

**Exploring the Phytochemical Diversity and Pharmacological Potentials of
Balanite Aegyptiaca: A Review**

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ABSTRACT

Balanite aegyptiaca, commonly called the desert date or soapberry tree, thrives in arid regions across Africa and the Middle East, showcasing its adaptability to challenging environments. This versatile plant is deciduous, featuring leathery leaves, small greenish-yellow flowers, and fleshy, date-like fruits. Beyond its botanical allure, Balanite aegyptiaca holds significant medicinal value, with various plant parts exhibiting antimicrobial, anti-inflammatory, and antioxidant properties. On a socioeconomic scale, this tree plays a crucial role, offering sustenance during scarcity through its edible fruits, contributing durable wood for furniture and implements, and aiding in soil conservation through its extensive root system. The economic potential extends further, as commercial cultivation for fruit production and seed oil extraction presents promising opportunities. A comprehensive understanding of Balanite aegyptiaca supports conservation initiatives and advocates for its sustainable utilization across diverse fields, underlining its importance in both natural ecosystems and human communities.

Keywords: Balanite aegyptiaca, soapberry tree, Desert date plant, phytochemical screening

INTRODUCTION

Balanite aegyptiaca, often referred to as the Egyptian balsam or desert date, stands as a versatile plant within the Balanitaceae family. Flourishing in the arid landscapes of Africa and the Middle East, this remarkable botanical specimen has played a crucial role in traditional medicinal practices for centuries. Its multifaceted therapeutic attributes and a wealth of phytochemical components have captivated the interest of researchers, leading to numerous scientific inquiries into its potential applications. In-depth investigations into the phytochemical composition of Balanite aegyptiaca have unveiled a diverse array of bioactive compounds. Among these constituents are saponins, alkaloids, flavonoids, terpenes, and phenolic compounds, each contributing to the plant's complex chemical profile. These findings underscore the richness of

Balanite aegyptiaca in bioactive elements, prompting further exploration into the potential pharmacological and therapeutic benefits associated with these compounds.^[1-2] The diverse array of phytoconstituents found in Balanite aegyptiaca plays a pivotal role in the plant's multifaceted biological activities. These include notable effects such as antioxidant properties that combat oxidative stress, anti-inflammatory actions to alleviate inflammation, antimicrobial capabilities against various pathogens, antiviral activities targeting viral infections, anticancer potentials in impeding cancerous growth, antidiabetic effects in regulating blood sugar levels, and hepatoprotective qualities that safeguard the liver. This spectrum of biological activities highlights the broad therapeutic potential of Balanite aegyptiaca, making it a subject of significant interest in various fields of research.^[3-4] Furthermore, Balanite aegyptiaca has long served

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as a traditional remedy across diverse regions, addressing ailments such as gastrointestinal disorders, skin diseases, parasitic infections, and respiratory conditions.^[4] The traditional uses and pharmacological potential of *Balanite aegyptiaca* have sparked significant scientific curiosity. Researchers have conducted thorough studies to understand its mechanisms of action and therapeutic applications. A notable study by Abdelgadir et al., explored the antiplasmodial activity of *Balanite aegyptiaca* in Sudan, leading to the isolation of two new steroidal saponins.^[1] In a separate investigation, Ali et al., delved into the biological and phytochemical properties of *Balanite aegyptiaca* in Sudan.^[2] Elegami et al. (2015) performed a phytochemical screening and assessed the antibacterial and antioxidant activities of the stem bark extract.^[3] Mahboubi et al. conducted a comprehensive review encompassing the traditional uses, phytochemistry, and pharmacological properties of the plant.^[4] In 2020, Yagi et al. provided a thorough review of the phytochemical constituents, traditional uses, and pharmacological activities associated with *Balanite aegyptiaca*.^[5] This review seeks to compile the current understanding of *Balanite aegyptiaca*, exploring its phytochemical composition, traditional uses, and burgeoning pharmacological prospects. Utilizing credible research sources, the study aims to illuminate the therapeutic applications of this noteworthy plant and discern potential directions for future investigations.

TAXONOMIC RESEARCH

The plant is classified as shown in Table 1.

Table 1: Taxonomic classification of *Balanite aegyptiaca*^[6]

TAXONOMIC CLASSIFICATION:	
Kingdom	Plantae-Plants
Subkingdom	Tracheobionta-Vascular plants
Superdivision	Spermatophyta-Seed plants

Division	Magnoliophyta-Flowering plants
Class	Magnoliopsida-Dicotyledons
Subclass	Rosidae
Order	Sapindales
Family	Balanitaceae-Creosote-bush family
Genus	Balanites Delile-balanites
Species	Balanites aegyptiacus(L.) Delile-desert date

Habitat

Indigenous to Africa, the fruit-bearing *Balanites aegyptiaca* (L.) Delile tree, belonging to the Zygophyllaceae family, flourishes in tropical and subtropical areas throughout the continent. Its range extends from Senegal in the western part to Somalia in the east, and from Jordan in the north to Zimbabwe in the south. Additionally, *Balanites aegyptiaca* is found beyond Africa, with occurrences in Yemen, India, Myanmar, Iran, Jordan, Oman, Palestine, and Saudi Arabia.^[7]

BOTANICAL DESCRIPTION

Fruit and Seeds

The *Balanites aegyptiaca* fruits display dimensions ranging from 2 to 7 cm in length and a diameter of 2 to 4.5 cm. Initially covered with a tomentose and green skin, these fruits undergo maturation, transforming into a golden and glabrous state. The edible bitter-sweet pulp surrounds a stone seed encased in ripe fruit with a brown or light brown, brittle-coated exterior and sticky, brown, or brown-green flesh. The stone, referred to as the pyrene, measures 1 to 2.5 cm in length, possesses a light brown, fibrous texture, and is exceptionally hard, constituting approximately 45–55% of the fruit.^[8]

Stem, Bark, and Leaves

Standing at a height of 8–10 meters, this tree boasts an armed exterior and a distinctive fluted trunk. Its bark, ranging from grey to dark brown,

reveals fresh golden layers through large vertical fissures. The supraxillary or subracemose inflorescence gives way to yellow-green flowers, each measuring 1.3 cm. The tree bears fruit from December to July and blooms from November to April, as documented by Fadl in 2015. The ancient plant's stem bark is deeply fissured, displaying varying hues of brown and grey. Young shoots feature long, thick green thorns that mature into a woody state, reaching up to 8 cm in length. Spirally arranged on the stalks, the leaves consist of two firm, coriaceous leaflets in dark green or grey-green tones, both measuring 2.5 to 6 cm with a gritty surface. [9-10]

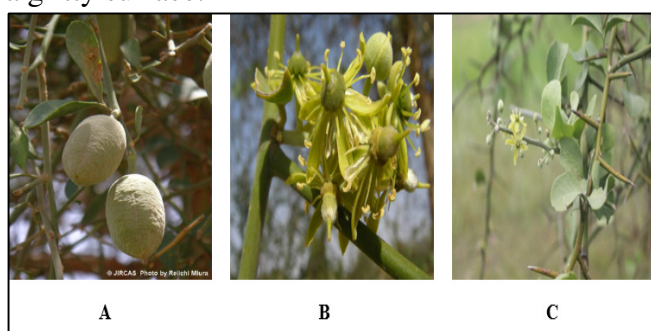


Fig 1: (A) Fruit (B) Flower (C) Stem with leaves of *B. aegyptiaca*

Traditional uses

The aqueous extracts from the fruit exhibit spermicidal properties in humans without inducing vaginal irritation. Upon contact, up to 4% of sperm becomes sluggish, progressing to complete immobility within 30 seconds. Prolonged administration of fruit pulp extract induces testicular dysfunction in canines due to hyperglycemia. The seeds, known for their expectorant, antimicrobial, and antifungal attributes, find application in various medicinal contexts. The fruit, on the other hand, is utilized for treating conditions such as leucoderma, whooping cough, and various skin disorders. Additionally, the bark is recognized for its spasmolytic properties, contributing to the plant's diverse range of therapeutic uses.^[11] In Egyptian traditional medicine, fruits serve as an oral

hypoglycemic and anti-diabetic remedy, addressing metabolic concerns. Meanwhile, Sudanese traditional medicine utilizes an aqueous preparation of the fruit's mesocarp to combat jaundice, highlighting its versatile therapeutic applications. Remarkably, extracts derived from different components of the plant, encompassing the root, branches, bark, fruit, and kernel, demonstrate lethal effects on both miracidia and cercariae of parasites like *Schistosoma mansoni* and *Fasciola gigantica*. This underscores the plant's significant potential in the control and treatment of parasitic infections.^[12] The bark, fruit, and oil of trees have been instrumental in treating a myriad of diseases and ailments, including cancer, diabetes, tuberculosis (TB), HIV/AIDS, malaria, and sleeping sickness. These natural resources showcase a broad spectrum of therapeutic potential, contributing to diverse healthcare applications.^[13]

PHYTOCHEMISTRY

Comprehensive investigations into the phytochemical composition of the plant have unveiled a myriad of compounds. The diversity of these chemical constituents underscores the intricate and multifaceted nature of the plant's biochemical profile, indicating potential applications across a range of fields, including medicine, nutrition, and industry.

Alkaloids

In an extract obtained from the stem and barks of *Balanites aegyptiaca* using dichloromethane, researchers have identified two alkaloids—N-trans-feruloyl tyramine and N-cis-feruloyl tyramine. Additionally, the presence of three common metabolites, namely vanillic acid, syringic acid, and 3-hydroxy-1-4-hydroxy-3-methoxyphenyl-1-propanone, was observed. This chemical composition underscores the potential pharmacological significance of *Balanites aegyptiaca*, indicating its potential role in traditional medicine or other diverse applications.^[14]

Glycosides

The mesocarp of the *Balanites aegyptiaca* fruit has been found to contain two pregnane glycosides. One of these compounds is identified as pregn-5-ene-3,16,20(R)-triol 3-O-D-glucopyranoside. The term "pregn-5-ene" indicates a steroid structure, specifically of the pregnane-type. The specification "3,16,20(R)-triol" denotes the presence of three hydroxyl (OH) groups at positions 3, 16, and 20 in the steroid structure, with the stereochemistry specified as (R). The addition of "3-O-D-glucopyranoside" implies the attachment of a glucose molecule at position 3 in the structure. Another compound identified in the mesocarp is named balagyptin 3-O-(2,6-di-O-L-rhamnopyranosyl)-D-glucopyranoside. The notation "3-O" indicates the position of the initial attachment on the compound. "(2,6-di-O-L-rhamnopyranosyl)" specifies the attachment of two rhamnose molecules at positions 2 and 6, configured in the L form. The term "D-glucopyranoside" implies the attachment of a glucose molecule at the specified position. These specific chemical constituents contribute to the overall biochemical profile of the plant, suggesting potential pharmacological relevance in various applications.^[15]

Saponins

The mesocarp of *Balanites aegyptiaca* fruit is rich in a prominent saponin (1), distinguished by the presence of both 22R and 22S epimers of 26-(O-β-D-glucopyranosyl)-3-β-[4-O-(β-D-glucopyranosyl)]. This major saponin exhibits a unique structure, namely 2-O-(α-L-rhamnopyranosyl)-β-D-glucopyranosyloxy]-22,26-dihydroxyfurost-5-ene, where the attachment site of the rhamnosyl residue sets it apart from a previously identified saponin from the same source, suggesting a structural modification. Additionally, the kernel of *Balanites aegyptiaca* contains a primary saponin (2), characterized as a xylopyranosyl derivative of saponin (1). These discoveries enhance our understanding of the

plant's diverse chemical composition, with potential implications for various applications.^[16]

Flavonoids

The extraction from the leaves and branches of *Balanites aegyptiaca* resulted in the identification of six flavonoid glycosides. These include quercetin 3-glucoside, quercetin 3-rutinoside, quercetin 3-7-diglucoside, and isorhamnetin derivatives such as 3-glucoside, 3-rutinoside, and 3-rhamnogalactoside. Notably, analogues of these isorhamnetin derivatives, specifically 3-rutinoside and 3-rhamnogalactoside, were also found in the fruits of the same plant. The presence of this diverse array of flavonoid compounds underscores the potential pharmacological significance of *Balanites aegyptiaca* and highlights the occurrence of similar constituents across various parts of the plant.^[17]

Coumarin

Bergapten, a furanocoumarin, and (+)-marmesin, a dihydrofurano coumarin, were successfully isolated from a chloroform extract of *B. aegyptiaca*'s stem bark. The *in vivo* anticancer efficacy of bergapten, also known as 5-methoxy psoralen, was demonstrated in mice bearing EHRLICH ascites carcinoma, as well as in the rat sarcoma 45 test system. These findings highlight the potential therapeutic value of specific compounds derived from *Balanites aegyptiaca* in combating certain types of cancer.^[18]

Fatty acids

The kernels of desert dates are notable for their substantial oil content, reaching up to 46.7% based on dry weight. This oil is primarily composed of four main fatty acids: palmitic (16:0), stearic (18:0), oleic (18:1), and linoleic (18:2). Collectively, these fatty acids make up 98–100% of the total fatty acids in the oil across all examined genotypes. Linoleic acid is particularly noteworthy in this fatty acid profile, accounting for approximately 31% to 51%, a composition

resembling that of soybean oil. This lipid composition highlights the potential versatility of desert date oil for various applications, given its similarity to commonly used vegetable oils.^[19]

Phenolic compounds

The phenolic acid profile in both the crude and hydrolyzed extracts revealed the presence of gentisic, p-coumaric, caffeic, ferulic, and sinapic acids. In the crude leaf extract, the flavonoid composition included hyperoside, isoquercitrin, rutoside, and quercitrin. Notably, following acid hydrolysis of the leaf extract, three additional compounds were identified: myricetol, quercetol, and kaempferol. Among the identified phenolic compounds, ferulic acid, isoquercitrin, rutoside, and quercitrin stood out as particularly noteworthy, underscoring the abundant and diverse phenolic content present in the plant's extracts.^[20]

Other compounds

The active principles or phytochemical substances in question encompass a range of compounds, including terpenes, bioflavonoids, benzophenones, xanthenes, and various metabolites such as tannins, saponins, cyanates, oxalate, and anthrax-quinones. These diverse components contribute to the plant's pharmacological and biochemical profile, suggesting a broad spectrum of potential therapeutic properties and biological activities.^[21]

PHARMACOLOGICAL ACTIVITIES

Anti-hyperglycemic activity

The ingestion of *Balanites aegyptiaca* by diabetic rats at a dose of 300 mg/kg for a duration of 45 days demonstrated significant antihyperglycemic effects. This was accompanied by advantageous effects in reducing lipid peroxidation and bolstering the antioxidant defense system. The decrease in blood sugar levels observed is linked to the plant's ability to stimulate insulin release from the remaining pancreatic β -cells. Consequently, this mechanism enhances glucose utilization by

peripheral tissues in diabetic rats, highlighting the therapeutic potential of *Balanites aegyptiaca* in the management of diabetes.^[22] After a comprehensive analysis, it becomes apparent that the leaves, fruit mesocarp, and stem bark of *Balanites aegyptiaca* possess hypoglycemic effects. The detection of chemical elements such as phenolics and flavonoids in the extracts implies their likely involvement in this effect. Significantly, the leaves and fruit mesocarp, characterized by elevated concentrations of these compounds, manifest more pronounced antihyperglycemic advantages, underscoring their importance in the potential regulation of elevated blood sugar levels.^[23]

Hepatoprotective properties

In the assessment of *Balanites aegyptiaca*, a methanolic extract derived from its leaves demonstrated protective effects on the liver against damage induced by carbon tetrachloride (CCl₄) in rats. Administered orally at doses of 200 and 400 mg/kg, the extract resulted in an increase in blood marker enzymes, including glutamate pyruvate transaminase, glutamate oxaloacetate transaminase, alkaline phosphatase, and bilirubin. Additionally, aqueous extracts obtained from the fruit mesocarp and stem bark alleviated CCl₄-induced hepatotoxicity in rats, evidenced by improvements in liver enzyme activity, blood parameters, and histological findings. Similarly, ethanolic extracts of the bark, akin to the protective effects of silymarin, safeguarded rat hepatocytes from paracetamol and CCl₄-induced hepatotoxicity. The presence of polyphenols, alkaloids, and phytosterols in these bioactive compounds, predominantly obtained from the diet, emphasizes their role as scavengers of free radicals and underscores their hepatoprotective properties.^[24]

Anti-inflammatory activity

The oral administration of the ethanolic extract derived from the aerial portions of *Balanites aegyptiaca*, at a daily dosage of 300 mg/kg body weight, resulted in a 55.03% reduction in paw

volume. At a higher dosage of 600 mg/kg body weight per day, this reduction increased to 65.54%, indicating a dose-dependent impact. The plant's anti-inflammatory potential was evident in two distinct animal models: the rat carrageenan-induced edema test and the mouse acetic acid-induced writhing test. It is noteworthy that the ethanol extract obtained from the fruit of *B. aegyptiaca* exhibited proinflammatory properties. The phytochemical analysis identified flavonoids, saponins isolated from both the bark and aerial parts of the plant, as the key components responsible for the observed anti-inflammatory and proinflammatory effects. This underscores the intricate nature of the plant's bioactive compounds in modulating inflammation.^[25]

Anti-fungal properties

Surprisingly, callus extracts from *Balanites aegyptiaca* exhibited stronger antifungal properties compared to other plant parts. This suggests that the callus may serve as a valuable source of medicinal compounds for treating infections caused by *Candida albicans* and other fungi. Callus cultivation presents a promising avenue for in vitro production of natural bioactive chemicals, providing an opportunity to harness and exploit plant-derived compounds for various therapeutic applications.^[26] The alcoholic extract from the fruit of *Balanites aegyptiaca* demonstrated potent antifungal efficacy against a range of *Candida* species and opportunistic fungi. The Minimum Inhibitory Concentration (MIC) of the alcoholic extract varied from 3.05 to 24.0 g/ml for *Candida* species and 1.53 to 49.0 g/ml for opportunistic fungi. This broad-spectrum antifungal activity suggests the potential of *Balanites aegyptiaca* extracts as an alternative treatment for various opportunistic and potentially life-threatening fungal infections. This is particularly significant for immunocompromised patients who may encounter challenges with antifungal drug resistance, highlighting the therapeutic promise of these natural extracts.^[27]

Antibacterial properties

The credibility of traditional healers' assertions regarding the therapeutic use of *Balanites aegyptiaca* leaf extracts for infectious disorders finds support in the substantiated antibacterial activity against test isolates. These extracts showcase promise in addressing illnesses caused by clinically significant isolates, including *S. aureus*, *S. pneumoniae*, *E. coli*, *S. typhimurium*, and *S. dysenteriae*. This underscores a broad spectrum of efficacy in combatting diverse infectious disorders.^[28] Employing the agar well diffusion technique, the antibacterial efficacy of the aqueous extract from *Balanite aegyptiaca* was assessed against both Gram-positive and Gram-negative bacteria obtained from cows with clinical and subclinical mastitis. The bacteria isolated from collected milk samples encompassed *Staphylococcus aureus*, *Escherichia coli*, *Streptococcus agalactiae*, *Salmonella* spp., *Bacillus subtilis*, *Klebsiella pneumoniae*, and *Pseudomonas aeruginosa*. Remarkably, with the exception of *K. pneumoniae*, which exhibited no inhibition at the 400 mg/ml dose, the extract displayed substantial antibacterial activity at concentrations of 400 and 800 mg/ml against all other isolates. These results underscore the potential of *Balanite aegyptiaca* as a valuable source of antibacterial agents for managing mastitis in cows.^[29]

Molluscicidal and Cercaricidal activities

Experiments were conducted to evaluate the molluscicidal and cercaricidal effects of *Balanite aegyptiaca* Del's leaves, fruits, and endocarp on adult schistosomiasis vectors, *Biomphalaria pfeifferi*. Systematic examination of cercaricidal and molluscicidal activities, along with recorded LC50 values, facilitated the comparison of snail mortalities across different plant components. The findings suggested that the leaf extract held a higher potential for inducing mortality in the snail species. In terms of LC50 values, the leaf extract exhibited the highest cercaricidal value at 0.0726, while the fruits and endocarp showed values of

0.0531 and 0.0426, respectively. These results underscore the potential of *Balanite aegyptiaca* components in combating schistosomiasis vectors.^[30]

Chemotherapeutic potential

The methanol extract derived from the stem bark of *Balanite aegyptiaca* (MBA) displayed notable anticancer activities, exhibiting cytotoxic effects on leukemia cell lines and the MCF-7 breast cancer cell line. Additionally, MBA demonstrated strong antiangiogenic effects in an ex vivo rat aorta ring model. The observed effects indicated that MBA enhanced its antiangiogenic properties by suppressing the crucial growth factor VEGF, hindering HUVEC cell migration, and reducing tumor growth in colon cancer-bearing animals. Various extracts from *Balanite aegyptiaca* stem bark showcased a range of anticancer and antiangiogenic activities. MBA, in particular, exhibited robust in vivo antiangiogenic and anticancer characteristics. These results highlight the potential of *Balanite aegyptiaca* stem bark for the development of chemotherapeutic agents effective against both leukemia and solid tumors.^[31]

Insecticidal properties

The research uncovered considerable diversity in the insecticidal impacts of different extracts from desert date on *T. granarium* larvae. Remarkably, the hexane extract derived from the seeds displayed both the highest extractive yield and the most pronounced larval mortality, surpassing the efficacy of other extracts with intermediate and high polarity. Furthermore, the oil extract demonstrated a significant decrease in sorghum damage in comparison to the control, highlighting a substantial repellent influence on insect larvae.^[32] Furthermore, the leaf extract derived from *B. aegyptiaca* exhibited strong efficacy against oviposition, survival in the immature stage, and emergence of cowpea bruchid (*C. maculatus*). This effectiveness was akin to that of a synthetic chemical pesticide and notably distinct from both

the acetone-treated and untreated controls. These results underscore the capability of *B. aegyptiaca* extracts as promising insecticidal agents.^[33]

Anti-oxidant activity

The methanol extract obtained from *Balanite aegyptiaca* showcased notable antioxidant activity, registering at 89.6% through the DPPH (2,2-Diphenyl-1-picryl hydrazyl) free radical scavenging technique at a concentration of 1 mg/mL. The IC₅₀ value, which quantifies antioxidant potency, was documented at 182.02 µg/mL, signifying its efficacy in counteracting free radicals. These findings imply that the methanol extract from *B. aegyptiaca* leaves exhibits potential as an antioxidant agent.^[34] Assessing its free radical scavenging capabilities using propyl gallate as a standard antioxidant and 3-(4,5-dimethylthiazol-2-yl)-2,5-diphenyltetrazolium bromide (MTT) for cytotoxicity screening, the methanol extract derived from *Balanite aegyptiaca* leaves underwent examination. The MTT experiment confirmed the extract's safety, as the evaluated antioxidant activity yielded a Relative Scavenging Activity (RSA) of 70.07%, in contrast to the control levels of propyl gallate (88.07% RSA). These results indicate that the methanol extract of *B. aegyptiaca* leaves demonstrates antioxidant activity alongside a noteworthy safety profile, suggesting potential avenues for further exploration in antioxidant applications.^[35]

Anti-viral properties

Remarkable antiviral activity was identified, and the efficacy observed in plants with this activity may be linked to their heightened susceptibility to Vesicular Stomatitis Virus T2, a pathogen known to induce respiratory illnesses.^[36]

Wound healing activity

Balanites aegyptiaca is well-known for its effective wound-healing attributes, notably demonstrated through its ability to accelerate wound contraction. Additionally, the plant showcases strong

antioxidant activity, as observed in its capability to impede lipid peroxidation, counteract the DPPH radical, and shield fibroblast cells from oxidative damage. These characteristics underscore the potential therapeutic uses of *Balanites aegyptiaca* in enhancing tissue healing and combating the effects of oxidative stress.^[37]

Anti-venin activity

The intramuscular administration of *Balanites aegyptiaca* stem bark acetone and methanolic extracts to Wistar albino rats revealed notable antivenin efficacy against the saw-scaled (*Echis carinatus*) viper venom, even at the fatal dose of 0.194 mg/ml. Remarkably, both extracts exhibited efficiency at concentrations of 75 and 100 mg/ml, indicating their potential as effective antivenom agents against viper envenomation.^[37]

Toxicological study

In a repeated dosage toxicity study spanning four weeks and involving male Wistar strain rats, the investigation focused on the crude *Balanites aegyptiaca* seed oil. This oil, commonly utilized as a culinary ingredient and a substitute for groundnut oil in Nigeria, was administered to rats divided into four groups, each receiving diets with varying concentrations (0–5%) of the crude *B. aegyptiaca* seed oil. Notably, apart from the 5% group where ALT activity experienced an elevation, no significant ($p > 0.05$) alterations were observed in AST or ALT levels. Furthermore, serum parameters, including total protein, albumin, A/G ratio, serum urea, creatinine, mean final body weight, food intake, and relative liver and kidney weight, did not demonstrate statistically significant changes ($p > 0.05$). These results imply that exposure to crude *B. aegyptiaca* seed oil through dietary intake did not lead to notable toxicological effects, particularly concerning liver and kidney damage, indicating a relatively low safety risk at the current level of exposure.^[37]

CONCLUSION

This review offers a comprehensive analysis of *Balanite aegyptiaca*, encompassing its phytochemical constituents and pharmacological activities. The research on this plant underscores its vast potential in medicine and natural product development. Through the identification of diverse compounds such as saponins, flavonoids, and alkaloids, *Balanite aegyptiaca* exhibits promising pharmacological activities, including antioxidant, antimicrobial, anti-inflammatory, and anticancer properties. The findings from various studies emphasize the necessity for further exploration and utilization of *Balanite aegyptiaca* as a valuable source of bioactive compounds. Future investigations are crucial to unravel the mechanisms of action and potential therapeutic applications of these phytochemical constituents. In essence, this review lays a comprehensive foundation for future research endeavors, emphasizing the significance of *Balanite aegyptiaca* in the development of novel drugs and natural products for human health.

The method by that nature protects cells from reactive oxygen species (ROS) assault is through antioxidants. Our body produces antioxidant enzymes to stop these harmful chain reactions and naturally moves a range of nutrients for their antioxidant qualities. The condition known as oxidative stress occurs when our body's antioxidant protections are outnumbered by free radicals. Oxidants inhibit these vicious cycles by scavenging reactive precursors in addition to inhibiting other oxidation processes through oxidation. Damage to DNA can result in cancer if DNA repair processes cannot reverse the damage.

Conflicts of Interest: The authors declare that there are no conflicts of interest.

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NA

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