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Review Article

***Butea monosperma* (Palash): A Comprehensive Review of its Botany, Phytochemistry, and Pharmacological Potential**

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ABSTRACT

This review highlights the substantial pharmacological potential and extensive ethnobotanical significance of *Butea monosperma* (Lam.) Taub, commonly known as Palash or Flame of the Forest, is a deciduous tree of the family Fabaceae native to the Indian subcontinent and Southeast Asia. The accumulated evidence supports its prospective incorporation into contemporary therapeutic systems, as the plant has been traditionally employed in Ayurveda and indigenous medicine for the management of diverse ailments including diabetes, cancer, gastrointestinal disorders, inflammation, skin diseases, fever, and jaundice. Recent pharmacological studies have substantiated many of these traditional claims, demonstrating a wide range of bioactivities such as hepatoprotective, antidiabetic, anticancer, anti-inflammatory, antioxidant, antimicrobial, and anti-asthmatic effects, which are largely attributed to its rich phytochemical profile comprising flavonoids, lactones, diterpenoids, diterpene glycosides, and phytosterols, along with the therapeutically valuable red exudate known as *Butea* gum or Bengal kino obtained from its bark. Furthermore, the findings emphasize the necessity for systematic conservation and sustainable utilization strategies, as *B. monosperma* is increasingly threatened by habitat degradation, overexploitation, and climate change, and its preservation is essential for continued pharmacological research and drug development.

INTRODUCTION

Butea monosperma (Lam.) Taub, commonly known as Palash or “Flame of the Forest,” is a medium-sized deciduous tree of the Fabaceae family, native to India, Bangladesh, Sri Lanka, and Southeast Asia. Traditionally revered in Ayurveda

and Vedic texts, it has been used to treat a variety of ailments and is recognized as a valuable source of natural therapeutics. Rapid population growth and unintended pregnancies have highlighted the urgent need for safe and effective male contraceptives. Conventional options, such as condoms and vasectomy, have limitations, while

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emerging hormonal and non-hormonal methods may cause undesirable side effects. Plant-based alternatives have gained attention, and *B. monosperma* has demonstrated antifertility effects in males, likely due to bioactive compounds influencing reproductive parameters and steroidogenic activity (Parween et al. 2022).

Plants have served as primary sources of medicine for centuries, with nearly 80% of the global population relying on herbal remedies (Ambastha et al. 2023). Many plants produce phenolic compounds that exhibit antioxidant, anti-inflammatory, antimicrobial, and anticancer properties. *B. monosperma* contains flavonoids, chalcones, glycosides, steroids, and triterpenes in its flowers, bark, gum, and roots, which exhibit anticancer, antidiabetic, anti-hepatotoxic, antihelminthic, and other medicinal activities (salar& seasotiya et al. 2011).

Oxidative stress induced by reactive oxygen species (ROS) is a major contributor to degenerative diseases, including liver disorders and cancer. Polyphenolic compounds from *B. monosperma* counteract oxidative stress and modulate the PI3K/Akt/mTOR signaling pathway, providing hepatoprotective and chemopreventive effects (Kaura et al. 2017). In addition, the plant exhibits anti-inflammatory, analgesic, anticonvulsant, and neuroprotective activities, largely attributed to bioactive compounds such as butrin and butein. Different plant parts show

diverse pharmacological effects: roots (anti-parasitic, antifertility), leaves (antimicrobial, antifilarial), flowers (antioxidant, anticancer, antidiabetic), bark (hepatoprotective, anti-ulcer), and seeds/fruits (antidiabetic, protease inhibition) (Shahriar et al., 2015). These pharmacological properties underscore *B. monosperma* as a promising medicinal plant with potential applications in reproductive health, oxidative stress-related disorders, inflammation, and cancer prevention, warranting further pharmacological, mechanistic, and clinical studies.

1.1 Botanical Classification:

Botanical classification is essential for accurately identifying and naming plants, enabling clear scientific communication. It helps in understanding plant relationships, guiding medicinal research, conservation, and sustainable use of plant resources.

Table no 1.1: Botanical classification

Taxonomic Rank	Classification
Domain	Eukaryote
Kingdom	Plantae
Class	Magnoliopsida
Order	Fabales
Family	<i>Fabaceae</i>
Genus:	<i>Butea</i>
Division:	Magnoliophyta
Species	<i>Monosperma</i>

1.2 Macroscopy Study of *Butea Monosperma* Species.

Table no.1.2: Macroscopy study of *Butea monosperma* Species.

Sr. No.	Features	Leaf	Stem bark	Flower
1	Colour	Dark green or light green	Greyish brown to dark brown	Bright orange to red
2	Odor	None	Characteristic	Slightly characteristic
3	Surface	Smooth with fine hairs	Rough and cracks	Smooth
4	Texture	Leathery	Hard, fibrous	Soft and fleshy
5	Taste	Astringent and Slightly Bitter	Bitter	Astringent and slightly sweet



1.3 Botanical Description:

Table no.1.3: Botanical Description

Category	Description
Taxonomy	Kingdom: plantae, order: Fabales, family: Fabaceae, genus: <i>butea</i> , species: <i>butea monosperma</i> .
Synonyms	<i>Butea frondosa</i> Roxb ex Willd, <i>Erythrina monosperma</i> Lam, <i>Plaso monosperma</i>
Common names	Palash (India), Muthugada mara (Karnataka), flame of the forest (English), Tesu, Dhak (Hindi)
Habit	An erect, medium-sized tree (12–15 m) with irregular branches, rough ash-colored bark, and downy young parts.
Stem\bark	Erect stem 12–15 m tall with irregular branches; bark rough, ash- colored, young parts downy.
Leaves	Trifoliate, 10–20 cm, green, Stout petiole, lanceolate stipules, upper glabrous, lower silky-veined, deciduous stipels.
Flowers	Orange/salmon, 3.8–5 cm, in 15 cm racemes, velvety
Pods	Flat, brown, 12.5–20 × 2.5–5 cm, stalk 2 cm
Flowering season	February-April
Distribution	Tropical & subtropical India, South Asia, Indonesia, Japan, Laos, Myanmar, Nepal, Sri Lanka, Thailand, and Vietnam.
Habitat	It thrives in open grasslands and mixed forests, growing well on a wide range of soils from loamy and clay to gravelly, saline, and waterlogged.
Distinguish features	<i>Butea monosperma</i> : medium tree, bright orange flowers, trifoliate leaves, rough bark, single-seeded pods.

1.4 Distribution

Butea monosperma (Lam.) is a widely distributed medium-sized deciduous tree of South and Southeast Asia, commonly found on grasslands and mixed forests up to 1200 m, adaptable to various soils and climates, with seedlings thriving in rich loamy soil; it is the most common of the four *Butea* species, which include trees, shrubs, and lianas.

1.5 Propagation and Cultivation

Butea monosperma is commonly found in the drier regions of India and is drought tolerant. It grows in areas receiving 450–4500 mm annual rainfall and adapts to various soil types, including black cotton, clay loam, shallow, and waterlogged soils. The plant reproduces through seeds and root suckers. Seedlings grow best in loamy soil (pH 6–7) under warm and humid conditions. Cultivation

is carried out by sowing pods 25–30 cm apart or raising seedlings in nurseries at 10 × 10 cm spacing, followed by transplantation during the rainy season. Air layering is used for rapid clonal propagation, and better seedling growth has been reported in black soil. (Sourabh Jain et.al2020)

1.6 Traditional Uses

Butea monosperma has been traditionally used in Ayurveda, folk medicine, and cultural practices across India. Different parts of the plant are valued for their medicinal properties: the flowers are used as a blood purifier and to treat diarrhoea, dysentery, skin diseases, and wounds, and they are also used to produce natural dyes and colour for festivals like Holi. The seeds are traditionally used as a vermifuge to expel intestinal worms, while the bark is valued for its astringent properties and is used in the treatment of ulcers, menstrual disorders, and inflammatory conditions. The



leaves are used externally for boils, swelling, and skin problems and are also traditionally used as biodegradable plates during religious and social ceremonies. In addition to its medicinal uses, *Butea monosperma* holds cultural and religious significance and contributes economically through its use in dye-making, tanning, fodder, and fuel (Sourabh Jain et. al. 2020).

1.7 Common Preparation Methods:

Traditionally, various parts of *Butea monosperma* are prepared using simple and cost-effective techniques in Ayurveda and folk medicine.

Butea monosperma is traditionally prepared in various forms depending on the plant part used and the intended therapeutic application. The leaves are commonly used as decoctions, poultices, or ash to treat ulcers, wounds, and skin ailments. The

vibrant flowers are often dried and powdered or used as infusions and pastes for managing diarrhoea, urinary disorders, and as general tonics. Seeds are ground into powders or made into pastes for treating skin infections and parasitic infestations. The bark is typically used in powdered or decocted form, and its red resinous exudate, known as Bengal kino or Butea gum is dissolved in water or honey to address diarrhoea, sore throat, and as a cooling agent. Additionally, root decoctions are employed in traditional remedies for conditions like filariasis and night blindness. These diverse preparations reflect the plant's deep integration into Ayurvedic and folk medicinal systems. (Roshan S, et al. 2017.)

2. PHYTOCHEMISTRY

2.1 Phytochemical constituents of *butea monosperma* :

Table no.2.1 Phytochemical constituents of butea monosperma

Plant part	Phytoconstituents identified	References
Leaves	Glucoside, oleic acid, linolic acid, palmitic acid, lignoceric acid, and kino-oil	Khursheed, Jabin, Jilani, Azam &Javed(2023)
Flowers	Triterpene, butein, butin, isobutrin, coreopsin, isocoreopsin,(butin7glucoside), sulphurein, isomonospermoside monospermoside (butein 3-e-D-glucoside), chalkiness, aureoles, flavonoids(palasintrin,prunetin) and steroids.	Dwivedi, Kumar,et.al (2015)
Steam	Terpenoids, steroids, and long- chain fatty acids.3-z-hydroxyeuph-25-ene.	Lahori & Jain(2020)
Seeds	Fixed oil, proteolytic &lipolytic enzymes, proteinase - polypeptidase, palasonin,nitrogenous acidic compound, glycosides(monospermoside).	Dwivedi , kumar,et.al(2015).
Bark	Phenolics, flavonoids, glycosides, terpenoids, sterols, and fatty acid derivatives.	Somayaji,A, & Hegde,K.(2016).

2.2 Phytochemical parameters

Table no.2.2 Phytochemical parameters

Parameters	Results (% w/w)	References
Loss on drying at 1050C	4.39	Mahesh Babu TM, Vijayalakshmi A, Narasimha V. 2017
Total ash value	5.82	Mahesh Babu TM, Vijayalakshmi A, Narasimha V. 2017
Acid insoluble ash	1.07	Mahesh Babu TM, Vijayalakshmi A, Narasimha V. 2017
Water insoluble ash	0.78	Mahesh Babu TM, Vijayalakshmi A, Narasimha V. 2017
Water soluble extractive	28	Mahesh Babu TM, Vijayalakshmi A, Narasimha V. 2017
Alcohol soluble extractive	14.21	Mahesh Babu TM, Vijayalakshmi A, Narasimha V. 2017



2.3 Quantitative estimation of phytochemical constituents in *butea monosperma*

Table no. 2.3 Quantitative estimation of phytochemical constituents in *butea monosperma*.

Sr. No	Phytoconstituents	Leaves (mg/kg)	Flowers (mg/kg)	Stem/Bark (mg/kg)	Seeds (mg/kg)	References
1	Total alkaloids	1.5–2.0	0.8–1.2	1.2–1.8	0.5–0.8	Dwivedi R, Kumar S, et al., 2015; Lahori P, Jain S, 2020
2	Total flavonoids	2.5–3.2	4.0–5.0	1.8–2.4	1.0–1.5	Dwivedi R, Kumar S, et al., 2015; Lahori P, Jain S, 2020
3	Tannins	0.8–1.1	1.0–1.3	0.9–1.2	0.4–0.7	Somayaji A, Hegde K, 2016
4	Glycosides	0.2–0.4	0.5–0.8	0.3–0.5	0.1–0.2	Dwivedi R, Kumar S, et al., 2015
5	Sterols / Steroid glycosides	0.1–0.3	0.3–0.5	0.2–0.4	0.1–0.2	Shukla et al., 2000; Lahori P, Jain S, 2020
6	Phenols	1.5–2.5	2.0–3.5	1.2–2.0	0.8–1.5	Salar RK, Seasotiya L, et al., 2011
7	Terpenoids/ Triterpenoids	0.5–0.8	0.7–1.2	0.4–0.6	0.3–0.5	Guha et al., 1990; Lahori P, Jain S, 2020

3. PHARMACOLOGICAL POTENTIAL

3.1 ANTIOXIDANT AND FREE RADICAL SCAVENGING:

Butea monosperma exhibits significant pharmacological activity. The stem bark shows strong antioxidant and free radical scavenging effects, with acetone and methanol extracts being most potent due to high phenolic content (Salar & Seasotiya, 2012). The flower extracts, rich in butein, also display antioxidant activity and pro-apoptotic effects, indicating potential anticancer properties (Sehrawat & Kumar, 2012). Overall, both stem bark and flowers support therapeutic applications in oxidative stress-related disorders.

3.2 HEPATOPROTECTIVE ACTIVITY :

Butea monosperma bark exhibits marked hepatoprotective pharmacological activity against thioacetamide-induced liver injury in experimental rats. The ethyl acetate fraction of the bark showed strong antioxidant properties, including superoxide radical scavenging and

inhibition of lipid peroxidation. Pretreatment with the extract significantly normalized altered serum biochemical markers such as SGOT, SGPT, ALP, bilirubin, and albumin. It also restored hepatic antioxidant enzymes including SOD, CAT, GSH, and GR. Histopathological studies further confirmed the protection of liver architecture from toxic damage. These findings suggest that the hepatoprotective effect of *B. monosperma* bark is mainly mediated through its antioxidant mechanism and supports its traditional use in liver disorders (Kaur et.al.,2017).

3.3 ANTIOXIDANT AND ANTICONVULSANT ACTIVITIES :

The crude flavonoid fraction from *Butea monosperma* leaves exhibits potent antioxidant and anticonvulsant activities. In vitro studies showed strong DPPH radical scavenging (88.86%), reducing power, and nitric oxide scavenging (87.98%) (Bala et.al.,2023) . In vivo, it significantly reduced seizure duration and incidence in maximal electroshock-induced seizures and increased latency and protection in



pentylentetrazole-induced seizures in rats, in a dose-dependent manner (Bala et.al., 2023). These effects are likely due to its antioxidant properties and neuroprotective potential, suggesting therapeutic potential in epilepsy and oxidative stress-related neurological disorders.

3.4 ANTIMICROBIAL ACTIVITY:

The leaves of *Butea monosperma* exhibit significant antimicrobial activity against gram-positive and gram-negative bacteria, as well as fungi (Ambastha et al., 2023). Ethanol and methanol extracts showed broad-spectrum, dose-dependent effects, with bioactive compounds such as Dodecane, Phytol, Squalene, and Lup-20(29)-en-3-one responsible for activity. Additionally, aqueous and alcoholic leaf extracts inhibited growth of five bacterial and two fungal strains, demonstrating strong antimicrobial potential (Goyal et al., 2019). These studies highlight the presence of phytochemicals contributing to antimicrobial effects and support the traditional use of *Butea monosperma* leaves as natural antimicrobial agents.

3.5 ANTICANCER ACTIVITY:

Butea monosperma exhibits anticancer activity, specifically against breast cancer, demonstrated through both in-vitro and in-vivo models. In vitro studies showed that extracts of the plant inhibited proliferation of breast cancer cell lines and induced apoptosis. In vivo experiments using animal models revealed a significant reduction in tumor growth and tumor volume, along with modulation of biochemical markers associated with cancer progression. These effects are attributed to the presence of bioactive phytochemicals such as flavonoids, polyphenols, and other secondary metabolites, which exert antioxidant, pro-apoptotic, and cytotoxic effects. The study supports the potential of *Butea*

monosperma as a natural therapeutic agent for breast cancer management.(Karia et.al.,2018).

3.6 ANTIFERTILITY ACTIVITY:

The methanolic extract of *Butea monosperma* (Lam.) Taub. flower has demonstrated significant antifertility activity in male albino rats. Oral administration at 500 mg/kg body weight/day for 180 days caused a 40% reduction in fertility, accompanied by decreased testicular and epididymal weights, reduced sperm count, motility, and viability, and histological disruptions in germ cell arrangement at various stages of spermatogenesis. Notably, these effects were reversible after a 45-day withdrawal period, suggesting that the extract exerts its antifertility effects via reversible impairment of spermatogenesis and sperm quality rather than permanent hormonal disruption. These findings indicate that *B. monosperma* flower extract has potential as a safe, herbal male contraceptive (Parween et al., 2021).

3.7 ANTIDIABETIC ACTIVITY:

Butea monosperma (Lam.) Taub. has demonstrated significant antidiabetic activity in experimental studies. Its extracts, rich in flavonoids, polyphenols, and other bioactive compounds, have been shown to reduce blood glucose levels, improve insulin sensitivity, and enhance antioxidant status in diabetic animal models. The plant also helps prevent oxidative stress-induced damage to pancreatic β -cells and other tissues, contributing to its protective effects in diabetes management. These findings suggest that *B. monosperma* could serve as a promising herbal adjunct in the prevention and treatment of diabetes (Parween et al., 2021)

3.8 ANTIHELMINTHIC ACTIVITY:



Butea monosperma (Lam.) Taub. has demonstrated significant antihelminthic activity in experimental studies. Alcoholic and aqueous extracts of its leaves, roots, and seeds have been shown to cause paralysis and death of adult worms, such as *Pheretima posthuma*, and reduce egg counts in nematode-infected animals, indicating potent in vitro and in vivo anthelmintic effects. These activities are attributed to the plant's phytochemicals, including flavonoids and tannins, which interfere with parasite metabolism and motility, highlighting its potential as a natural anthelmintic agent (Kushwah & Kayande, 2014).

3.9 ANTI-ASTHMATIC ACTIVITY:

Butea monosperma (Lam.) Taub. exhibits potential anti-asthmatic activity, likely through its anti-inflammatory and broncho-modulatory effects, as indicated by studies showing that the *n*-butanolic fraction of its extract can significantly inhibit lipopolysaccharide-induced increases in total cell count, nitrate/nitrite, total protein, and albumin levels in bronchoalveolar lavage fluid in rat models of airway inflammation, suggesting attenuation of respiratory inflammatory responses relevant to asthma pathophysiology (Shirole et al., 2013).

3.10 ANTIDEPRESSANT ACTIVITY :

Butea monosperma (Lam.) Taub. has demonstrated potential antidepressant activity in preclinical studies. Methanolic and ethanolic extracts of the plant exhibit central nervous system depressant and mood-modulating effects in stress- and depression-related animal models, likely due to the presence of flavonoids and chalcones that influence neurotransmitter activity. These findings suggest that *B. monosperma* could serve as a promising herbal candidate for managing depressive disorders (Boya et al., 2025).

3.11 WOUND HEALING ACTIVITY :

Butea monosperma (Lam.) Taub. has shown significant wound healing activity in experimental studies. Topical application of its leaf and flower extracts accelerates wound contraction, epithelization, and collagen synthesis in incision and excision wound models in rats. The plant's flavonoids, tannins, and other bioactive compounds promote tissue regeneration and possess antioxidant and antimicrobial properties, contributing to faster wound repair and reduced infection risk (Kumari et al., 2018).

3.12 ANTI-DIARRHOEAL ACTIVITY :

Butea monosperma (Lam.) Taub. has demonstrated significant anti-diarrhoeal activity in experimental animal models. Ethanolic and aqueous extracts of the stem bark markedly inhibited castor oil-induced diarrhoea, reduced gastrointestinal motility, and decreased enteropooling, indicating its ability to suppress diarrhoeal symptoms and normalize gut function. These effects are attributed to the plant's astringent phytochemicals, such as flavonoids and polyphenols, which help restore intestinal integrity and reduce fluid loss, supporting its traditional use for diarrhoea management (Venkatesan et al., 2005).

3.13 ANTI-INFLAMMATORY ACTIVITY:

Methanolic extract of *Butea monosperma* flowers (MEBM) exhibits significant anti-inflammatory activity in albino rats. Oral administration of MEBM at 600 and 800 mg/kg dose-dependently inhibited carrageenan-induced paw edema and significantly reduced granuloma tissue formation in the cotton pellet model. The extract also lowered serum lysosomal enzymes (SGOT, SGPT, ALP) and lipid peroxides, indicating its efficacy in

suppressing both acute and chronic inflammation (Shahavi & Desai, 2007).

3.14 ANTIMICROBIAL ACTIVITY:

Butea monosperma (Lam.) Taub. exhibits significant antimicrobial activity, with methanolic, acetone, and aqueous extracts of its leaves and flowers showing inhibitory effects against pathogenic bacteria such as *Staphylococcus aureus*, *Bacillus cereus*, and *Bacillus subtilis*. Phytochemical analysis revealed the presence of secondary metabolites including flavonoids, tannins, and other bioactive compounds, which are likely responsible for the antimicrobial effects. These findings highlight the plant's potential as a natural alternative to chemical antimicrobial agents, supporting its traditional medicinal use and the development of herbal therapeutics (Dave et al., 2019).

3.15 ANTI-ALZHEIMER'S ACTIVITY :

Butea monosperma leaves show notable anti-Alzheimer's activity, as hydroalcoholic extract (100 and 200 mg/kg) significantly improved memory and learning in streptozotocin-induced Alzheimer's rats, reduced brain acetylcholinesterase levels, and enhanced cholinergic neurotransmission, effects attributed to neuroprotective phytoconstituents such as flavonoids, alkaloids, and phenolic compounds (Joshi & Malviya, 2019).

3.16 ANTI-HYPERGLYCEMIC ACTIVITY:

Butea monosperma leaves show significant anti-hyperglycemic activity, as ethanolic extracts (100–400 mg/kg) dose-dependently reduced blood glucose in adrenaline-induced and high-glucose-fed diabetic rabbits, with the highest dose (400 mg/kg) being most effective. The effect is attributed to flavonoids, tannins, phenols, and saponins, which enhance insulin secretion,

improve glucose utilization, and inhibit intestinal absorption, supporting its traditional use in diabetes management (Ray et al., 2017).

3.17 NEPHROPROTECTIVE ACTIVITY :

Butea monosperma exhibits nephroprotective activity against cisplatin-induced kidney damage, as pre- or post-treatment with its ethanolic extract (200–400 mg/kg) in rats significantly reduced plasma creatinine, uric acid, and blood urea nitrogen, lowered malondialdehyde, and improved antioxidant enzyme levels (glutathione, catalase, glutathione peroxidase). Histopathology confirmed protection of renal tissue, with pre-treatment being more effective, likely due to the antioxidant phytochemicals present in the plant (Bajaj et al., 2019).

4. CONCLUSION

Butea monosperma (Lam.) Taub. emerges from this review as a highly valuable medicinal tree with multifaceted biological, ecological, and socio-cultural significance. Extensive ethnobotanical usage supported by modern pharmacological investigations confirms that different parts of the plant leaves, flowers, bark, seeds, and roots possess a wide spectrum of therapeutic activities. These include antioxidant, hepatoprotective, antidiabetic, antifertility, anticancer, antimicrobial, anti-inflammatory, anticonvulsant, neuroprotective, nephroprotective, wound healing, and anti-asthmatic effects, largely attributed to its rich phytochemical profile comprising flavonoids, chalcones, phenolics, glycosides, terpenoids, sterols, and tannins.

Experimental in vitro and in vivo studies have validated many traditional claims, highlighting the plant's potential role in managing oxidative stress related disorders, metabolic diseases, reproductive health, inflammatory conditions, and



neurodegenerative disorders. Notably, the reversible antifertility activity observed in male models underscores the promise of *B. monosperma* as a candidate for the development of safe, plant-based male contraceptives. The presence of potent antioxidant and bioactive compounds further strengthens its relevance in preventive and adjunctive therapy for chronic diseases.

Despite its therapeutic promise, *Butea monosperma* faces increasing threats from habitat loss, overexploitation, and environmental change. Therefore, sustainable harvesting practices, conservation strategies, and cultivation programs are essential to preserve this species. Future research should focus on detailed mechanistic studies, standardization of extracts, toxicity evaluation, and well-designed clinical trials to translate its traditional and experimental potential into evidence-based pharmaceutical applications. Overall, *Butea monosperma* represents a promising natural resource that bridges traditional knowledge and modern medicine, with significant scope for drug discovery and sustainable healthcare development.

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