food chemistry*. 2012;130(1):20-3.
- Sharma S, Gupta P, Kumar A, Ray J, Aggarwal BK, Goyal P, Sharma A. In vitro evaluation of roots, seeds and leaves of *Sesamum indicum* L. for their potential antibacterial and antioxidant properties. *African Journal of Biotechnology*. 2014;13(36):3692-701.
- Shashirekha MN, Rajarathnam S, Bano Z. Chemical and biochemical changes in the rice straw substrate related to the morphogenesis, cropping pattern and yield of *Pleurotus florida* (Block & Tsao.). *The Journal of Horticultural Science and Biotechnology*. 2001;76(3):332-7.
- Singh MP. *Medicinal Herbs with their Formulations*. (New Delhi, India: Daya Publishing House Delhi), pp.763, 2005.
- Sireesha R, Sandeep D, Lakshman K, Lakshman C, Kiran K, Mohaboob S, Pushpalatha B. In vitro Anthelmintic Activity of Different Solvent Extracts. *International Journal Of Pharmaceutical And Chemical Sciences*. 2013;2(3): 1208-12.
- Slover HT, Thompson RH, Merola GV. Determination of tocopherols and sterols by capillary gas chromatography. *Journal of the American Oil Chemists' Society*. 1983;60(8): 1524-8.

Speck AJ, Schrijver J, Schreurs WH. Vitamin E composition of some seed oils as determined by high-performance liquid chromatography with fluorometric detection. *Journal of Food Science*. 1985;50(1):121-4.

Visavadiya NP, Narasimhacharya AV. Sesame as a hypocholesterolaemic and antioxidant dietary component. *Food and Chemical Toxicology*. 2008;46(6):1889-95.

Visavadiya NP, Soni B, Dalwadi N. Free radical scavenging and antiatherogenic activities of *Sesamum indicum* seed extracts in chemical and biological model systems. *Food and chemical toxicology*. 2009;47(10):2507-15.

Wallis TE. *Textbook of pharmacology*. (New Delhi, India: CBS New Delhi), pp.220, YNM.

Wang BS, Chang LW, Yen WJ, Duh PD. Antioxidative effect of sesame coat on LDL oxidation and oxidative stress in macrophages. *Food chemistry*. 2007;102(1):351-60.

Weiss EA. *Oilseeds Crops*. (London, UK: Longman London), pp. 282-340, 1983.

William D. *Pharmacographia indica "A History of the Principles Drugs of vegetable origin, met with in British India"*. (New Delhi, India: Srishti book Distributors), pp.26, 2005.

Yamada Y, Obayashi M, Ishikawa T, Kiso Y, Ono Y, Yamashita K. Dietary tocotrienol reduces UVB-induced skin damage and sesamin enhances tocotrienol effects in hairless mice. *Journal of nutritional science and vitaminol*. 2008;54(2):117-23.