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EXPLORING THE PHARMACOLOGICAL AND PHYTOCHEMICAL PROPERTIES OF *TECOMA ALATA*: A COMPREHENSIVE REVIEW

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ABSTRACT

The objective of the present investigation is to evaluate the pharmacological characteristics of alcohol and *Tecoma alata* (Bignoniaceae) aqueous extracts. Yellow trumpetbush, or *Tecoma alata*, is a flowering plant in the Bignoniaceae family that has been used historically for therapeutic purposes. Its varied pharmacological activities have been brought to light by recent studies. The plant demonstrates noteworthy antimicrobial characteristics, efficiently counteracting diverse bacterial and fungal infections. Bioactive substances like flavonoids and phenolics are responsible for their anti-inflammatory and antioxidant properties, which further enhance their capacity to fend off oxidative stress and chronic illnesses. Tecoma alata also offers potential antidiabetic benefits by controlling blood sugar levels. The plant may be able to protect the liver from illnesses and toxins due to its hepatoprotective qualities. Its cytotoxic effects against specific cancer cell lines are indicated by preliminary studies, suggesting that it may have anticancer potential. *Tecoma alata* has long been used to treat fever and pain, and this use is further supported by its analgesic and antipyretic properties. It will take more investigation, including clinical trials, to validate these advantages and guarantee secure therapeutic uses.

KEYWORDS: *Tecoma alata*, Bignoniaceae, Antimicrobial properties, Anti-inflammatory, Antioxidant,Antidiabetics, Traditional medicine, Bioactive compounds.

INTRODUCTION

One cultivar name is "Orange Jubilee." According to one account, Orange Bells are a cross between Yellow Trumpetbush (Tecoma stans) and Cape Honeysuckle (Tecoma capensis). The plant belongs to the Bigoniaceae or Trumpet Creeper Family, which consists primarily of tropical trees and shrubs. Flaming Bells, Orange Star, Orange Trumpet Bush, and Tecoma Orange Jubilee are some more common names. 'Orange Jubilee' is a variety. Alata is the Latin name for the species, meaning "winged" or having furnished with wings.[1]

While Tecoma alata and other Tecoma species, like Tecoma stans, belong to the same genus, it's vital to remember that each species may have different pharmacological properties and chemical makeup. It even though there may be some overlap in activity due to comparable phytochemicals or similar biological features. *Tecoma stans* is a potent diuretic, vermifuge, and tonic that is used as an herbal remedy for diabetes, digestive issues, and yeast infections. This plant has been shown to contain tannins, flavonoids, alkaloids, quinones, and trace amounts of amino acids and saponins, according to preliminary phytochemical screening. Most leaf extracts contained phenolic chemicals, flavonoids, tannins, alkaloids, and saponins, according to the results. A small number of plants also displayed glycoside, phytate, and vitamin C. Although it is indigenous to Mexico and Central America, it has been brought to and grown in many other parts of the world, including India. It grows in parks, gardens, and occasionally even in the wild in areas that are ideal for it in India. It is frequently planted as an ornamental plant in gardens and landscapes across the nation because of its valued attractive qualities, especially its vivid orange blossoms.[2]

One of the greatest health issues facing the world today is pain and inflammation. An overabundance of inflammation can cause septic shock, which can result in multiple organ dysfunction syndrome and even death.[3]

In Charak, Sushruta, the root, bark, stem, and leaf of some Bignoniaceae species are used to treat snake bites, while the stem and wood are used to treat scorpion stings. In Bangladesh, the whole plant of Tecoma gaudichaudi DC is used as a remedy for diabetes and infertility.[4]

While Tecoma alata has shown promising biological activities in various studies, these are the biological activities associated with other species of Tecoma: Antioxidant, Antimicrobial, Wound healing properties, Antidiabetic, Anti-cancer activity and various other biological effects. The extracted phytoconstituents of Tecoma alata can improve the measured biological activity. These substances will be concentrated in activities.[5] The fields of biology hide countless unknown in vivo models for evaluating the biomedical potential of nanoparticles. We report here on an in vivo floral model that tests nanoparticles for biocompatibility, bioactivity, antimicrobial potency, and biological barrier penetrability. The model utilizes the harvested flowers of Tecoma alata, also known as Orange Jubilee, a trumpet vine belonging to the Bignoniaceae family.[6]

DISTRIBUTION

The Americas are home to Tecoma varieties. It stretches from the southern United States to the northern part of Venezuela via Mexico, Central America, and the Antilles, and from there to the northern part of Argentina via the Andes Mountain range. It was brought to Hawaii, India, and southern Africa. Being a ruderal species, yellow trumpetbush easily spreads throughout cleared, rocky, sandy, and disturbed areas, often turning into an invasive weed. It grows well in a broad range of environments, including xerophilous scrub, the intertropical littoral zone, high altitude temperate forests, and tropical deciduous and evergreen forests. It takes swift hold in cleared, rocky, sandy, and disturbed areas. The species favors sunny, dry coastal locations.[1]

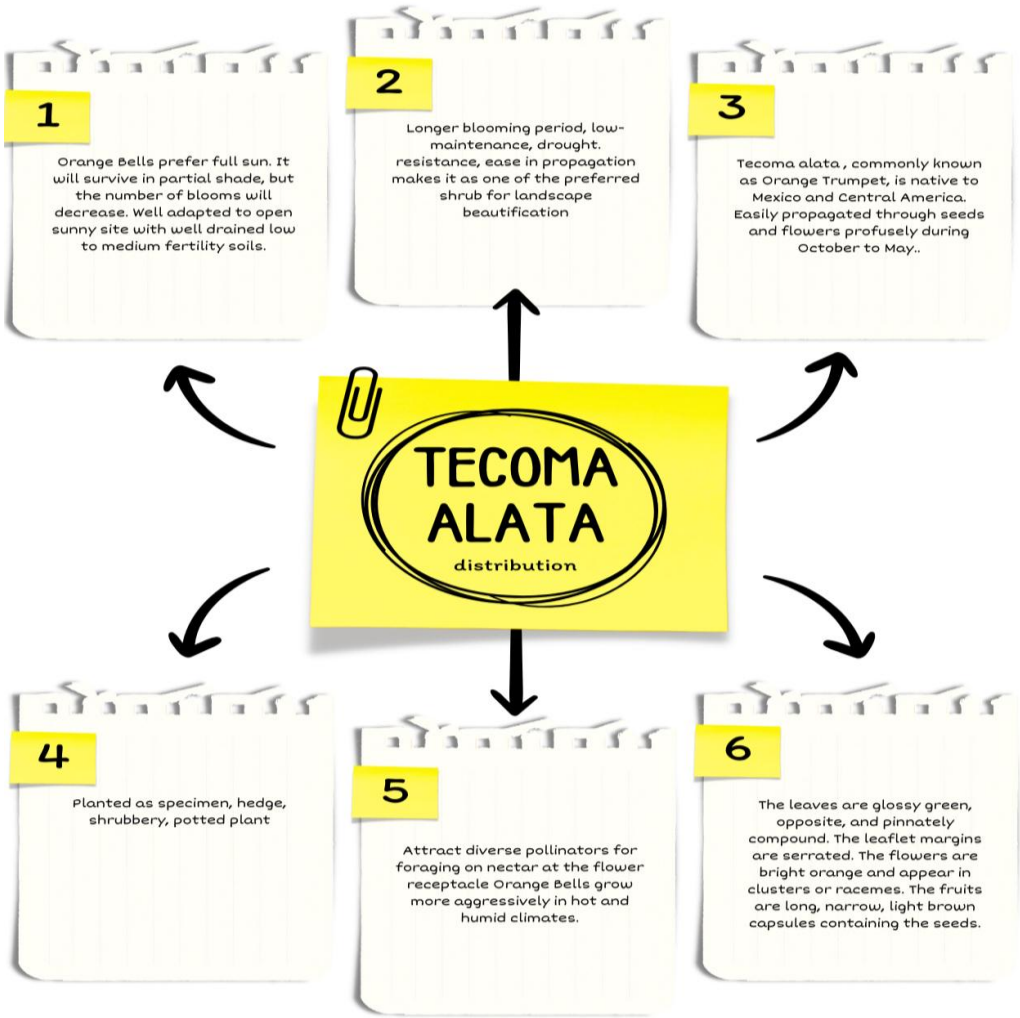

Figure 01: Representation of *Tecoma alata'* ecological, cultural, and ecosystem services.

APPEREANCE

The leaves are opposite, bright green, and complex with pinnately. There are serrated edges on the leaflets. The vivid orange blossoms are arranged in racemes or clusters. The seeds are enclosed in long, thin, light brown capsules called fruits. Hummingbirds, butterflies, and numerous other birds are drawn to the nectar of the blooms. *Tecoma alata* has the same cultural requirements as *Tecoma stans* var stans and might even be colder tolerant, the difference between them is color.[1]

Figure 02: ***Tecoma alata.***

CULTURE

In warmer climes, orange bells are frequently cultivated in containers on patios as part of landscape design. They can serve as a hedge, border, or accent to offer seclusion and screening.[1]

SYNONYMS

Common Name(s)

- Flaming Bells
- Orange Bells
- Orange Esperanza
- Orange Star
- Orange Trumpet Bush
- Tecoma Orange Jubilee.

Previously known as

- *Bignonia alata*
- *Bignonia guarume*
- *Gelseminum alatum*
- *Tecoma fulva subsp. guarume*
- *Tecomaria alata*
- *Tecoma stans* 'Orange Jubilee'.

TAXONAMICAL CLASSFICATION

Kingdom	**Plantae (Plants)**
Clade	Angiosperms (Flowering plants), Eudicots, Asterids
Order	Lamiales
Family	Bignoniaceae
Genus	Tecoma
Species	Tecoma alata

OTHER SPECIES

- Tecoma arequipensis (Sprague) Sandwith
- Tecoma capensis (Thunb.) Lindl. – Cape Honeysuckle (Southern Africa)
- Tecoma castanifolia (D.Don) Melchior – Chestnutleaf Trumpetbush
- Tecoma cochabambensis (Herzog) Sandwith
- Tecoma fulva (Cavanilles) D.Don
- Tecoma garrocha Hieronymus
- Tecoma guarume DC.
- Tecoma nyassae Oliv.
- Tecoma rosifolia Humboldt, Bonpland & Kunth
- Tecoma sambucifolia Humboldt, Bonpland & Kunth
- Tecoma stans (L.) Juss. ex-Humboldt, Bonpland & Kunth – Yellow Trumpetbush (Americas)
- Tecoma tanaeciiflora (Kränzlin) Sandwith
- Tecoma tenuiflora (DC.) Fabris
- Tecoma weberbaueriana (Kränzlin) Melchior.[2]

Figure 03: ***Tecoma stans.***

Figure 04: *Tecoma capensis.*

PHYTOCHEMICAL STUDIES

Wani et al. (2014) conducted experimental research on callus induction, active ingredients, and antioxidant activity analysis using callus and leaves of Tecoma fans L. The *Tecoma stans* plants' phytochemical screening differed depending on the solvents utilized to extract the leaves. All the secondary metabolites investigated—saponins, flavonoids, tannins, phenols, anthraquinones, alkaloids, and glycosides—were present in the leaves' methanol and ethanol extracts, suggesting that these compounds are the plant's active ingredients. While aqueous extracts from T. stans leaves revealed saponins, flavonoids, phenols, and alkaloids, ethyl acetate extracts revealed the presence of tannins, phenols, and saponins. Seventeen chemicals (phytochemical) were found in the ethanolic extract of Tecoma stans (Family: Bronziaceae) according to Anburaj et al.'s 2016 phytochemical screening and GC-MS analysis.[7]

ACTIVE CONSTITUENTS WITH MEDICINAL VALUE

- Tetradecanoic acid- Antioxidant, Lubricant, hypercholesterolemia, Cancer-preventive, Cosmetic.
- Hexadecanoic Acid, Ethyl Ester- Antioxidant, hypocholesterolemic, Antiandrogenic, hemolytic, Alpha-reductase inhibitor. (Govindappa et al., 2011, Sridharan et al., 2014)
- l-(+)-Ascorbic acid 2,6-dihexadecanoate- Vitamin C, Antioxidant, Immunomodulator.
- N-Nonadecanol-1- Anti-inflammatory, Hypocholesterolemic, Cancer preventive, Hepato-protective, Nematicide, Insectifuge Antihistaminic, Anti-arthritic, Anti-coronary, Antieczemic Antiacne, 5-Alpha-reductase inhibitor Antiandrogenic.
- 9, 12-Octadecadienoic Acid (Z, Z)- Hypocholesterolemic, 5-Alpha-reductase inhibitor, Antihistaminic, Insectifuge, Antieczemic, Antiacne.
- 9, 12, 15-Octadecatrienoic Acid, (Z, Z, Z)- Hypocholesterolemic, Nematicide Anti-arthritic, Hepatoprotective, Antiandrogenic, Nematicide 5-Alpha-reductase inhibitor, Antihistaminic, Anticoronary, Insectifuge, Antieczemic, Anticancer.
- Octadecanoic acid- Cosmetic, Flavor, Hypocholesterolemic, Lubricant, Perfumery, Propecia, Suppository.[7]

PHARMACOLOGICAL ACTIVITIES

The Tecoma genus is home to a number of bioactive substances with diverse pharmacological properties, including antifungal, antibacterial, and antioxidant properties. Tecomine, which inhibited the growth of B. subtilis and E. coli at varying concentrations, was isolated from the whole alcoholic and aqueous extract of T. stans, which demonstrated antibacterial activity.[8]

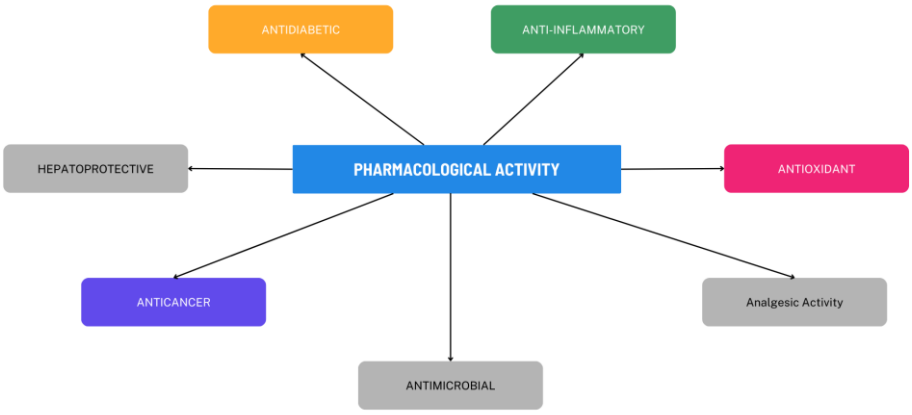

Figure 05: Pharmacological activity.

ANTI-INFLAMMATORY AND ANALGESIC ACTIVITY

Classical symptoms of acute inflammation include edema, erythema, pain, and heat. The infiltration of serum and red blood cells (leucocytes) into the tissues causes the classical signs. A steady change in the type of cells present at the site of inflammation is the outcome of chronic inflammation. It is typified by the injured tissue's simultaneous deterioration and healing due to inflammation. The world is blessed with an abundance of therapeutic plants. Plants used medicinally aid in easing human suffering. In India, herbal medicine has long been the mainstay of healthcare. Today, it's spreading throughout the developed world as people look for ways to stay healthy in the face of ongoing stress and pollution, as well as to use medications to treat illness that complement the body's natural defenses. Throughout human civilization, plants have been a significant source of medicinal materials. The use of these medications as anti-inflammatory and analgesic agents has not always been effective due to negative side effects like gastric lesions brought on by NSAIDs and tolerance and dependence brought on by opiates. Because they are inexpensive, rarely cause side effects, and, according to the World Health Organization, still account for 80% of global drug consumption, plant-based medications have garnered significant attention in this process as they explore the effectiveness of these treatments in traditional medicine. Overview Natural plant-derived products with anti-inflammatory, analgesic, antioxidant, anti-allergic, and antiviral properties have long been known, such as flavonoids.[3] Some studies evaluated the plant's analgesic and anti-inflammatory qualities. The carrageenan-induced paw oedema in albino rats was observed to be inhibited by the extracts and Indomethacin. Indomethacin 5 mg/kg showed a strong activity of 53.88% inhibition, while Tecoma stans Linn 200 mg/kg and 400 mg/kg showed 18.09% and 49.38% inhibition, respectively. When mice were given acetic acid to induce writhing, it produced mild to moderate analgesic activity in comparison to the control group. Bioactive components, including flavonoids (5.70 mg. 100 g-1), alkaloids (5.40 mg. 100 g-1), tannins (0.40 mg. 100 g-1), saponins (0.38 mg. 100 g-1) and phenols (0.10 mg. 100 g-1), were found in the plants according to phytochemical studies. *Tecoma stans* Linn may have therapeutic qualities because of these bioactive substances.[9] One of the most widely used techniques for screening anti-inflammatory drug candidates is based on the agents' ability to prevent edema from being produced in the rat's hind paw following injection with a phlogistic agent. Numerous phlogistic agents, or irritants, have been employed, including formaldehyde, brewer's yeast, dextran, egg albumin, kaolin, aerosil, sulfated polysaccharides like naphthoylheparamine or carrageenan, formalin, and so forth.[10] It has long been believed that Tecoma stans leaves can help with inflammatory conditions. In light of this, the plant Tecoma stans has been chosen for scientific validation of its antiarthritic properties.[12]

ANTIOXIDANT AND ANTIFUNGAL ACTIVITY

T. stans has been discovered in various parts of the UAE, including Ras Al Khaimah, Abu Dhabi, and Dubai, where it can be found in public parks, side roads, and private gardens. The Flash Chromatography System is used in a variety of drug discovery studies due to its ability to purify secondary metabolites from crude plant extracts. Using the Flash Chromatography System, three components were isolated from the ethanolic extract of T. stans leaves that demonstrated in vitro antioxidant activity. The antioxidant activity of T. stans isolated components was evaluated in vitro using the 1,1-diphenyl-2-picryl hydrazyl and 2,2′-azinobis-3-ethylbenzothiazoline-6-sulfonic acid methods. When compared to ascorbic acid, the isolated components A-4, A-3, and A-2 demonstrated antioxidant activity. Component A-3 demonstrated antioxidant activity using the DPPH and ABTS methods, antifungal activity against Candida albicans, and over 80% inhibition in the third dilution when compared to itraconazole and nystatin as positive controls. This rapid and efficient flash chromatography method was used to isolate and purify an isolated component A-3, which exhibited both antioxidant and antifungal properties.[11] Tecoma capensis ethanolic extract's antioxidant and free radical scavenging activity was examined using the 2, 2 Diphenyl-1-picrylhydrazyl (DPPH) assay. Its superoxide and hydroxyl radical scavenging activity was compared with that of the standard (ascorbic acid), and its antimicrobial activity was assessed using the cup plate method against four clinically significant bacterial strains: Bacillus subtilis, Staphylococcus aureus (gram +ve), Escherichia coli, Proteus vulgaris (gram -ve), and two fungal strains, Aspergillus niger and Candida albicans.[13]

ANTIDIABETIC ACTIVITY

In Mexico, *Tecoma stans* aqueous extract (TAE) of the leaves is a common traditional antidiabetic treatment. It was demonstrated that tecomecine was one of the substances causing the hypoglycemic effect. Aguilar-Santamaria et al examined intestinal α-glycosidase inhibition in vivo and in vitro as a potential mechanism of action for TAE in animal models of type 2 diabetes mellitus (DM2). Tecoma stans infusion administered intravenously to healthy dogs causes an early hyperglycemic response, arterial hypotension, and a gradual drop in blood glucose levels with concurrent hypertriglyceridemia; no significant changes in immunoreactive insulin were found. After the first 60 minutes of medication administration, heart frequency progressively increased and continued for several hours. The changes in blood parameters appear to be associated with hepatic glycogen metabolism, specifically with an increase in glycogenolysis. The observed hepatic glucose output may take precedence over Tecoma stans infusion's late hypoglycemic effect. This study aims to clarify the widely believed antidiabetic characteristics of this medicinal plant from Mexico. [10] In Mexico, *Tecoma stans* aqueous extract (TAE) is a common traditional

antidiabetic medication; its rational application is debatable. Chlorogenic acid (CGA), a phenylpropanoid found in *Tecoma stans*, has been shown to have medicinal benefits, including a hypoglycemic effect by reducing the gastrointestinal index of glucose absorption and the postprandial hyperglycemia peak. It also lowers levels of triglycerides and cholesterol. *Tecoma stans* aqueous extract has at least four antidiabetic-related properties, including postprandial anti-hyperglycemic, intestinal -glucosidase inhibition, and effects on cholesterol and triglycerides. The phenolic compounds in TAE responsible for the majority of these activities.[14]

HEPATOPROTECTIVE AND CARDIAC GLYCOSIDES

When compared to standard and control, the ethanolic extract of leaves exhibits good histopathological data and significantly lowers liver weight, indicating good hepatoprotective activity at 200 mg/100g and 400 mg/100g. The ethanolic leaf extract's polyphenolic components may have a positive hepatoprotective effect.[15] In terms of medicinal potential, two less studied and overlooked plant species are *Tecoma capensis* and Ixora pavetta. I. Pavetta flowers, bark, and roots are used as a treatment for cough, anemia, and urinary issues in women. *Tecoma capensis* bark powder is helpful in treating fever, pneumonia, gastrointestinal issues, and enhances blood coagulation. It's unclear how these plants' leaves are used in medicine at this time. The purpose of the current study was to investigate the leaf extracts' potential for treating chronic liver and cardiovascular illnesses. Cardiac glycosides were detected in the leaf extracts by testing. The isoproterenol method and the MTT assay were used to measure the cardioprotective and hepatoprotective effects, respectively. Both plants' leaf extracts demonstrated the presence of cardiac glycosides, with T. capensis' leaf extracts exhibiting a high yield of these glycosides. Both plant extracts demonstrated strong hepatoprotective and cardioprotective properties.[16]

ANTI-CANCER ACTIVITY

One of the diseases that affects both developed and developing nations and is the main cause of mortality is cancer. Chemotherapy is a widely used cancer treatment, but one of its main side effects is the toxicity it causes to normal cells because the chemical drugs don't know the difference between normal and cancerous cells (Balamurugan et al., 2014).[17] *Tecoma stans* may serve as a substitute treatment for lung cancer. A useful component for cancer medication recipes is T. stans extract. By using the free radical scavenging activity (2, 2-diphenyl1-picryl-hydrazyl-hydrate), the percentage of antioxidant assay was ascertained. It has been demonstrated that the presence of phenolic compounds and their derivatives causes cancer cells to undergo a cascade-based apoptosis, which results in cytotoxicity. The ability of antioxidants to reduce chronic diseases, such as cancer and cardiovascular (CAD) diseases, is crucial. According to Prajpati and Patel's (2010) phytochemical analysis, *Tecoma stans* contains alkaloids, steroids, glycosides, and carbohydrates.[18] The *Tecoma stans* plant extract may be an effective anti-cancer medication, as evidenced by the decrease in cell viability observed at higher concentrations of the extract. The extract's potential anti-cancer properties could be attributed to its antioxidant and free radical scavenging properties.[19] A Plenty of flowers and fruits with antioxidant properties have been found in Tecoma fruits and flowers; these fruits' potent anti-cancer properties were investigated against cancer cell lines (Marzouk et al., 2006).[20]

OTHER ACTIVITIES

- **IMMUNOMODULATORY ACTIVITY:** According to G.P. Choudhary (2011), T. undulata's ethanolic extract stimulates the humoral and cell-mediated immune responses. The daily oral administration of Tecomella's alcoholic extract significantly reduced the suppression of humoral and cell-mediated responses induced by cyclophosphamide. Additionally, the ethanolic extract was found to suppress the delayed type of hypersensitivity reaction induced in mice by sheep red blood cells.[21]

- **OTHERS:** An Ayurvedic drug called Rohitakarista is traditionally used to treat pliha (disease of the spleen), udara (disease of the abdomen), and gulma (localized abdominal swelling or tumour). In actuality, it involves preparing Tecomella undulata stem and bark in small amounts with a few other medicinal plants (Ullah et al., 2008). Other plants included in this formulation are Emblica officinalis, Terminalia bellerica, Piper longum, and Cinnamomum zeylanicum oil.[22] Ullah et al. (2008) conducted research to examine the safety profile and impact of rohitakarista on multiple biochemical parameters in rats. In both sexes, there was a noticeable rise in albumin content and a fall in creatinine content. A number of biochemical markers, including urea, alkaline phosphates, and bilirubin, revealed an intriguing sex dependency. In male rats, all these parameters went down, but in female rats, they went up significantly.[23]

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