REVIEW ARTICLE

Palasha, a holy plant: Its phytochemistry, biological effects, and therapeutic uses

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Abstract

The present review article explains phytochemistry, biological effects, and therapeutic uses of *Butea monosperma* and its associating species. This plant possesses great esthetic, medicinal, and therapeutic value in India. Palash is mentioned in holy Indian spiritual texts and has a long traditional use in Ayurvedic medicines. Its leaf decoction is used in the treatment of leukorrhea, diabetes, and for eye diseases. Flower, stem bark, root bark, and leaves possess diverse chemical constituents such as butrin, isobutrin, and isocoreopsin which showed very wide range of biological activities such as antioxidant, anti-inflammatory, anticonvulsant, antidiabetic, hepatoprotective, anti-gout activity, anti-inflammatory activity, ameliorative activity, anti-obese activity, anti-hyperglycemic, anti-nociceptive, anti-peroxidative anti-hepatotoxic, anthelmintic, chemopreventive, and hepatoprotective activity. Plant contains nutritive contents as fat 3.1, fiber 2.10, protein 16.87, and carbohydrate 75 (% per 100 g) and physiological important minerals such as Fe, Mn, Zn, Mg, and calcium. Plant flowers are good source of color which is traditionally used in religious rituals.

Key words: Biological effects, *Butea monosperma*, phytochemistry, therapeutic uses

INTRODUCTION

Palash (*Butea monosperma*) (Lam.) Taub is a holy plant native of Indian subcontinent and found in India and its neighboring countries Nepal, Bangladesh, Sri Lanka, Laos, Thailand, Myanmar, Cambodia, Malaysia, Vietnam, and Indonesia. It is also commonly known as "Dhak" and symbolized by three leaves. This is a shade giving plant having 10–15 m medium-sized height. It remains covered with green deciduous leaves and bright orange, saffron, and red colored flower with yellow bracts. Plant has great esthetic and religious value in Hindu mythology. Plant has another common name flame of the forest due to its red-colored flowers. This name is originated from Agni, the God of fire. In Indian states, plant is recognized by different names. In Gujarati, it is known as Kesudo, in Teulgu, Modugu, Kannada is Muthuga, Polash in Bengali, Marathi, it is called as PaLash, and Palashpapra (Urdu). In Burmese language, it is known as Pauk, in Javanese, it is known as Ploso.[1] Its saffron- or red-colored flowers are used for worship of Lord Shiva in South Indian states on Mahashivratri. Plant has enlarged distribution in Uttar Pradesh, Uttarakhand, Madhya Pradesh, Bihar, and Orissa and has most prevalent name "Tesu." Palash plant is the state flower of Jharkhand. Dense population of Kimsuka or Dhak trees are found in forests of Gangatic planes where it is a part of agriculture production and known as wealthy plant.[2,3] Full blossomed tree looks like a Kimsuka and a net of flame colored flowers.[4] In spring season, when plant losses it's all the leaves than saffron color flowers become attraction of nectar feeding insects and birds. Its flowers are collected and color is extracted and used on Holi festival. Flower bunches are used by tribal women to adorn themselves. Plant is used as a Lawn specimen, small shade tree, and fodder tree. Plant belongs to family Fabaceae is commonly grown in different parts of India for shade, fodder, and medicinal and esthetic purposes (Singh *et al.*, 2014).[5] Palash tree is a good source of gum, timber, resin, fodder, medicine, and dye. Its wood is soft, blackish-white in color.

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ESTHETIC USE

In many Indian states, Kimsuka is an attraction of folk culture and religious tradition. Plant stick is used in Yagopavitra ritual (Yajurveda) both kopin and stick bearing is essential for *brahmacharya follower*. In India, Vedic scholars (Brahmins) use bark of this tree as a main component of *Samidhahavan*, for agnihotra. Leaf falling and flowering are symbol of beginning of spring season and a blissful life. In Indian, Jyotish plant depicts Poorvaphalguni Nakshatra. *B. monosperma* or palash is leaves are symbol of devoid of tri doshas and it is known as attainment of self-enlightenment, or App DeepoBhav of Buddhism (Theravada), it is called *Medhankara* by Lord Budha. Full blossomed tree looks like a net of flame colored flowers. In Sanskrit it is in available in holy texts as kimsuka. Leaves of this plant are joined to make ladles and spoons which are used in religious rituals. Plant wood is used to make charcoal; tick leathery leaves are used for making pattals to serve food besides using plastic plates.

MEDICINAL USE

In Ayurvedic text, Chakra Samhita Palash flowers, seeds, bark, and gum are used for medicinal purpose. Its flowers are tonic and nutritive. Its bark powder is used to kill worms and treatment of piles, splenomegaly; tumors; ulcers; and wounds. Due to its powerful pharmacological properties, this plant is extremely important. Plant is a good source of fiber, protein, carbohydrates, gum, and dye (color). Various parts of this plant such as flower, bark, leaf, and seed gum are used in traditional medicine. The Ayurvedic formulations made from this plant are used to reduce the vāta and kapha among the tridosa. Hot leaf decoction is used to treat leucorrhea and diabetes. The leaves are good for eye infection and aliments.[6] The root powder is beneficial in night blindness and other eye defects. *This also* is used in the treatment of constipation.[7] A paste of the stem bark relieves body swelling. Stem juice benefits if applied on goiter.

Palash seed powder and coriander aqueous extract help to reduce heat in the body. Palash seed powder boiled in hot water and its hot poultice is applied externally to remove joint inflammation and pain if applied externally It mobilizes uric acid stored in the joints. The powdered seeds are used as a febrifuge and tonic and in bronchitis and whopping cough. It increases urinary bladder functions and detoxifies blood. Seed powder and cumin water save from skin infection and leukoderma. The seed oil is also used in bleeding piles, ulcers, and depurative. It from relief in swelling and promote menstrual flow. In rural areas of India, plant is used for the treatment of gastric problems, joint pain, and ulcer.[8,9] Palash root extract is used to normalize stomach functions, pelvis burning sensation, and extra thirst. Palash flower water extract is anti-inflammatory, antimicrobial, antihelmintic, antidiabetic, diuretic, analgesic, antitumor, and astringent. Palash leaf juice, flower powder, seed powder, and churna are used for various medicinal purposes. Bark extracts are used for the treatment of hepatitis, stress, anxiety, cognition, and fertility control.[10-12] Aqueous extract of leaf shows anti-ovulatory properties. Plant contains phenolic and flavonoid compounds show multiple therapeutic activity.[13,14] Plant contains Butein and (*S*)-Butin which are good anti-oxidants.[15] Plant is a good source of natural drugs which used for cure of so many diseases.[16,17] Plant displays enormous genetic diversity and chemotypic diversity that can be used for medicinal purposes.[18]

SOURCE OF INFORMATION

For writing this comprehensive research review on palash: A holy plant, various databases were searched. For the collection of relevant information, specific terms such as medical subject headings (MeSH) and key text words, such as "palash (*B. monosperma*) and its therapeutic uses" published till 2022 were used in Medline. Most specially for retrieving all articles pertaining to the traditional uses of *B. monosperma* for therapeutics, electronic bibliographic databases were searched, and abstracts of published studies with relevant information on the *B. monosperma* were collected. Furthermore, additional references were included through searching the references cited by the studies done on the present topic. Relevant terms were used individually and in combination to ensure an extensive literature search. For updating the information about a subject and incorporation of recent knowledge, relevant research articles, books, conferences proceedings', and public health organization survey reports were selected and collated based on the broader objective of the review. This was achieved by searching databases, including SCOPUS, Web of Science, and EMBASE, PubMed, Swiss-Prot, and Google searches." From this common methodology, discoveries and findings were identified and summarized in this final review.

From database, the following species of palash plant have been identified *Butea maingayi*, *Butea merguensis*, *Butea minor*, *Butea oblong folia*, *Butea parviflora*, *Butea pellita*, *Butea peltata*, *Butea philippinensis*, *Butea potting*, *Butea pulchara*, *Butea purpurea*, *Butea ridleyi*, *Butea riparia*, *Butea rosea*, *Butea sanguinea*, *Butea sericophylla*, *Butea spirei*, *Butea squirmier*, *Butea suberecta*, *Butea superba*, *Butea varians*, *Butea volubilis*, *Butea acuminate*, *Butea affinis*, *Butea africana*, *Butea apoensis*, *Butea balansae*, *Butea braamiana*, *Butea bracteolate*, *Butea cuneiforms*, *Butea crassfolia*, *Butea dubia*, *Butea ferruginous*, *Butea. gyrocarpa*, *Butea harmandii*, *Butea laotica*, *Butea listeri*, *Butea littoralis*, *Butea loureirii*, and *Butea macroptera.*

PHYTOCHEMISTRY

B. monosperma possess diverse bio-organic components.[19] Its leaves contain flavonoids, that is, rhamnetin, quercetin, kaempferol, and catechin which were found highly active at a very low EC50 value ($P < 0.001$).[20] Plant stem contains sterol-e-D-glucopyranoside,

daidzein (C15H10O4) a isoflavone and nonacosanoic acid, 3-Z-hydroxyeuph-25-ene, while stem bark Kino-tannic acid, gallic acid, and pyrocatechin. Leaves are rich in glucoside, kino-oil while flowers possess monospermoside (butein 3-e-d-glucoside) and isomonospermoside, chalkiness', aureoles, flavonoids (palasitrin, prunetin) and steroids, triterpene, butein, butin, isobutrin, coreopsin, isocoreopsin (butin 7-glucoside), and sulfurein. Its sap contains isomeric flavanone and its glucosides, butrin, chalcones, butein, and butin while gum contains pyrocatechin[21] [Table 1]. Galactose-specific lectin and palasonin have been isolated from palash seeds.[22,23] Palash flowers contain seven flavonoid glucosides, that is, butrin, isobutrin, monospermoside, isomonospermide, coreopsin, isocoreopsin, and sulfurein. Plant flower contains isobutrin and butrin.[24] It also contains seuphane triterpenoid and lipid constituents.[25] Palash contains alkaloids, flavonoids, phenolic compounds, amino acids, glycosides, resin, saponin, and steroids, among other phytoconstituents. Gallic and tannic acids are abundant in the red gum produced from the stem [Table 1 and Figure 1].

BIOLOGICAL EFFECTS

Hepatoprotective

B. monosperma hepatoprotective activity against paracetamol induced liver intoxication in experimental animals.[26] It also shows protective role against thioacetamide-mediated hepatic changes in Wistar rats.[27,28] Its aqueous extract shows hepatoprotective activity against CCl(4)-induced damage in rats.[29] Plant flower contains isobutrin and butrinactive ingredients which showed antihepatotoxic effect.[24] It also shows nephroprotective activity in albino rats.[30] *B. monosperma* contains natural polysaccharides[31] and isoflavones which showed hepatoprotective activity.[32]

CHEMOPREVENTIVE AND ANTICANCER ACTIVITY

B. monosperma leaves possess butein that causes apoptosis induction and inhibition of cyclooxygenase2 expression in A549 lung cancer cells.[33] Butein also down regulates phorbol 12-myristate 13-acetate-induced COX-2 transcriptional activity in cancerous and non-cancerous breast cells.[34] Its aqueous extract shows anti-proliferative effects against tumor growth in liver and restores size of nucleus in hepatic cells.[35] Its active ingredients showed pro-apoptotic, anti-metastatic, and anti-angiogenic activity.[36] Both butein and isocoreopsin isolated from flowers are important anticancer agents which effectively work at very minimum dose[36] against colorectal[37] and breast cancer.[38] Similarly, butrin, isobutrin, and butein isolated from *B. monosperma* cause suppression of tumor necrosis[39] and showed chemopreventive effects against cancer growth.[40] It represses DDX3 expression and obstruct

Table 1: Chemical constituents found in various plant parts of *Butea monosperma* and its various uses

Plant part	Chemical constituents	Biological effects/treatment
Stem	Stigma sterol-e-D-glucopyranoside and nonacosanoic acid, 3-Z-hydroxyeuph-25-ene and 2, 14-dihydroxy- 11, 12-dimethyl-8-oxo-octadec-11 enylcyclohexane.	Antihyperglycemic and antioxidant effect
Bark	The plant contains Kino-tannic acid, Gallic acid, pyrocatechin, palasitrin, and major glycosides as butrin, butolic acid, cyanidin, histidine, lupenone, lupeol, (-)-medicarpin, miroestrol, palasimide, and shellolic acid.	Antibacterial and antidiarrheal, anti-obese activity
Leaves	The leave soft *Butea monosperma* contains glucoside, Kino-oil containing oleic and linoleic acid, palmitic and lignoceric acid.	Treatment of leucorrhea, diabetes and for eye diseases.
Flower	Monospermoside (butein 3-e-d-glucoside) and isomonospermoside, chalkiness', aureoles, flavonoids (palasitrin, prunetin) and steroids, triterpene, butein, butin, isobutrin, coreopsin, isocoreopsin (butin 7-glucoside), sulfurein	Antioxidant, anti-inflammatory, anticancer, anticonvulsant and antidiabetic, hepatoprotective effects.
Gum	Tannins, mucilaginous material, pyrocatechin	Antibacterial and antifungal
Seed	A nitrogenous acidic compound, along with palasonin is present in seeds. It also contains monospermoside (butein 3-e-d-glucoside) and so monospermoside, oil (yellow, tasteless), proteolytic and lypolytic enzymes, plant proteinase and polypeptidase	Febrifuge and tonic and in bronchitis and whopping cough
Resin	From seed coat allophanic acid, Z- Amyrin, e-sitosterone its glucoside and sucrose; lactone-nheneicosanoic acid-delta-lactone, jalaric esters i, ii and laccijalaric esters iii, iv	Antibacterial and antifungal
Sap	Colorless isomeric flavanone and its glucosides, butrin, chalcones, butein, butin.	Antihyperglycemic, antinociceptive effect, antiperoxidative, and hypoglycemic effects

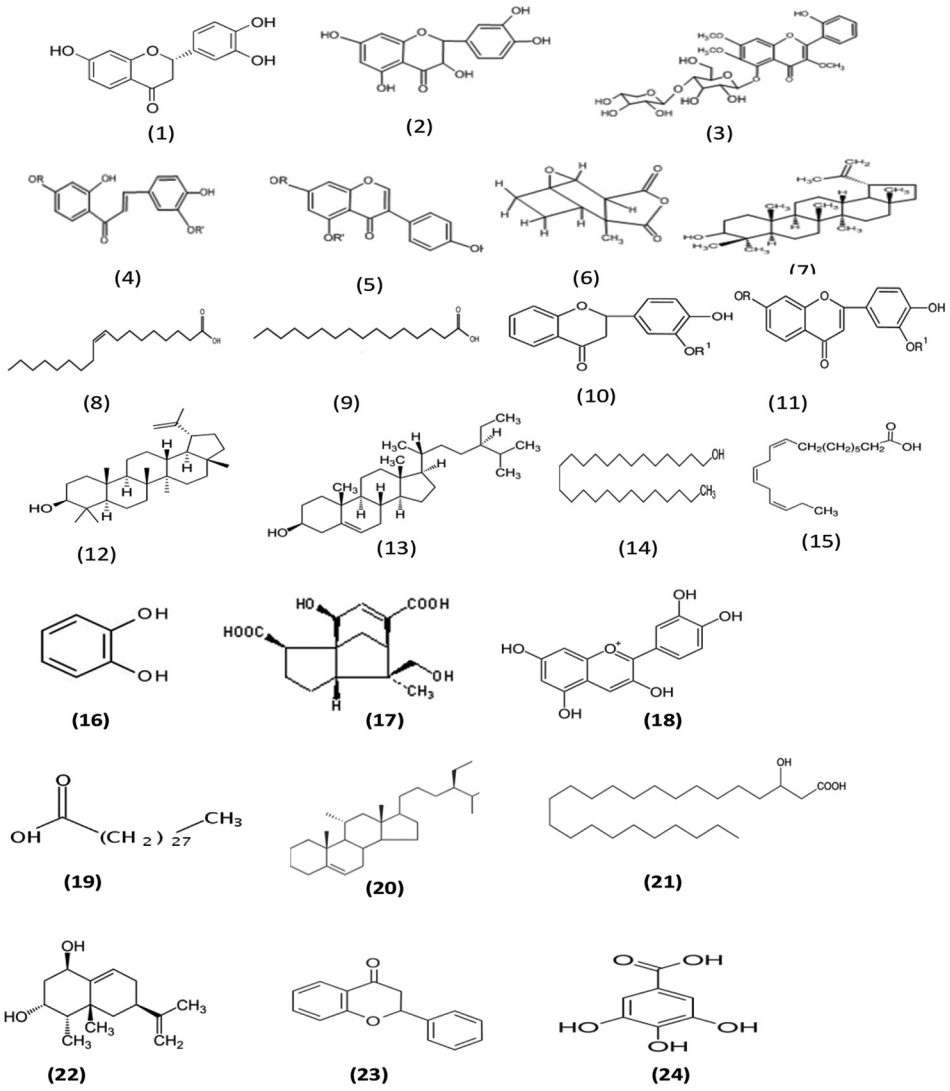

Figure 1: Various bio-organic compounds isolated from various species of Palash. (1) Butin, (2) Quercitin, (3) 5, 2'dihydroxy-3,6,7-trimethoxyflavone-5-O butin, (4) isobutrin, (5) Prunetin, (6) palasonin, (7) Lupeol, (8) oleic acid, (9) Palmitic acid, (10) Isocorepsin, (11) Isomonospermoside, (12) lupeol, (13) beta-sitosterol, (14) hexacosanol, (15) linoleic acid (16) Pyrochatecol, (17) Shellolic acid, (18) Cyanidin, (19) Nonacosanoic acid, (20) Sterol-e-D-glucopyranoside, (21) Lignoceric acid, (22) Allixin, (23) Flavanone, and (24) Gallic acid

PI3K/AKT Signaling pathway in cancer lines.[41] It also suppresses expression of nuclear factor-kappa β-mediated matrix metalloproteinase-9 and vascular endothelial growth factor in prostate cancer cells.[42] It induces apoptosis in MCF-7 breast cancer cells through cell cycle arrest.[43]

ANTIOXIDANT AND ANTIHYPERGLYCEMIC EFFECT

B. monosperma Lam. bark hydroethanolic extract shows antihyperglycemic and antioxidant effect in alloxan-induced diabetic mice.[44,45] These also showed free radical scavenging activity.[46] *B. monosperma* seeds are medicinally useful.[47] Plant contains polyphenols such as ellagic acid, catechin, quercetin, and gallic acid as its major constituent's antioxidant activity. Similarly, phenolic and flavonoid compounds also showed antioxidant activity.[48] Butein isolated from flower extracts showed antioxidant and proapoptotic properties.[49] It resulted in increased reactive oxygen species generation and decreased mitochondrial membrane potential and stress-mediated alteration in V-ATPase and V-Pase activity.[50] The stigmasterol isolated from *B. monosperma* bark increases in the activities of catalase, superoxide dismutase, and glutathione.[51]

B. monosperma ethanolic extract of leaves showed strong antidiabetic and antioxidant potential in alloxan-induced[43] and streptozotocin-induced severely diabetic rats.[52,53] Butea leaves and bark extract cut down glucose level in blood.[52] Its ethanolic extract modulates dyslipidemia in streptozotocin-induced diabetic rats[54] antihyperglycemic prospective of

hydroethanolic leaf extract of *B. monosperma*.[55] Antidiabetic potential of *B. monosperma*.[56]

ANTI-INFLAMMATORY ACTIVITY

B. monosperma extracts from flowers show metalloproteinases inhibitory activities and anti-aging property.[57] Butein found in flowers of activity of *B. monosperma* shows anti-inflammatory activity.[58,59] Butein inhibits IL-1β-induced inflammatory response in human osteoarthritis chondrocyte,[60] butein derivatives showed inhibition of adipocyte inflammation[61] and response suppression in lymphedema.[62]

Osteogenic Activity

Stem bark extract of *B. monosperma* shows osteoprotective activity due to the presence of phytoalexin.[63-67] Bark extract also shows estrogenic and anti-estrogenic activities.[68] Methoxylated isoflavones, cajanin and isoformononetin, have non-estrogenic bone forming effect through differential mitogen-activated protein kinase signaling.[69,70] *B. monosperma* stem shows bone conserving effect.[71]

Ameliorative Activity

B. monosperma showed ameliorative potential on chronic constriction injury of sciatic nerve-induced neuropathic pain in rats.[72] Plant shows positive skeletal effects of cladrin, a naturally occurring dimethoxy daidzein in osteopenic rats.[73] Lyophilized extract of *Butea frondos*a leaves on scopolamine-induced amnesia in rats.[54]

Anti-Obese Activity

B. monosperma (Lam) bark shows anti-obese activity in experimentally induced obese rats.[74] Butein found in bark modulates dyslipidemia in streptozotocin-induced diabetic roots[75] assists in control of adipogenesis.[76]

Anti-gout Activity

B. monosperma root extract is highly beneficial in gout.[77]

Antinociceptive Effect

B. monosperma provide extreme relief in vincristine-induced neuropathic pain in experimental rats.[78]

THYROID INHIBITORY

Stigmasterol isolated from *B. monosperma* shows thyroid inhibitory effects.[51]

WOUND HEALING

Efficacy of *B. monosperm*a on dermal wound healing in rats.[79]

Anti-Venin Activity

B. monosperma (Lam.) Kuntze stem bark decreased the hyaluronidase activity found in *Vipera russelli* snake venom.[80]

Anthelmintic Activity

B. monosperma shows anthelmintic activity of against trichostrongylid nematodes in sheep.[81] It also attracts worms for litter decomposition in forests.[82]

Anticonvulsive Activity

Euphane triterpenoid and lipid constituents isolated from *B. monosperma* showed in experimental animals.[83-86]

Anticonceptive Activity

B. monosperma seeds contain active ingredients which are herbal contraceptive.[87] These modulate anti-fertility effects in experimental rats at very low physiological dose.[88] Butin isolated from flowers showed estrogenic and postcoital anticonceptive activity in rats.[89,90]

Antimicrobial Activity

Active constituents isolated from *B. monosperma* possess anti-enteric potential against multidrug-resistant *Salmonella typhi*.[91] Its bark extracts were found effective against *Enterobacter cloacae*[20] and *Cryptococcus neoformans*.[93] These also inhibit growth of Gram-positive strains (*Bacillus subtilis and Staphylococcus aureus*) and Gram-negative strains (*Vibrio cholera, Enterobacter aerogenes, Klebsiella pneumoniae*, *Agrobacterium tumefaciens, and Escherichia coli*).[93] *B. monosperma* seed oil easily kills human pathogenic bacteria and cure diseases caused by phytopathogenic fungi.[94] Stem bark of *B. monosperma* contains flavone glycosides which show antifungal anti-viral effects.[95-97] These inhibit growth of *A. niger* and *A. arvensis*.[93] Flower, leaves, and gum of *B. monosperma* showed antimicrobial activity.[98] Bioactive flavonoids isolated from flowers of *B. monosperma* showed antimycobacterial and antidiarrheal effects in experimental animals.[14,20,99]

ANTIPARASITIC

Flowers and seeds of *B. monosperma* are used to prepare "Pippali rasayana" that controls giardiasis by

Photograph 1: Aerial and floral parts of *Butea monosperma* plant grown in Indian subtropical climate

an immunomodulatory.[100,101] Its oligosaccharides act as agglutinin.[102] These show antifilarial effect in vitro against *Brugia malayi microfilariae*.[103,104]

INSECTICIDAL ACTIVITIES

Flower, leaf, bark, and root extracts of *B. monosperma* showed insecticidal activity[105] against several crop pests.[106,107] Its methanolic seed extract is also found active against dengue vector, *Aedes aegypti*.[108]

MISCELLANEOUS

Isobutrin from *B. monosperma* possesses natural sensitizer which belong to chalcone class.[109] Plant contains butein which is used for maintaining health and many diseases.[110]

CONCLUSION

From literature searches, it is clear that *B. monosperma* possesses diverse chemical constituents of pharmacological, medicinal, and therapeutic importance. Almost all the plant parts contain bioactive components among which stem contains sterol-e-D-glucopyranoside and nonacosanoic acid, 3-Z-hydroxyeuph-25-ene, while stem bark contains Kino-tannic acid, gallic acid, and pyrocatechin. Leaves are rich in glucoside and Kino-oil. Flowers of Butea monosperma contain monospermoside, flavonoids (palasitrin, prunetin) and steroids, triterpene, butein, butin, isobutrin, coreopsin, isocoreopsin (butin 7-glucoside), and sulfurein. Its gum contains pyrocatechin and sap contains isomeric flavanone and its glucosides, butrin, chalcones, butein, and butin. Plant seeds contain galactose-specific lectin and palasonin. Plant also contains metabolically important flavonoids, that is, rhamnetin, quercetin, kaempferol, and catechin. All these bioactive components show multiple biological activity. These could be used for the production of highly efficacious broad-spectrum pharmaceutical products or novel herbal drugs, pesticides, and therapeutic agents. Plant is widely used in traditional medicinal system of India and has great aesthetic and cultural value.

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REFERENCES

1. United States Department of Agriculture. "*Butea monosperma*". Germplasm Resources Information Network (GRIN). United States: Agricultural Research Service (ARS), United States Department of Agriculture (USDA)
2. Mann M. Ecological Change in North India: Deforestation and Agrarian Distress in the Ganga-Yamuna Doab 1800-1850, In: Grove RH, Damodaran V, Sangwan S, editors. Nature and the Orient. Oxford: Oxford University Press.
3. Wallis TE. Text Book of Pharmacognosy. 5th ed. London: J and A Churchill; 1967.
4. Cowen DV. Flowering Trees and Shrubs in India. 6th ed. Bombay: Thacker and Co. Ltd.; 1984. p. 3.
5. Singh H, Singh S, Srivastava A, Tandon P, Bharti P, Kumar S, *et al*. Conformational analysis and vibrational study of daidzein by using FT-IR and FT-Raman spectroscopies and DFT calculations. Spectrochim Acta A Mol Biomol Spectrosc 2014;120:405-15.
6. Varsha S. Therapeutic significance of *Butea monosperma*: A review. J Drug Deliv Ther 2011;1:63-7.
7. Khan K, Rahman IU, Calixto ES, Ali N, Ijaz F. Ethnoveterinary therapeutic practices and conservation status of the medicinal flora of Chamla Valley, Khyber Pakhtunkhwa, Pakistan. Front Vet Sci 2019;6:122.
8. Otilia J, Banji F, Singh M, Rao KN. *Butea frondos*a as a gastro protective against induced gastric lesions. Rev Brasil Farmacogn 2011;21:691-6.
9. Londonkar R, Ranirukmini RK. Antimicrobial activity of *Butea frondosa* (Roxb). J Pharmacogn 2010;1:1-5.
10. Laumas KR, Unival JP. A preliminary report on the Anti-estrogenic activity of petals of *Butea* frondosa. Indian J Exp Biol 1966;4:246.
11. Ramachandran S, Sridhar Y, Kishore S, Sam SK, Saravanan M, Leonard JT, *et al*. Aphrodisiac activity of *Butea frondosa* Koen. ex Roxb. extract in male rats. Phytomedicine 2004;11:165-8.
12. Soman I, Mengi SA, Kasture SB. Effect of leaves of *Butea frondosa* on stress, anxiety, and cognition in rats.

Pharmacol Biochem Behav 2004;79:11-6.
13. Choudhary RK, Swarnkar PL. Antioxidant activity of phenolic and flavonoid compounds in some medicinal plants of India. Nat Prod Res 2011;25:1101-9.
14. Chokchaisiri R, Suaisom C, Sriphota S, Chindaduang A, Chuprajob T, Suksamrarn A. Bioactive flavonoids of the flowers of *Butea monosperma*. Chem Pharm Bull (Tokyo) 2009;57:428-32.
15. Liu J, Li X, Cai R, Ren Z, Zhang A, Deng F, *et al*. Simultaneous study of anti-ferroptosis and antioxidant mechanisms of butein and (*S*)-Butin. Molecules 2020;25:674.
16. Samuelsson G. Drugs of Natural Origin. Sweden: Swedish Pharmaceutical Press; 1999. p. 38-55.
17. Padmavathi G, Roy NK, Bordoloi D, Arfuso F, Mishra S, Sethi G, *et al*. Butein in health and disease: A comprehensive review. Phytomedicine 2017;25:118-27.
18. Vashishtha A, Jehan T, Lakhanpaul S. Genetic diversity and population structure of *Butea monosperma* (Lam.) Taub-a potential medicinal legume tree. Physiol Mol Biol Plants 2013;19:389-97.
19. William RS, Kavya A. Recent advances on the pharmacological profile of *Butea monosperma*. GERF Bull Biosci 2011;2:33-40.
20. Sharma D, Patel S, Verma K, Gudlawar S, Chakraborty D, Paliwal S, *et al*. Antibacterial and antidiarrheal activity of *Butea monosperma* bark extract against waterborne enterobacter Cloacae in rodents: *In-vitro*, *Ex-vivo* and *in-vivo* evidences. J Ethnopharmacol 2019;241:112014.
21. Pal P, Bose S. Phytopharmacological and phytochemical review of *Butea monosperma***.** Int J Res Pharm Biomed Sci 2011;2:1374-88.
22. Abhilash J, Geethanandan K, Bharath SR, Sadasivan C, Haridas M. *Butea monosperma*. Acta Crystallogr Sect F Struct Biol Cryst Commun 2011;67:524-6.
23. Ghosh B, Dasgupta B, Sircar PK. Bacto-arga--a binding matrix for purification of a lectin from *Butea monosperma* (Lam) Kuntze. Indian J Biochem Biophys 1981;18:166-9.
24. Wagner H, Geyer B, Fiebig M, Kiso Y, Hikino H. Isobutrin and butrin, the antihepatotoxic principles of *Butea monosperma* flowers. Planta Med 1986;2:77-9.
25. Mishra M, Shukla Y, Kumar S. Euphane triterpenoid and lipid constituents from *Butea monosperma*. Phytochemistry 2000;54:835-8.
26. Gupta A, Sheth NR, Pandey S, Shah DR, Yadav JS. Design and evaluation of herbal hepatoprotective formulation against paracetamol induced liver toxicity. J Young Pharm 2013;5:180-7.
27. Sehrawat A, Khan TH, Prasad L, Sultana S. *Butea monosperma* and chemomodulation: protective role against thioacetamide-mediated hepatic alterations in Wistar rats. Phytomedicine 2006;13:157-63.
28. Kaur V, Kumar M, Kaur P, Kaur S, Singh AP, Kaur S. Hepatoprotective activity of *Butea monosperma* bark against thioacetamide-induced liver injury in rats. Biomed Pharmacother 2017;89:332-41.
29. Sharma N, Shukla S. Hepatoprotective potential of aqueous extract of *Butea monosperma* against CCl(4) induced damage in rats. Exp Toxicol Pathol 2011;63:671-6.
30. Sonkar N, Ganeshpurkar A, Yadav P, Dubey S, Bansal D, Dubey N. An experimetal evaluation of nephroprotective potential of *Butea monosperma* extract in albino rats. Indian J Pharmacol 2014;46:109-12.
31. Qu J, Huang P, Zhang L, Qiu Y, Qi H, Leng A, Shang D. Hepatoprotective effect of plant polysaccharides from natural resources: A review of the mechanisms and structure-activity relationship. Int J Biol Macromol 2020;161:24-34.
32. Alipour MR, Karimi-Sales E. Molecular mechanisms of protective roles of isoflavones against chemicals-induced liver injuries. Chem Biol Interact 2020;329:109213.
33. Li Y, Ma C, Qian M, Wen Z, Jing H, Qian D. Butein induces cell apoptosis and inhibition of cyclooxygenase-2 expression in A549 lung cancer cells. Mol Med Rep 2014;9:763-7.
34. Lau GT, Huang H, Lin SM, Leung LK. Butein downregulates phorbol 12-myristate 13-acetate-induced COX-2 transcriptional activity in cancerous and non-cancerous breast cells. Eur J Pharmacol 2010;648:24-30.
35. Mathan G, Fatima G, Saxena AK, Chandan BK, Jaggi BS, Gupta BD, *et al*. Chemoprevention with aqueous extract of *Butea monosperma* flowers results in normalization of nuclear morphometry and inhibition of a proliferation marker in liver tumors. Phytother Res 2011;25:324-8.
36. Tahir ul Qamar M, Maryam A, Muneer I, Xing F, Ali Ashfaq U, Khan FA, *et al.* Computational screening of medicinal plant phytochemicals to discover potent pan-serotype inhibitors against dengue virus. Sci Rep 2019;9:1433.
37. Subramaniyan B, Polachi N, Mathan G. Isocoreopsin: An active constituent of n-butanol extract of *Butea monosperma* flowers against colorectal cancer (CRC). J Pharm Anal 2016;6:318-25.
38. Karia P, Patel KV, Rathod SS. Breast cancer amelioration by *Butea monosperma in-vitro* and *in-vivo*. J Ethnopharmacol 2018;217:54-62.
39. Rasheed Z, Akhtar N, Khan A, Khan KA, Haqqi TM. Butrin, isobutrin, and butein from medicinal plant *Buteamonosperma* selectively inhibit nuclear factor-kappaB in activated human mast cells: Suppression of tumor necrosis factor-alpha, interleukin (IL)-6, and IL-8. J Pharmacol Exp Ther 2010;333:354-63.
40. Padmavathi G, Rathnakaram SR, Monisha J, Bordoloi D, Roy NK, Kunnumakkara AB. Potential of butein, a tetrahydroxychalcone to obliterate cancer. Phytomedicine 2015;22:1163-71.
41. Rampogu S, Kim SM, Shaik B, Lee G, Kim JH, Kim GS, *et al*. Novel butein derivatives repress DDX3 expression by inhibiting PI3K/AKT signaling pathway in MCF-7 and MDA-MB-231 cell lines. Front Oncol 202118;11:712824.
42. Moon DO, Choi YH, Moon SK, Kim WJ, Kim GY.

Butein suppresses the expression of nuclear factor-kappa B-mediated matrix metalloproteinase-9 and vascular endothelial growth factor in prostate cancer cells. Toxicol *In Vitro* 2010;24:1927-34.
43. Kaur V, Kumar M, Kumar A, Kaur S. *Butea monosperma* (Lam.) Taub. Bark fractions protect against free radicals and induce apoptosis in MCF-7 breast cancer cells *via* cell-cycle arrest and ROS-mediated pathway. Drug ChemToxicol 2020;43:398-408.
44. Sharma N, Garg V. Antidiabetic and antioxidant potential of ethanolic extract of *Butea monosperma* leaves in alloxan-induced diabetic mice. Indian J Biochem Biophys 2009;46:99-105.
45. Sharma N, Garg V. Antihyperglycemic and antioxidative attribute of hydroethanolic extract of *Butea monosperma* (Lam.) seeds and its active constituents. Indian J Exp Biol 2011;49:756-66.
46. Lavhale MS, Mishra SH. Evaluation of free radical scavenging activity of *Butea monosperma* Lam. Indian J Exp Biol 2007;45:376-84.
47. Srivastava M, Banerji R, Rawat AK, Mehrotra S. Fatty acid composition of some medicinally useful seeds. J Herb Pharmacother 2006;6:41-7.
48. Saeed N, Khan, MR, Shabbir M. Antioxidant activity, total phenolic and total flavonoid contents of whole plant extracts *Torilis leptophylla* L. BMC Complement Altern Med 2012;12:221.
49. Sehrawat A, Kumar V. Butein imparts free radical scavenging, anti-oxidative and proapoptotic properties in the flower extracts of *Butea monosperma*. Biocell 2012;36:63-71.
50. Kumari N, Sharma V. Stress-mediated alteration in V-ATPase and V-PPase of *Butea monosperma*. Protoplasma 2010;245:125-32.
51. Panda S, Jafri M, Kar A, Meheta BK. Thyroid inhibitory, antiperoxidative and hypoglycemic effects of stigmasterol isolated from *Butea monosperma*. Fitoterapia 2009;80:123-6.
52. Ahmed F, Siddaraju NS, Harish M, Urooj A. Effect of *Buteamonosperma* Lam. leaves and bark extracts on blood glucose in streptozotocin-induced severely diabetic rats. Pharmacognosy Res 2012;4:33-6.
53. Harish M, Ahmed F, Urooj A. *In vitro* hypoglycemic effects of *Butea monosperma* Lam. leaves and bark. J Food Sci Technol 2014;51:308-14.
54. Divya BT, Mini S. Ethanol extract of *Butea monosperma* bark modulates dyslipidemia in streptozotocin-induced diabetic rats. Pharm Biol 2014;52:1021-7.
55. Farooq MU, Mumtaz MW, Mukhtar H, Rashid U, Akhtar MT, Raza SA, *et al*. UHPLC-QTOF-MS/MS based phytochemical characterization and anti-hyperglycemic prospective of hydro-ethanolic leaf extract of *Butea monosperma*. Sci Rep 2020;10:3530.
56. Somani R, Kasture S, Singhai AK. Antidiabetic potential of *Butea monosperma* in rats. Fitoterapia 2006;77:86-90.
57. Shahavi VM, Desai SK. Anti-inflammatory activity of *Butea monosperma* flowers. Fitoterapia 2008;79:82-5.
58. Krolikiewicz-Renimel I, Michel T, Destandau E, Reddy M, André P, Elfakir C, *et al*. Protective effect of a *Butea monosperma* (Lam.) Taub. flowers extract against skin inflammation: Antioxidant, anti-inflammatory and matrix metalloproteinases inhibitory activities. J Ethnopharmacol 2013;148:537-43.
59. Gao L Gao L, Cui S, Huang Z, Cui H, AwadAlahmadi T, *et al*. Antinociceptive and anti-inflammatory activities of butein in different nociceptive and inflammatory mice models. Saudi J Biol Sci 2021;28:7090-7.
60. Zheng W, Zhang H, Jin Y, Wang Q, Chen L, Feng Z, *et al*. Butein inhibits IL-1β-induced inflammatory response in human osteoarthritis chondrocytes and slows the progression of osteoarthritis in mice. Int Immunopharmacol 2017;42:1-10.
61. Roh K, Lee JH, Kang H, Park KW, Song Y, Lee S, *et al*. Synthesis and evaluation of butein derivatives for *in vitro* and *in vivo* inflammatory response suppression in lymphedema. Eur J Med Chem 2020;197:112280.
62. Wang Z, Lee Y, Eun JS, Bae EJ. Inhibition of adipocyte inflammation and macrophage chemotaxis by butein. Eur J Pharmacol 2014;738:40-8.
63. Pandey R, Gautam AK, Bhargavan B, Trivedi R, Swarnkar G, Nagar GK, *et al*. Total extract and standardized fraction from the stem bark of *Butea monosperma* have osteoprotective action: Evidence for the nonestrogenic osteogenic effect of the standardized fraction. Menopause 2010;17:602-10.
64. Taneja I, Raju KS, Challagundla M, Raghuvanshi A, Goel A, Wahajuddin M. LC-ESI-MS/MS method for bioanalytical determination of osteogenic phytoalexin, medicarpin, and its application to preliminary pharmacokinetic studies in rats. J Chromatogr B Analyt Technol Biomed Life Sci 2015;1001:9-16.
65. Maurya R, Yadav DK, Singh G, Bhargavan B, Murthy PS, Sahai M, *et al*. Osteogenic activity of constituents from *Butea monosperma*. Bioorg Med Chem Lett 2009;19:610-3.
66. El-Halawany AM, El Dine RS, Chung MH, Nishihara T, Hattori M. Screening for estrogenic and antiestrogenic activities of plants growing in Egypt and Thailand. Pharmacognosy Res 2011;3:107-13.
67. Bhargavan B, Gautam AK, Singh D, Kumar A, Chaurasia S, Tyagi AM, *et al*. Methoxylatedisoflavones, cajanin and isoformononetin, have non-estrogenic bone forming effect via differential mitogen activated protein kinase (MAPK) signaling. J Cell Biochem 2009;108:388-99.
68. Raghavan RN, Somanathan N, Sastry TP. Evaluation of phytochemical-incorporated porous polymeric sponges for bone tissue engineering: A novel perspective. Proc Inst Mech Eng H 2013;227:859-65.
69. Srivastava K, Khan K, Tyagi AM, Khan MP, Yadav DK, Trivedi R, *et al*. Greater Skeletal Gains in ovary intact rats at maturity are achieved by supplementing a standardized extract of *Butea monosperma* stem bark that confers better bone conserving effect following

ovariectomy and concurrent treatment withdrawal. Evid Based Complement Alternat Med 2013;2013:519387.
70. Thiagarajan VR, Shanmugam P, Krishnan UM, Muthuraman A, Singh N. Ameliorative potential of *Butea monosperma* on chronic constriction injury of sciatic nerve induced neuropathic pain in rats. An Acad Bras Cienc 2012;84:1091-104.
71. Khan K, Sharan K, Swarnkar G, Chakravarti B, Mittal M, Barbhuyan TK, *et al*. Positive skeletal effects of cladrin, a naturally occurring dimethoxydaidzein, in osteopenic rats that were maintained after treatment discontinuation. Osteoporos Int 2013;24:1455-70.
72. Malik J, Kumar M, Deshmukh R, Kumar P. Ameliorating effect of lyophilized extract of *Butea frondosa* leaves on scopolamine-induced amnesia in rats. Pharm Biol 2013;51:233-9.
73. Dixit P, Prakash T, Karki R, Kotresha D. Anti-obese activity of *Butea monosperma* (Lam) bark extract in experimentally induced obese rats. Indian J Exp Biol 2012;50:476-83.
74. Hemmeryckx B, Vranckx C, Bauters D, Lijnen HR, Scroyen I. Does butein affect adipogenesis? Adipocyte 2019;8:209-22.
75. Nile SH, Park SW. HPTLC analysis, antioxidant and antigout activity of Indian plants. Iran J Pharm Res 2014;13:531-9.
76. Thiagarajan VR, Shanmugam P, Krishnan UM, Muthuraman A, Singh N. Antinociceptive effect of *Butea monosperma* on vincristine-induced neuropathic pain model in rats. Toxicol Ind Health 2013;29:3-13.
77. Abu Bakar FI, Abu Bakar MF, Rahmat A, Abdullah N, Sabran SF, Endrini S. Anti-gout Potential of Malaysian Medicinal Plants. Front Pharmacol. 2018;9:261.
78. Forouzanfar F, Hosseinzadeh H. Medicinal herbs in the treatment of neuropathic pain: A review. Iran J Basic Med Sci 2018;21:347-58.
79. Sumitra M, Manikandan P, Suguna L. Efficacy of *Butea monosperma* on dermal wound healing in rats. Int J Biochem Cell Biol 2005;37:566-73.
80. Tarannum S, Mohamed R, Vishwanath BS. Inhibition of testicular and Viperarusselli snake venom hyaluronidase activity by *Butea monosperma* (Lam) Kuntze stem bark. Nat Prod Res 2012;26:1708-11.
81. Iqbal Z, Lateef M, Jabbar A, Ghayur MN, Gilani AH. *In vivo* anthelmintic activity of *Butea monosperma* against Trichostrongylid nematodes in sheep. Fitoterapia 2006;77:137-40.
82. Manna MC, Jha S, Ghosh PK, Acharya CL. Comparative efficacy of three epigeic earthworms under different deciduous forest litters decomposition. Bioresour Technol 2003;88:197-206.
83. Kasture VS, Kasture SB, Chopde CT. Anticonvulsive activity of *Butea monosperma* flowers in laboratory animals. Pharmacol Biochem Behav 2002;72:965-72.
84. Prashanth D, Asha MK, Amit A, Padmaja R. Anthelmintic activity of *Butea monosperma*. Fitoterapia 2001;72:421-2.
85. Mishra M, Shukla YN, Kumar S. Euphane triterpenoid and lipid from constituents *Butea monosperma*. Phytochemistry 2000;54:835-8.
86. Kasture VS, Chopde CT, Deshmukh VK. Anticonvulsive activity of *Albizzia lebbeck*, *Hibiscus rosasinesis* and *Butea monosperma* in experimental animals. J Ethnopharmacol 2000;71:65-75.
87. Chaudhury RR. The quest for a herbal contraceptive. Natl Med J India 1993;6:199-201.
88. Johri RK, Pahwa GS, Sharma SC, Zutshi U. Determination of estrogenic/antiestrogenic potential of antifertility substances using rat uterine peroxidase assay. Contraception 1991;44:549-57.
89. Bhargava SK. Estrogenic and postcoital anticonceptive activity in rats of butin isolated from *Butea monosperma* seed. J Ethnopharmacol 1986;18:95-101.
90. Tandon R, Shivanna KR, Ram HY. Reproductive biology of *Butea monosperma* (*Fabaceae*). Ann Bot 2003;92:715-23.
91. Rani P, Khullar N. Antimicrobial evaluation of some medicinal plants for their anti-enteric potential against multi-drug resistant *Salmonella typhi*. Phytother Res 2004;18:670-3.
92. Randhawa HS, Mussa AY, Khan ZU. Decaying wood in tree trunk hollows as a natural substrate for *Cryptococcus neoformans* and other yeast-like fungi of clinical interest. Mycopathologia 2001;151:63-9.
93. Shakoor A, Zaib G, Rahman A. Biological activities of three medicinal plants from district Mirpur, AJK, Pakistan. Pak J Pharm Sci 2018;31:2341-6.
94. Mehta BK, Dubey A, Bokadia MM, Mehta SC. Isolation and *in vitro* antimicrobial efficiency of *Butea monosperma* seed oil on human pathogenic bacteria and phytopathogenic fungi. Acta Microbiol Hung 1983;30:75-7.
95. Bandara BM, Kumar NS, Samaranayake KM. An antifungal constituent from the stem bark of *Butea monosperma*. J Ethnopharmacol 1989;25:73-5.
96. Yadava RN, Tiwari L. A potential antiviral flavone glycoside from the seeds of *Butea monosperma* O. Kuntze. J Asian Nat Prod Res 2005;7:185-8.
97. Yadava RN, Tiwari L. New antifungal flavone glycoside from *Butea monosperma* O. Kuntze. J Enzyme Inhib Med Chem 2007;22:497-500.
98. Malpani MO, Rajput PR, Mane VD, Deshpande AR. Phytochemical screening, *Characterization* and *in vitro* antimicrobial activity of *Butea monosperma* flower, leaves and gum: Methanolic and aqueous extract. Int J Chem Res 2012;3:17-20.
99. Gunakkunru A, Padmanaban K, Thirumal P, Pritila J, Parimala G, Vengatesan N, *et al*. Anti-diarrhoeal activity of *Butea monosperma* in experimental animals. J Ethnopharmacol 2005;98:241-4.
100. Agarwal AK, Tripathi DM, Sahai R, Gupta N, Saxena RP, Puri A, *et al*. Management of giardiasis by a herbal drug "PippaliRasayana": A clinical study. J Ethnopharmacol 1997;56:233-6.

101. Agarwal AK, Singh M, Gupta N, Saxena R, Puri A, Verma AK, *et al*. Management of giardiasis by an immuno-modulatory herbal drug Pippalirasayana. J Ethnopharmacol 1994;44:143-6.
102. Wongkham S, Taketa K, Liu M, Taga H. Affinity electrophoretic determination of oligosaccharide specificity of *Butea monosperma* agglutinin. Electrophoresis 1996;17:98-103.
103. Sharma RD, Veerpathran AR, Dakshinamoorthy G, Sahare KN, Goswami K, Reddy MV. Possible implication of oxidative stress in anti filarial effect of certain traditionally used medicinal plants *in vitro* against *Brugia malayi* microfilariae. Pharmacognosy Res 2010;2:350-4.
104. Sahare KN, Anandharaman V, Meshram VG, Meshram SU, Gajalakshmi D, Goswami K, *et al*. *In vitro* effect of four herbal plants on the motility of *Brugiamalayi* microfilariae. Indian J Med Res 2008;127:467-71.
105. Fan Q, Li X, Wei C, Wang P, Sun H, Zheng S, *et al*. Extraction, structure characterization and biological activity determination of (S)-(-)-palasonin from *Butea monosperma* (Lam.) Kuntze seeds. Ind Crops Prod 2022;187A:115393.
106. Deepa B, Remadevi OK. Insecticidal activity of the phyto-extracts derived from different parts of the trees of Fabaceae family against *Hyblaea puera* Cramer (*Lepidoptera*: *Hyblaeidae*). Int J 2011;3:1-8.
107. Ahmad M, Sharif H, Mahboob A, Mehjabeen, Jahan N, Sherwani SK, Standardization and toxicological studies of *Butea frondosa* methanolic seeds extract Am J Res Commun 2013;1:42-55.
108. Ananth S, Thangamathi P. Larvicidal efficacy of fabricated silver nanoparticles from *Butea monosperma* flower extract against dengue vector, *Aedesa egypti.* Int J Biol Sci 2018;8:20-9.
109. Agarkar SA, Kulkarni RR, Dhas VV, Chinchansure AA, Hazra P, Joshi SP, *et al*. Isobutrin from *Butea monosperma* (flame of the forest): A promising new natural sensitizer belonging to chalcone class. ACS Appl Mater Interfaces 2011;3:2440-4.
110. Tripathi D, Kulkarni S. Can Butein be a Future Candidate for the Treatment of Advance Metastatic Thyroid Cancer? J Cancer Immunol. 2022;4:43-46.

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