

REVIEW ON THE BIOACTIVE PHYTOCONSTITUENTS OF *LUFFA CYLINDRICA* AND THEIR MECHANISTIC ROLE IN PHARMACOLOGICAL ACTIVITIES*¹Basavachetan Kharabe, ²Dr. Jose Gnana Babu, ³D. Visagaperumal, ⁴Vineeth Chandy¹Student, T. John College of Pharmacy Gottigere, Bannerghatta Road, Bengaluru- 560083.²Associate Professor, T. John College of Pharmacy Gottigere, Bannerghatta Road, Bengaluru- 560083.³Vice Principal, T. John College of Pharmacy Gottigere, Bannerghatta Road, Bengaluru- 560083.⁴Principal, T. John College of Pharmacy Gottigere, Bannerghatta Road, Bengaluru- 560083.

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Research, 9(11), 01–08.**ABSTRACT**

A medicinal plant of considerable ethnopharmacological significance, *Luffa cylindrica* (Family: Cucurbitaceae), also referred to as vegetable sponge or sponge gourd, has long been utilized for its therapeutic properties in a variety of cultures. A thorough summary of the bioactive phytoconstituents that were separated from *Luffa cylindrica* and their molecular functions in various pharmacological activities is what this review attempts to provide. Numerous secondary metabolites, such as flavonoids, saponins, alkaloids, phenolics, and terpenoids, are abundant in the plant and have been demonstrated to possess strong antibacterial, anticancer, antioxidant, anti-inflammatory, and hepatoprotective qualities.

Indexterms: Cucurbitaceae, *Luffa cylindrica***INTRODUCTION**

Modern pharmacological research continues to heavily rely on the centuries-old usage of therapeutic plants in traditional healthcare systems. Among these is the tropical climbing vine *Luffa cylindrica* (Family: Cucurbitaceae), sometimes referred to as sponge gourd, Egyptian cucumber, or loofah. It is widely grown throughout Asia, Africa, and portions of the Americas. Although its fibrous fruit is well known for its natural scrubber properties, *Luffa cylindrica* has attracted scientific interest because of its rich phytochemical composition and variety of therapeutic uses.^[1,2]

Traditionally, various parts of the plant—including the fruit, seeds, roots, and leaves—have been used in the treatment of conditions such as asthma, sinusitis, jaundice, leprosy, hemorrhoids, and intestinal parasites.^[3,4] These ethnomedicinal uses are supported by modern phytochemical studies revealing the presence of bioactive constituents like flavonoids, alkaloids, saponins, phenolic acids, terpenoids, and cucurbitacins.^{[5-}

^{7]} The pharmacological potential of the plant, which includes antibacterial, anticancer, antioxidant, hepatoprotective, anti-inflammatory, and antidiabetic properties, has been the subject of recent studies.^[8-10] The way that particular phytoconstituents of *Luffa cylindrica* interact with cellular targets to produce therapeutic effects has been further clarified by mechanistic investigations, such as molecular docking and in vitro experiments.^[11]

Given the increasing global interest in plant-based drug discovery and natural product chemistry, *Luffa cylindrica* presents a promising candidate for pharmaceutical exploration. This review aims to consolidate current findings on the phytochemical constituents of *Luffa cylindrica*, discuss their mechanisms of pharmacological action, and highlight potential directions for future research in drug development and molecular medicine.

Distribution and Geographical Availability of *Luffa cylindrica*

The Cucurbitaceae family includes *Luffa cylindrica*, which is indigenous to South and Southeast Asia, especially Bangladesh, India, Nepal, and Myanmar. Both culinary and medicinal uses have long been associated with its cultivation. It is currently widely dispersed throughout tropical and subtropical regions of the world because of its agricultural versatility and resilience to different soil and temperature conditions.^[12]

The Indian states of West Bengal, Uttar Pradesh, Bihar, Odisha, Andhra Pradesh, Maharashtra, and Tamil Nadu are the most popular places to grow *Luffa cylindrica*, which is used in both traditional medicine and cooking. One of the main cucurbit vegetables grown throughout the Indo-Gangetic plains is this one.^[13]

The plant is also widely grown as a commercial crop and as a garden vegetable in Southeast Asian nations like Thailand, Vietnam, the Philippines, and Indonesia. It has been utilized for ages in traditional Chinese medicine as well as as a food item in China.^[14]

Beyond Asia, *Luffa cylindrica* is cultivated in parts of Africa, particularly Nigeria, Sudan, and Egypt, where the mature fibrous fruits are often used as natural sponges. It is also cultivated in tropical regions of South and Central America, including Brazil, Colombia, and Mexico. In the United States, it is grown primarily in the southern states like Florida, Texas, and California, where it is valued for its use in crafts and as an eco-friendly sponge alternative.^[15,16]

Taxonomic Classification

Table 1: Taxonomical Classification of *Luffa cylindrica*.^[17]

Kingdom	Plantae
Subkingdom	Tracheobionta
Superdivision	Spermatophyta
Division	Magnoliophyta
Class	Magnoliopsida
Subclass	Dilleniidae
Order	Cucurbitales
Family	Cucurbitaceae
Genus	<i>Luffa</i>
Species	<i>Luffa cylindrica</i> (L.) M. Roem

Vernacular Names

Table 2: Vernacular Names of *Luffa Cylindrica*.^[18]

Language /Region	Vernacular Name
English	Sponge gourd, Smooth loofah, Vegetable sponge
Hindi	Ghiya torai, Nenua
Bengali	Dhundhul
Tamil	Peer कांगai
Telugu	Beerakaya
Kannada	Hirekayi
Malayalam	Peechinga
Marathi	Dodka
Gujarati	Galka
Punjabi	Ghia tori
Urdu	Torai

Morphological Characteristics^[19,20]

Habit:- Herbaceous, annual climbing or trailing vine with angular, ridged stems.

Stem:- Pentangular, green, hairy when young, becoming glabrous with age; climbing with coiled tendrils.

Leaves:- Alternate, palmately lobed (5–7 lobes), rough-textured, 10–20 cm across.

Tendrils:- Branched or unbranched, spring-like, used for climbing support.

Flowers :- Monoecious (male and female flowers on the same plant); yellow, solitary or racemose. Male flowers borne in clusters; female flowers solitary.

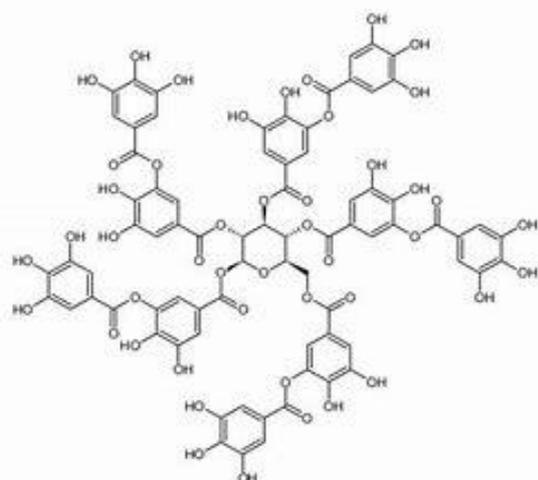
Fruit :- Cylindrical, elongated (20–60 cm), green with smooth skin, fibrous at maturity; spongy network of vascular bundles forms inside.

Seeds :- Flat, smooth, black or dark brown, elliptical in shape; encased in a fibrous network.

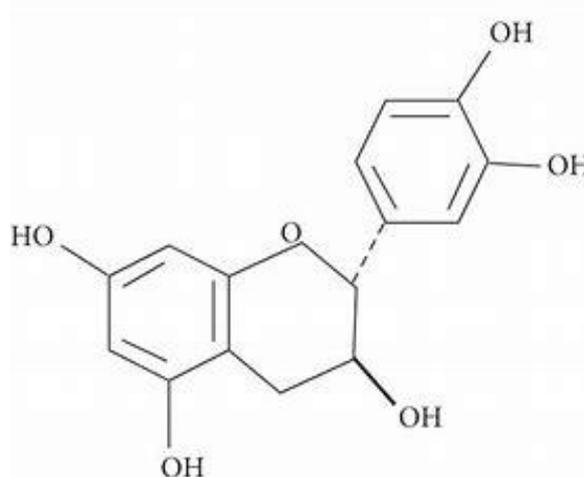
Root :- Taproot system with lateral branches.

Fig. 1: *Luffa cylindrica* leaves and flowers.Fig. 2: *Luffa cylindrica* fruits and seeds.CHEMICAL CONSTITUENTS^[18]Table 3: Chemical constituents of *Luffa Cyclindrica*.

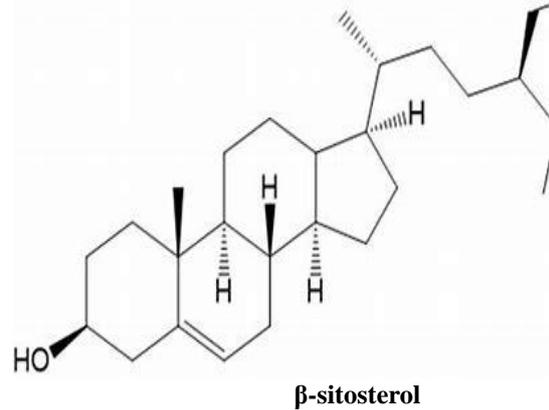
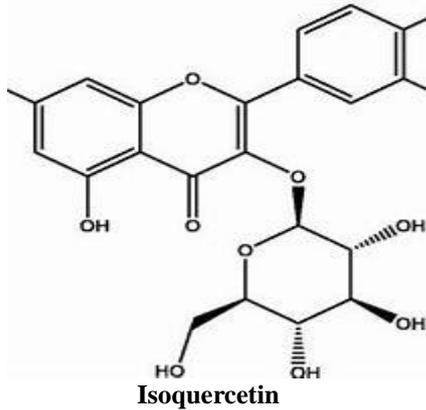
Plant Part	Specific Phytochemicals	Phytochemical Class
Leaves	- Luteolin, Apigenin, Quercetin, Kaempferol - Gallic acid, Ferulic acid - β -sitosterol	- Flavonoids - Phenolic acids - Phytosterol
Fruits	- Cucurbitacin B, Cucurbitacin E - Stigmasterol, β -sitosterol - Saponarin	- Triterpenoids - Steroids - Flavone glycoside
Seeds	- Luffin A & B (type-I ribosome-inactivating proteins) - Linoleic acid, Oleic acid, Palmitic acid, Stearic acid - β -sitosterol, Campesterol	- Proteins - Fatty acids - Phytosterols
Root	- Lupeol, Oleanolic acid - Tannic acid	- Triterpenoids - Tannin
Stem	- Triterpenoids Saponins - Vanillic acid	- Saponins - Phenolic compounds
Peel	- Chlorogenic acid, p-Coumaric acid - Isoquercetin	- Phenolic acids - Flavonoid glycoside
Pulp	- Cellulose, Lignin, Hemicellulose	- Structural polysaccharides



Tannic acid



Catechin



Active Chemical Constituents of *Luffa cylindrica*

Luffa cylindrica is a medicinal plant well-known for its rich phytochemical profile and diverse pharmacological effects. It contains a variety of bioactive constituents such as tannins, saponins, flavonoids, alkaloids, phenols, terpenoids, steroids, and glycosides. Condensed tannins including catechin, epicatechin, and procyanidins have been associated with potent anthelmintic activity, where they bind to and disrupt parasite cuticle proteins, leading to paralysis and death of helminths.^[24] Saponins, another major group present in the plant, contribute to anthelmintic and antibacterial activity through membrane disruption of parasites and microbes.^[22]

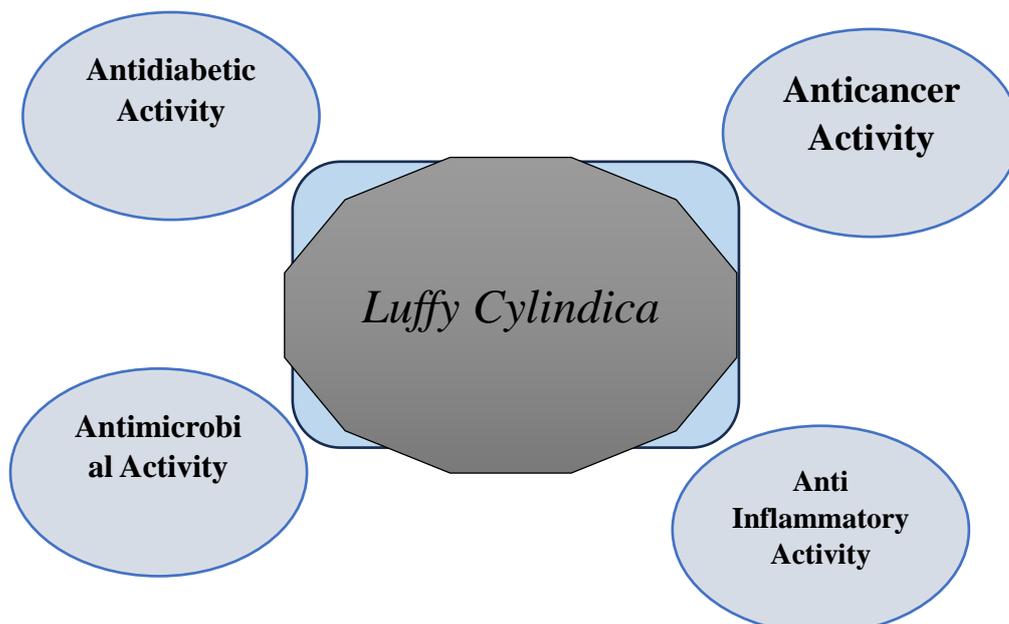
Flavonoids such as quercetin and kaempferol, found in the leaves and fruits, exert antioxidant, anti-inflammatory, and anticancer effects by scavenging free radicals and inducing apoptosis in tumor cells.^[25] Alkaloids in *Luffa cylindrica*, notably luffin A and B, have shown antitumor and cytotoxic properties by inhibiting protein synthesis and interfering with cellular division.^[23] Phenolic compounds including gallic acid and ellagic acid enhance antioxidant and anthelmintic activity through oxidative damage to parasite tissues.^[26]

The presence of terpenoids and steroids, such as lupeol and stigmasterol, has been linked to anti-inflammatory, hepatoprotective, and antimicrobial activities by modulating immune responses and disrupting pathogen cell membranes.^[27] Additionally, glycosides, particularly cucurbitacins, have been identified in the seeds and exhibit potent cytotoxic and anticancer effects by inhibiting cancer cell proliferation and altering signaling pathways.^[21]

In conclusion, the biological activities of *Luffa cylindrica*—including anthelmintic, antibacterial, anticancer, antioxidant, and anti-inflammatory effects—are attributed to the synergistic action of its diverse phytoconstituents. These findings support the therapeutic potential of this plant in traditional and modern medicine.

PHARMACOLOGICAL EFFECTS

Luffa Cylindrica contains various therapeutic activities. The activities are displayed in the picture below.



Anti inflammatory Activity

Intraperitoneal administration of water decoction of Sigaluo inhibited carrageenan induced plantar edema in rats.^[28] P Muthumani et al has carried out phytochemical screening and Anti inflammatory, Bronchodilator and Antimicrobial activities of the seeds of *Luffa cylindrica* and concluded all the extracts revealed the presence of sugar, protein, alkaloids, flavonoids, sterols and glycosides as major constituents. Cu-1 is oil has shown more unstauration and less acid value which has been hydrolyzed and the resulting free fatty acids have been converted into their respective methyl esters for separation on GLC. CU-2 this is the unsaponifiable fraction of the oil. The sterols or related compounds are present in this fraction as the chemical and spectral data suggests. This showed very high antifungal and significant anti bacterial activity. CU-3 has significant anti-inflammatory activity. CU-4 showed bronchodilator

activity. This extract showed very high degree of antifungal activity.^[29]

Rats' cotton pellet granuloma development and paw edema caused by carrageenan are indicative of the edematous phases of both acute and chronic inflammation.^[30, 31] Carrageenan-induced rat paw edema was used in the current investigation to assess the anti-inflammatory effect of *Luffa cylindrica* chloroform extract at doses of 50 mg/kg and 25 mg/kg. The results were compared with those of the control group (Table 4). Treatment with *Luffa cylindrica* chloroform extract (25 mg/kg and 50 mg/kg) demonstrated a substantial reduction in rat paw edema caused by carrageenan. In comparison to the control, the highest level of inhibition was seen at a dosage of 50 mg/kg. When it comes to carrageenan-induced hind paw edema, it was found that the chloroform extract of *Luffa cylindrica* (50 mg/kg, p.o.) has the strongest anti-inflammatory effects.

Table 4: Effects of the various extracts of *Luffa cylindrica* on extracts on rat paw edema induced by carrageenan.

Paw volume in ml				
Time (in hrs)	Control	Ibuprofen (10mg/kg)	Extract (25mg/kg)	Extract (50mg/kg)
0	0.24 ± 0.01	0.22 ± 0.035	0.25 ± 0.012	0.26 ± 0.01
1	0.28 ± 0.023	0.25 ± 0.04	0.28 ± 0.02	0.25 ± 0.014
2	0.31 ± 0.031	0.28 ± 0.03	0.3 ± 0.012	0.28 ± 0.014
3	0.37 ± 0.04	0.22 ± 0.03 ^a	0.29 ± 0.024	0.27 ± 0.03
4	0.38 ± 0.04	0.2 ± 0.014 ^{ab}	0.27 ± 0.012	0.23 ± 0.03 ^a
5	0.34 ± 0.03	0.18 ± 0.02 ^{ab}	0.22 ± 0.015 ^a	0.2 ± 0.03 ^{ab}
6	0.3 ± 0.03	0.15 ± 0.003 ^{ab}	0.20 ± 0.014 ^a	0.18 ± 0.014 ^{ab}

All values are expressed as Mean ± SEM; n =6. Statistical Significance was calculated by ANOVA followed by post hoc Dunnett's using SPSS package (a p<0.01).

Anticancer Activity

Cell Culture Condition

The cells were propagated using Dulbecco's modified Eagle's medium (DMEM), which is enhanced with 10% fetal bovine serum and 1 unit/mL of the antibiotics streptomycin and penicillin. Dimethyl sulfoxide (DMSO) was used to prepare a stock of silver nanoparticles mediated by LAAgNP extract (10 mg/mL). For experimental purposes, various doses of 10, 25, 50, 75, and 100 µg/mL in culture media were generated.

Determination of Cell Viability by MTT Assay

For 24 hours, human glioma cells (DBTRG and U87) and human breast cancer cells (MCF-7 and MDA-MB-231) with a concentration of $0.5 - 1.0 \times 10^4$ were cultured with LAAgNPs and kept at 37°C in a humidified atmosphere with 5% CO₂. The MTT test was used to count the number of viable cells in both samples. Tamoxifen (5) was used as a reference standard for activity against DBTRG and U87 cell lines, while gefitinib (6) was used as a reference standard for activity against MCF-7 and MDA-MB-231 cell lines. The absorbance was measured at 570 nm wavelength, and the cell viability percentage against LAAgNPs concentrations was calculated in the form of IC₅₀.^[32]

Antidiabetic Activity

In alloxan-induced diabetic rats, the study was conducted to assess the anti-diabetic effects of *Luffa cylindrica* (native sponge/spongegourd) seed and leaf extracts. Four groups of four rats each were created from the sixteen experimental rats: a, diabetic control; b, normal control; c, diabetic rats treated with 400 mg/kg of seed extract; and d, diabetic rats treated with 400 mg/kg of leaf extract. Rats in groups A, C, and D received intraperitoneal injections of alloxan (150 mg/kg bw) to induce diabetes. The following biochemical tests were performed after the plant seed and leaf extracts underwent phytochemical screening: Most biochemical parameters, including blood glucose, serum lipid profile, serum alanine aminotransferase, serum aspartate aminotransferase, serum alkaline phosphatase, total protein, albumin, creatinine, urea, uric acid, and some electrolytes like Na⁺, K⁺, HCO₃⁻, and Cl⁻, increased when alloxan was given to experimental rats. These included serum total cholesterol, triglycerides, low density lipoprotein, creatinine, urea, and uric acid. After two weeks of administering *Luffa cylindrica* seed and leaf extracts to groups C and D of diabetic rats, respectively, the results were compared to those of the normal control and diabetic control rats. The diabetic groups' parameters were significantly (p<0.05) higher

than those of the normal control groups. The raised blood levels of glucose, cholesterol, triglycerides, alkaline phosphatase, amylase, aspartate aminotransferase, alanine aminotransferase, creatinine, urea, and uric acid linked to alloxan-induced diabetic rats were considerably ($p < 0.05$) decreased by treatment with the plant extract. The plant tested negative for cardiac glycosides, phenols, resins, terpenes, and steroids, but positive for alkaloids, flavonoids, saponins, and tannins. In rats with diabetes produced by alloxan, extracts of *Luffa cylindrica* seed and leaf have demonstrated anti-diabetic and anti-lipidemic properties in general. The results of the study have confirmed the traditional usage of the *Luffa cylindrica* plant in the treatment of diabetes and its complications by demonstrating that the plant has hypoglycemic and hypolipidemic properties.^[33]

Antimicrobial Activity:-

Antimicrobial activities of the plant extracts were tested using agar-well diffusion method.^[34] 0.1 ml of the overnight culture of the selected strains of bacteria was seeded into molten nutrient agar and potato dextrose agar for fungi using pour plate method. 5 wells were made on the agar surface with a 5 mm sterilized cork borer. The extracts were poured into the wells using sterile syringe. The plates were incubated at 37°C for 24 hours for bacteria and 48 hours for fungal activity. The plates were observed for the zone of inhibition around the wells. The zones of inhibition were recorded in millimetres excluding the diameter of the wells. Chloramphenicol and Gentamicin were used as standard antibiotic drug

respectively. The extracts were prepared by dissolving 0.5g, 1g, 1.5g, and 2g of the concentrates obtained from the solvent (methanol) and made up to 10 ml with distilled water to give a concentration of 0.05 g/ml, 0.1 g/ml, 0.15 g/ml, and 0.2 g/ml respectively.^[35,36]

Table 5 displays the antibacterial activity of methanolic extracts of *Luffa cylindrica*'s leaves and flowers. The findings were presented as the methanolic extracts' zone of inhibition (mm) of the indicator fungus and bacteria. With the exception of *Salmonella typhi*, which was only inhibited by the methanolic leaf extract, *Escherichia coli*, *Staphylococcus aureus*, *Aspergillus niger*, and *Candida albicans* were susceptible to both the leaf and flower methanolic extracts of *L. cylindrica*, whereas *Klebsiella* spp. were not. At doses of 0.10 g/ml, 0.15 g/ml, and 0.2 g/ml, every susceptible organism showed sensitivity.

The only organisms that were responsive at the lowest dose employed in the study, 0.05 g/ml, were *Staphylococcus aureus* and *Candida albicans*. Zones of inhibition ranging from 2.0 to 20.0 mm demonstrated the antibacterial activity of the methanolic extracts against the tested microorganisms. At 20 mm, *Candida albicans* exhibited the maximum susceptibility.

These findings suggest that methanolic leaf extract had superior antibacterial action against *S. aureus*, *E. coli*, and *S. typhi*, and that methanolic floral extract had superior antifungal activity against *A. niger* and *C. albicans*.

Table 5: Zone of inhibition (mm) of indicator microorganisms by methanolic extracts of *Luffa cylindrica* leaves and flowers.

Extract (conc.)	Microorganisms							
	E. coli		Klebsiella spp.		S. aureus		S. typhi	
	MLE	MFE	MLE	MFE	MLE	MFE	MLE	MFE
0.05 g/ml	0.0	0.0	0.0	0.0	4.0	0.0	0.0	0.0
0.10 g/ml	3.0	2.0	0.0	0.0	5.0	4.0	4.0	0.0
0.15 g/ml	4.0	4.0	0.0	0.0	6.0	5.0	5.0	0.0
0.2 g/ml	6.0	6.0	0.0	0.0	7.0	6.0	6.0	0.0
Chloram-phenicol	30.0	30.0	24.0	24.0	32.0	32.0	21.0	21.0
Gentamicin	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Key: MLE: Methanolic Leaf Extract MFE: Methanolic Flower Extract (0.0): No Zone of Inhibition

Table 6 displays the findings of a quantitative analysis of the phytochemical active components in *Luffa cylindrica* methanolic extracts for the leaves and flowers independently. It was discovered that flowers have higher levels of the phytochemicals oxalate, phytate, saponin, tannin, and alkaloids than leaves. Certain chemical compounds that have a specific physiological effect on the human body are what give plants their therapeutic value. Numerous phytochemicals have been discovered to have a variety of properties that could aid in preventing chronic illnesses.^[37] In addition to being a source of novel compounds with antimicrobial activity and perhaps new modes of action, several medicinal plants are thought to be prospective antibacterial crude medicines.^[38] The proportional antibacterial activity of

the extracts determines the zones of inhibition of growth of the microorganisms used in this investigation. According to Oyetayo et al. (2007)^[36], the main components of medicinal herbs that give them their antibacterial qualities include saponin and tannin. Kumarawa et al. (2007)^[39] have documented the significance of alkaloids, saponins, and tannins in a variety of antibiotics used to treat prevalent pathogenic strains.

Table 6: Phytochemical analysis of methanolic extracts of the leaves and flowers of *Luffa cylindrica*.

Methanolic Extracts		
Phytochemicals	Leaf	Flower
Alkaloid (g/100g)	0.11	1.13
Tannin (mg/g)	84.9	238.8
Saponin (g/100g)	0.01	0.03
Phytate (g/100g)	2.02	2.93
Oxalate (mg/g)	2.43	4.68

It can be concluded that some methanol-extractable phytochemicals from leaf and flower of *Luffa cylindrica* possess in-vitro antimicrobial activity against the test microorganisms. The ability of the *L. cylindrica* methanolic extracts to inhibit the pathogens used as test microorganisms holds promise for potential application in the pharmaceutical industry as a source of useful drugs.^[40]

CONCLUSION

With a broad spectrum of pharmacological actions, including as strong, antibacterial, anticancer, antioxidant, anti-inflammatory, and antidiabetic effects, *Luffa cylindrica* shows promise as a medicinal plant. Its extensive phytochemical composition—in particular, flavonoids, tannins, saponins, alkaloids, and terpenoids—is responsible for these functions. Both in vitro and in vivo experimental investigations have confirmed its conventional uses and created novel therapeutic opportunities. Nevertheless, more investigation is necessary to fully realize its promise in contemporary medicine, including clinical trials and bioassay-guided active compound separation. Thus, *Luffa cylindrica* has a lot of potential for creating natural health solutions that are safe, efficient, and reasonably priced.

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