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Pharmacognostic and Pharmacological Study of Syzygium Cumini

Neha Mohite[1], Sakshi Lagad[2], Anirudha Pawar[3], Akanksha More[4]
[1, 2, 3]*Student of Department of Pharmacy,* [4]*Assistant Professor, Department of pharmacy, (Delonix Baramati College of pharmacy, Barhanpur)*

Abstract: ***Syzygium cumini commonly known as "jamun" has been used in traditional medicine systems like Ayurveda, Unani, and Siddha for treating various diseases. It contains diverse phytoconstituents, including tannins, alkaloids, steroids, flavonoids, and vitamins, contributing to its therapeutic effects. The plant exhibits pharmacological actions such as hypoglycemic, diuretic, analgesic, anti-inflammatory, antimicrobial, antioxidant, and gastro-protective properties. Studies highlight its ability to protect against radiation-induced DNA damage and reduce the fertilizing capacity of male albino rats. It is effective in treating diabetes, inflammation, ulcers, and diarrhea, with preclinical studies showing chemopreventive and radio protective properties. The seeds contain compounds like jambosine and jambolin, which inhibit starch conversion to sugar. "Further investigation is necessary to isolate and identify the active compounds responsible for the pharmacological effects. Identifying these bioactive constituents is crucial for developing safer and more effective drugs for treating various conditions, including diabetes."***
Keywords: Jamun, Medicine, Antioxidant, Antidiuretic, Radioprotective

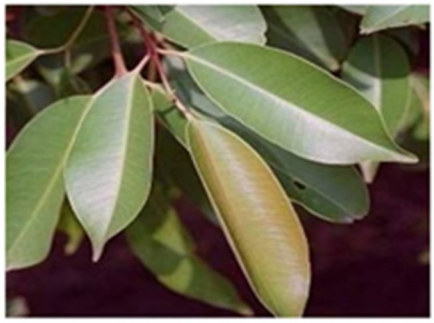
I. INTRODUCTION

Syzygium cumini, also known as Jamun or black plum, is a large evergreen tree from the Myrtaceae family, native to India and the East Indies. It thrives across India up to 1800 meters in altitude and is also found in Myanmar, Afghanistan, Thailand, the Philippines, and Madagascar.

The tree is well-regarded for its pharmacological properties due to compounds like malic acid, oxalic acid, Gallic acid, and tannins. It exhibits a range of medicinal activities, including gastro protective, antiulcerogenic, antibacterial, and antimalarial effects. Syzygium cumini is also known by names such as Jambul, Java Plum, and Indian Blackberry, and is cultivated in regions like Eastern Africa, South America, and the United States [1].

The Jamun tree produces fruit annually, with berries that are sweet and sour, used in health drinks, preserves, and wine [1]. Its parts, especially the seeds, are employed in treating ailments like diabetes. The plant has demonstrated antioxidant, anti-inflammatory, antimicrobial, and anti-HIV properties, among others. Jamun is culturally significant, often associated with Hindu and Buddhist traditions. Its leaves and fruits are used in religious offerings [2].

In traditional medicine systems such as Ayurveda, Siddha, and Unani, various parts of the tree, including bark, leaves, fruit, and seeds, are used to treat conditions like leucorrhoea, stomach ache, fever, constipation, and to reduce radiation-induced DNA damage. The fruit is effective for treating bleeding piles and liver disorders. India, with its diverse climate and rich biodiversity, supports a variety of medicinal plants, and the World Health Organization has advocated for the evaluation of plant-based treatments where synthetic drugs are inadequate.



Leaves



Fruit

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Flower Steam

A. Botanical Description

Kingdom: Plantae
Division: Angiosperms
Order: Myrtles
Family: Myrtaceae
Genus: Syzygium
Species: cumini

B. Traditional Medicinal Use

In traditional Ayurvedic medicine, all parts of the Jamun tree, including its fruits, leaves, seeds, and bark, are utilized.[3] Jamun is a medicinal plant extensively used in various ethno medicinal practices to address a range of human disorders.[4] S. cumini is esteemed in Siddha, Ayurveda, and Unani medicine for its therapeutic properties. The entire plant is utilized in various traditional Indian medical systems, with the leaves and bark being particularly significant. In Ayurveda, the bark is noted for being acrid, sweet, digestive, and astringent to the bowels, as well as anti-helminthic. It is also used to treat sore throat, bronchitis, asthma, thirst, biliousness, dysentery, blood impurities, and ulcers.[5].

- Ayurveda: The bark is used for its acrid, sweet, digestive, and astringent properties. It treats sore throat, bronchitis, asthma, thirst, biliousness, dysentery, blood impurities, and ulcers.
- Siddha: Jamun is considered a haematinic, semen promoter, and thermo-regulant.
- Unani: Leaf ash strengthens teeth and gums; seeds act as an astringent, diuretic, and remedy for diabetes; bark is known for wound healing.
- Madagascar: Seeds are used to manage diabetes complications.
- Surinam: Leaves are used by women post-delivery to contract the vagina, reduce mucus, and eliminate odours.

The whole plant is utilized in traditional medicine, but the leaves and stem bark are considered the most potent parts. The seeds have demonstrated anti-inflammatory effects in rats and antioxidant properties in diabetic rats.[7].[Previous reports from Indian medical journals suggest that jambul seeds and bark might be advantageous for individuals with diabetes.[8] The seeds and pulp of jamun fruit have been noted to fulfill several roles for diabetic patients, such as reducing blood glucose levels and delaying complications like neuropathy and cataracts.[2,9] Jamun is regarded as an effective general health tonic for humans, functioning as a blood purifier. Jamun stem bark is used for its properties as an astringent, anthelmintic, antibacterial, carminative, constipating, diuretic, digestive aid, febrifuge, refrigerant, stomachic, and for its sweet qualities. The fruits and seeds are employed in treating asthma, diabetes, bronchitis, and splenopathy.[10] A decoction made from Jamun seeds alleviates fatigue and strain. Research into Jamun's traditional uses has explored the application of all parts of the plant through various study systems, aiming to validate the claims of traditional healers and utilize its diverse medicinal properties in evidence-based modern clinical practice.

C. Phytochemical Analysis

The medicinal benefits of Jamun are likely attributed to its synthesis of various phytochemicals. Numerous researchers have examined the phytochemical composition of Jamun's roots, stem, leaves, and fruits, with their findings summarized in this section.[1]

Jamun leaves have been extracted using methanol and water and analyzed for different phytochemicals. Both extracts revealed a variety of alkaloids, flavonoids, glycosides, steroids, phenols, tannins, saponins, and cardiac glycosides. The ethanol extract of Jamun stem bark showed the presence of terpenoids, alkaloids, catechins, phenols, quinones, saponins, and tannins, while the methanol extract additionally contained flavonoids. In contrast, the aqueous stem bark extract was found to contain only catechins, phenols, quinones, and flavonoids. Similarly, The ethyl acetate and methanol extracts of Jamun seeds were identified as having contain flavonoids, alkaloids, glycosides, triterpenoids, steroids, saponins, and tannins [11]

D. Roots

The root of S. cumini is known to contain various flavonoids, glycosides, and isorhamnetin 3-O-rutinoside.

E. The Stem Bark

The stem bark of S. cumini contains a variety of compounds, including friedelin, friedelan-3-a-ol, betulinic acid, β-sitosterol, kaempferol, β-sitosterol-D-glucoside, Gallic acid, ellagic acid, gallotannin, ellagitannin, and myricetin.[13] It also includes eugenin, fatty acid ester of epi-friedelanol, quercetin, bergenins, flavonoids, tannins, and a range of lignan derivatives such as cuminiresinol, syzygiresinol A and B, and various forms of pinoresinol.[12]

F. Leaves

Jamun leaves contain a wide range of bioactive compounds, including:

- Flavonoids and related compounds**: Myricetin, quercetin, kaempferide, butin, isoquercetin, astragalin, 5,4′-dihydroxy, 7-methoxy, 6-methylflavone, 3,5,7,4′-tetrahydroxy-6-(3-hydroxy-3-methylbutyl) flavone
- Phenolic acids: Gallic acid, ferulic acid, caffeic acid, diferulic acid, methyl gallate, 3,4,5-trihydroxybenzoic acid
- Sterols and terpenoids**: β-sitosterol, betulinic acid, crategolic (maslinic) acid, morolic acid 3-O-caffeate
- Long-chain hydrocarbons and alcohols: n-nonacosane, n-octacosanol, n-dotricontanol, n-hentriacontane, n-hepatcosane, n-triacontano, eicosane, octacosane, octadecane[14]
- Other notable compounds: Mycaminose, prenylbenzoic acid 4-β-D-glucoside, isoetin-7-O-β-D-glucopyranoside 4′-hydroxy-3′-methoxyphenol-β-D-[6-O-(4″-hydroxy-3″,5″-dimethoxylbenzoate)]glucopyranoside, cianidanol, 4′-hydroxyflavan, taxifolin, palmitic acid, punicic acid, cedrol, 3-(3-hydroxyphenyl) propanoic acid, xanthoxylin, quinic acid, 6-O-feruloyl-d-glucose.These compounds have been isolated from the aqueous extract of Jamun leaves, highlighting their diverse chemical profile.[15]

G. Fruit

The fruits are abundant in raffinose, glucose, fructose, citric acid, malic acid, Gallic acid, and anthocyanins. Specific anthocyanins include delphinidin-3-gentiobioside, malvidin-3-laminaribioside, petunidin-3-gentiobioside, cyanidin diglycoside, petunidin, and malvidin.

The sour taste of the fruits is likely due to Gallic acid, while their coloration is attributed to anthocyanins [16]. Nutritional content per 100 grams of the edible portion includes 83.70–85.80 grams of moisture, 0.70–0.13 grams of protein, 0.15–0.30 grams of fat, 0.30–0.90 grams of crude fiber, 14.00 grams of carbohydrates, and 0.32–0.40 grams of ash. Mineral content includes 8.30–15.00 mg of calcium, 35.00 mg of magnesium, 15.00–16.20 mg of phosphorus, 1.20–1.62 mg of iron, 26.20 mg of sodium, 55.00 mg of potassium, 0.23 mg of copper, 13.00 mg of sulfur, and 8.00 mg of chlorine.[16] Vitamin content includes 80 I.U. of vitamin A, 0.01–0.03 mg of thiamine, 0.009–0.01 mg of riboflavin, 0.20–0.29 mg of niacin, 5.70–18.00 mg of ascorbic acid, 7.00 mg of choline, and 3.00 mcg of folic acid.

A variety of jambolan from Brazil contains malvidin-3-glucoside and petunidin-3-glucoside. Additionally, jambolan peel powder can be used as a food and pharmaceutical colorant, with studies highlighting the antioxidant stability of anthocyanin pigments from fruit peels in both extract form and formulations. [17].

H. Flower

The flowers are fragrant and grow in clusters ranging from 2.5 to 10 cm in length. Each flower measures 1.25 cm in width and 2.5 cm in length, featuring a funnel-shaped calyx and 4-5 fused petals. Initially white, the petals quickly turn rose-pink before shedding, leaving behind numerous stamens[15,16]

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II. MEDICINAL PROPERTIES

The bark of the plant is known for its acrid and sweet properties, making it effective as a digestive aid and astringent. It is used in treating sore throats, bronchitis, asthma, thirst, biliousness, dysentery, ulcers, and acts as a blood purifier. The fruit shares similar properties, being acrid, sweet, cooling, and astringent. It is used to freshen breath, treat biliousness, and as a stomachic, diuretic, and antidiabetic agent.[15]. The fruit is historically valued for medicinal purposes, particularly in treating chronic diarrhea and other digestive disorders. The seeds are sweet, astringent, and beneficial for diabetes management. Leaf ash is used to strengthen teeth and gums. Vinegar made from the ripe fruit juice serves as a stomachic, carminative, and diuretic, and is also helpful for spleen enlargement and as an astringent in chronic diarrhea.

The juice extracted from the tender leaves of this plant, when combined with mango leaves and myrobalan, is traditionally administered with goat's milk and honey to treat dysentery accompanied by bloody discharge [18]. Alternatively, the juice from the tender leaves alone or mixed with carminatives like cardamom or cinnamon is given with goat's milk to treat diarrhea in children. In Madagascar, traditional healers have long utilized jambolan seeds as a key component in therapies to mitigate the gradual effects of diabetes.[19].In Tamil Nadu, villagers use seed extracts to address colds, coughs, fevers, and skin issues such as rashes, as well as ulcers in the mouth, throat, intestines, and genitourinary tract caused by Candida albicans. Jambolan fruit is versatile; it can be consumed raw, or used to make tarts, sauces, and jams. Its juice is highly regarded for making sherbet, syrup, and "squash," a popular Indian beverage [20].

Jambolan fruit is edible in its raw form and can be transformed into tarts, sauces, and jams. High-quality jambolan juice is ideal for making sherbet, syrup, and "squash," a traditional Indian beverage. In Tamil Nadu, villagers use seed extracts to treat colds, coughs, fevers, skin rashes, and ulcers in the mouth, throat, intestines, and genitourinary tract, particularly those caused by Candida albicans [21].

III. PHARMACOLOGICAL ACTIVITIES

A. Hypoglycemic Activities

The antidiabetic properties of various parts of Syzygium cumini, such as the pulp, seed, bark, and stem, have been studied. Achrekar et al. (1991) found that a water extract from the pulp of S. cumini significantly reduced blood glucose levels in diabetic rats induced by streptozotocin, with the hypoglycemic effect varying based on dosage and administration method. In another study by Madhuri Pandey and Aqueel Khan, diets comprising 15% intact seeds, 15% defatted seeds, and 6% water-soluble gummy fiber from S. cumini seeds fed over 21 days significantly decreased blood glucose levels by 26-28% and enhanced glucose tolerance in both normal and diabetic rats compared to controls.[22] This indicates the hypoglycemic potential of S. cumini seed diets. The study further revealed that defatted seeds and water-soluble gummy fibers from the seeds exhibited hypoglycemic effects in alloxan-induced diabetic rats. Quantitative analysis showed that S. cumini seeds consist of 40% water-soluble gummy fibers and 15% water-insoluble fibers. While defatted seeds and gummy fibers effectively lowered blood glucose levels and improved glucose tolerance, the insoluble fibers did not demonstrate significant hypoglycemic activity[23].

B. Anti-inflammatory Activities

Excessive production of free radicals by activated inflammatory leukocytes, particularly in chronic inflammation, can significantly contribute to various diseases. Research indicates that polyphenols may help alleviate inflammation-related conditions. Muruganandan et al. demonstrated in their study that a 70% ethanolic extract of S. cumini bark exhibited notable anti-inflammatory effects, comparable to those of acetylsalicylic acid at a dose of 300 mg/kg administered orally. [23] This suggests the extract has strong anti-inflammatory properties. In The ethanolic extract of Syzygium cumini bark has demonstrated anti-inflammatory effects against histamine, serotonin, and prostaglandin.The study, inflammation was induced using autacoids such as histamine (1 mg/ml), serotonin (5-HT, 1 mg/ml), bradykinin (0.02 mg/ml), and prostaglandin (PGE2, 0.001 mg/ml) in rat paws. The extract effectively reduced inflammation in histamine, PGE2, and 5-HT induced paw edema, but not in bradykinin-induced edema at any tested dose. Additionally, the extract demonstrated anti-inflammatory effects in carrageenan, kaolin-carrageenan, formaldehyde-induced edema, and cotton pellet granuloma tests in rats [24].

C. Antioxidant Activity

Zhi-Ping et al. explored the antioxidant properties of S. cumini leaf extracts using DPPH free radical scavenging and ferric reducing antioxidant power (FRAP) assays. Their findings revealed that the ethyl acetate fraction exhibited the strongest antioxidant activity among the tested fractions [25].

High-performance liquid chromatography (HPLC) analysis identified phenolic compounds, such as ferulic acid and catechin, as key contributors to this antioxidant effect. Additionally, the ethanolic extract of Syzygium cumini seed kernel was found to reduce oxidative stress associated with diabetic tissue damage. This was evidenced by the normalization of elevated plasma glucose, vitamin E, ceruloplasmin, and lipid peroxide levels, as well as the restoration of decreased vitamin C and glutathione levels in diabetic rats after treatment with the seed kernel extract. Histopathological studies further confirmed its protective effects on pancreatic β-cells [26]. The ethanolic extract also reduced thiobarbituric acid reactive substances (TBARS) and increased levels of reduced glutathione (GSH), superoxide dismutase (SOD), and catalase (CAT) [25]

D. Antineoplastic Effect

In the treatment of cancer, nine plant-derived compounds have been approved for clinical use in the United States, including vinblastine, vincristine, and paclitaxel. Some studies have indicated the potential of Syzygium cumini (L.) fruits in cancer treatment. Anthocyanin-rich Java plum fruit extract (JPE) has shown anti-cancer properties, effectively targeting early-stage HCT-116 human colon cancer cells, inducing apoptosis, and inhibiting the self-renewal capability of colon cancer stem cells (CSCs) [23]. Mittal et al. developed and characterized silver nanoparticles (AgNPs) from Syzygium cumini fruit extract in vitro, with sizes ranging from 10-15 nm. The study identified the biomolecules responsible for the synthesis and stabilization of these nanoparticles, primarily flavonoids, which played a key role in their reduction and stabilization. These nanoparticles were effective against Dalton lymphoma cell lines in vitro, reducing cell viability by 50% at a concentration of 100 µg/mL. In vitro research has also demonstrated that whole Jamun extract exhibits cytotoxic effects on human cervical cancer cells, specifically the HeLa (HPV-18 positive) and SiHa (HPV-16 positive) cell lines, with a concentration-dependent cell death effect more pronounced in HeLa cells. Both crude and methanolic extracts of the pulp increased apoptosis over time when used at 80% concentration, with the crude extract proving more effective than the methanolic extract in both cell lines [23,27].

E. Anti-Bacterial Effect

Methanol and ethyl acetate extracts of E. jambolana seeds, at a concentration of 200 µg/disc, demonstrated antibacterial activity against several bacteria, including Bacillus cereus, B. subtilis, B. megaterium, Streptococcus β-haemolyticus, S. aureus, Shigella dysenteriae, Sh. shiga, Sh. boydii, Sh. flexneri, Sh. sonnei, E. coli, S. typhi B, S. typhi, and Klebsiella species. Additionally, leaf extracts of E. jambolana exhibited moderate antibacterial effects against Escherichia coli and antibiotic activity against Micrococcus pyogenes var aureus. The essential oil from Syzygium cumini leaves showed enhanced antibacterial properties, with leaf extracts displaying activity against Escherichia coli and Staphylococcus aureus[25.26].

IV. CONCLUSION

Jamun seeds are a rich area of research due to their numerous beneficial effects. They are a significant source of phytochemicals, including both phenolic and non-phenolic bioactive compounds. Pharmacological studies link these phytochemicals to a range of therapeutic effects, such as antioxidant, anticancer, antidiabetic, antimicrobial, and radioprotective properties, with the most extensively researched being their ability to ameliorate diabetes mellitus. Additionally, the seeds contain alkaloids that contribute to their hypoglycemic effects.

One of the key products derived from jamun seeds is seed powder, which is particularly developed for diabetes management and is often recommended to diabetic patients. This powder has also proven effective in addressing urinary issues and kidney infections. Sometimes, the powder is extracted from other parts of the plant and retains strong antioxidant properties. Overall, the entire jamun fruit is rich in therapeutic potential, indicating a promising future for its use.

Although the levels of zinc, iron, copper, manganese, and chromium in jamun seeds are low, they are high in polyphenols and contain adequate amounts of vitamin C and iron. Supplementation with jamun seed powder has shown a significant improvement in lipid profiles in diabetic patients, although this effect was observed in a limited number of subjects. The powder also helps prevent oxidative stress and exhibits anti-inflammatory and antifibrotic activities in the liver of rats fed a high-carbohydrate, high-fat diet.

This review, which provides comprehensive information on the nutritional, chemical, and therapeutic aspects of jamun seeds, aims to highlight their potential in the therapeutic and functional food sectors. Further research is necessary to explore various forms of jamun seed, such as seed powder, to fully realize their benefits. The current study explores the introduction of seed oil to a broader audience. It compares various methods for extracting phytochemicals and highlights the presence of numerous medicinally significant bioactive compounds in jamun leaves, supporting their traditional use in treating various diseases. Future research will focus on further purifying, identifying, and characterizing these bioactive chemical constituents.

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Emphasis should be placed on leveraging the biomedical applications of jamun leaves, thanks to specific classes of phytocompounds, to maximize their potential benefits.

V. RECOMANDATION

Considering all the points discussed, it is advisable to include jamun seeds in the daily diet. Fresh extracts from the seeds are particularly beneficial for health. Jamun is a readily accessible fruit in tropical regions and can offer a refreshing change to the usual fruit options.

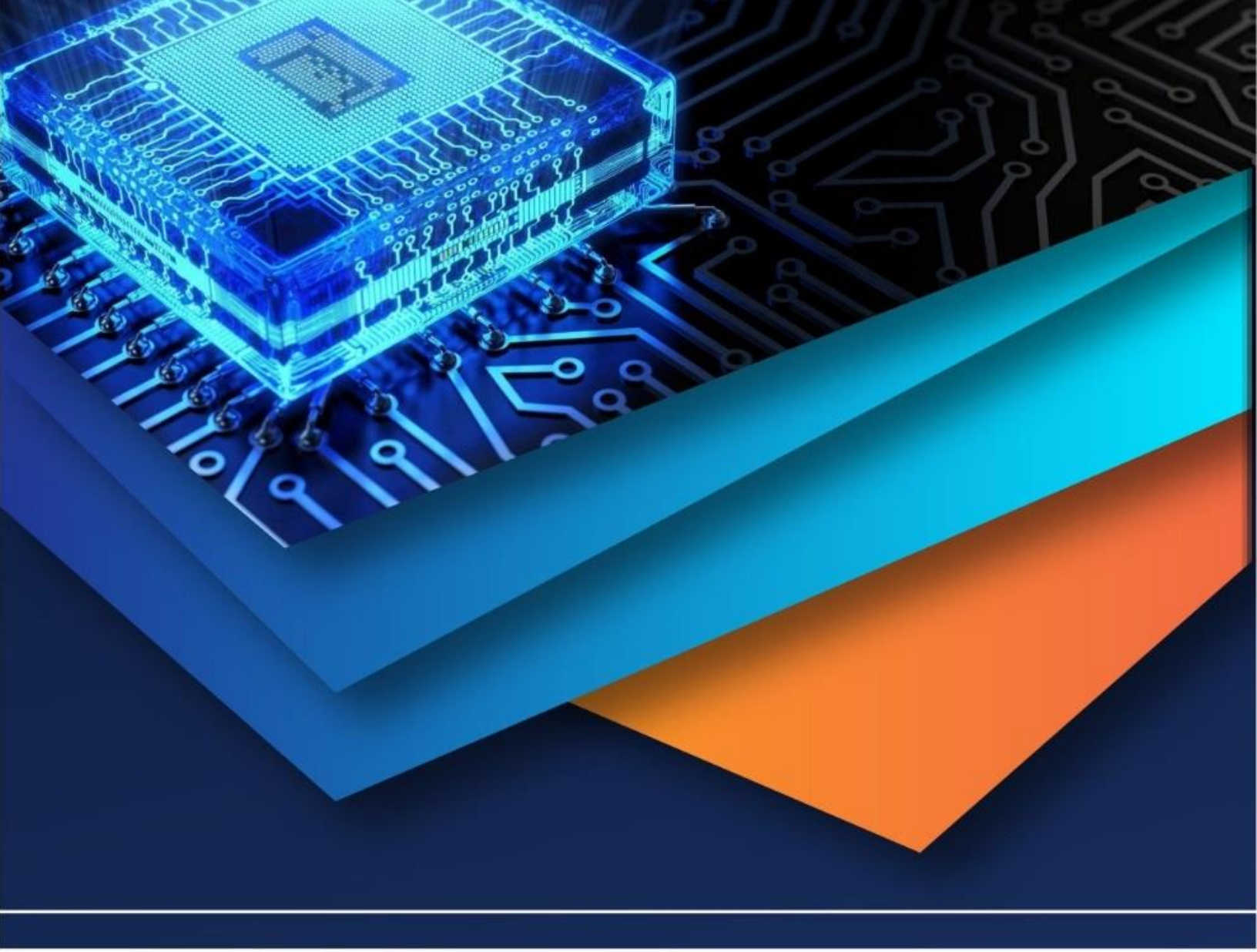
VI. FUTURE RESEARCH

Thorough research is necessary to determine the recommended daily safe dosage of jamun seeds. Future studies could also explore whether jamun seeds affect the absorption of any nutrients.

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