

**Phytochemical Screening and Biological Activities of *Kigelia africana* Fruit Extracts**

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Abstract

Phytochemicals have a widespread role in traditional medical systems and are essential in the treatment of many illnesses. It is well known that medicinal plants are abundant in bioactive substances with potential for treatment. In this study *Kigelia africana* (sausage tree) fruits were collected, shade-dried, powdered, and used to extract phytochemicals with water and organic solvents. The Standard phytochemical screening procedures were applied to the extracts in order to detect the presence of secondary metabolites and additional constituents. Numerous secondary metabolites, including flavonoids, alkaloids, tannins, saponins, and phenolic compounds, are found in *Kigelia africana*, which is well known for its therapeutic benefits. The ethanol extract of fruit revealed the presence of carbohydrates, alkaloids, proteins, flavonoids, tannins, saponins, glycosides, cholesterol, triterpenoids, phytosterols, and phenolic compounds. The antibacterial activity was evaluated using ethanol and acetone as solvents using the Gram-positive bacteria *Streptomyces erythraeus* and *Bacillus subtilis*. Both ethanol and acetone extracts had shown good antibacterial properties against the microorganisms. Additionally, tests indicated that the plant exhibits antioxidant and anti-inflammatory activities. These results offer a phytochemical basis for *Kigelia africana's* traditional usage in the treatment of infections, inflammation, and oxidative stress diseases. The abundance of different and effective phytochemicals encourages future pharmacological research and the possible creation of plant-based medicinal medicines are supported by the existence of a variety of strong phytochemicals.

Keywords: *Kigelia africana*, Phytochemicals, Secondary metabolites, Antibacterial, Antioxidant and Anti-inflammatory

1. Introduction

Medicinal herbs have been used for ages to prevent and treat a variety of human illnesses, and they are the foundation of traditional medical systems such as Ayurveda, Traditional Chinese Medicine, Siddha, and Unani (Lakshmi et al., 2014). These plants are treasured not just for their historical and cultural significance, but also for their therapeutic efficacy, which is mostly due to their high concentration of bioactive secondary metabolites (Breijyeh et al., 2024). Phenolics, flavonoids, alkaloids, saponins, terpenoids, and glycosides all contribute to a variety of pharmacological actions, including antibacterial, anti-inflammatory, antioxidant, hepatoprotective, antidiabetic, anticancer, and immunomodulatory properties (Riaz et al.,

2024). These chemical elements frequently work synergistically to increase the plant's overall medicinal potential (Al-Kuraishy et al., 2022).

Plant-based medicine has seen a worldwide rise in interest in recent decades. Growing worries about the drawbacks of synthetic medications such as unfavourable side effects, exorbitant prices, diminished effectiveness as a result of antibiotic resistance, and restricted availability in poor and rural areas have prompted this fresh focus (Mosihuzzaman, 2012). Because of this, scientific research and public health campaigns are increasingly looking to plant-derived therapies as safer and more environmentally friendly substitutes. In order to standardize herbal compositions and guarantee their safety and effectiveness, researchers are actively working to validate traditional knowledge using pharmacological testing, chemical profiling, and clinical trials (Hua et al., 2025; Wei et al., 2020).

One of the biggest benefits of medicinal plants is their availability, affordability, and cultural acceptability, especially in low-resource environments where contemporary medications may be hard to find or prohibitively expensive (Karunamoorthi et al., 2013). These plants are also a great source of lead compounds for contemporary drug development. Some notable examples are paclitaxel from *Taxus brevifolia*, quinine from *Cinchona species*, artemisinin from *Artemisia annua*, and morphine from *Papaver somniferum* (Alamgir, 2017). New bioactive chemicals from medicinal plants have a lot of promise to be improved and turned into widely used medications (Dar et al., 2023).

The preservation of ethnomedicinal knowledge, comprehension of ecological adaptations, and the discovery of novel compounds with therapeutic potential all depend on the ongoing investigation of plant biodiversity, in addition to its pharmacological importance (Buenz et al., 2018). Ethnobotanical surveys are improving drug discovery pipelines and deepening our understanding of medicinal flora in conjunction with contemporary technologies like metabolomics, genomics, and high-throughput screening. Nonetheless, ethical bioprospecting and sustainability principles must direct this process. Conservation efforts and equitable benefit-sharing with indigenous communities are more crucial than ever because many medicinal plant species are seriously threatened by overharvesting, habitat loss, and climate change (Howes et al., 2020). As a link between traditional knowledge and contemporary research, medicinal plants continue to be an essential resource for world health. In addition to addressing current health issues, these natural treatments have the potential to promote a greater regard for biodiversity and traditional knowledge systems through careful scientific validation and appropriate use (Alves et al., 2007).

Kigelia africana (Lam.) Benth, also known as the sausage tree, is a significant medicinal plant because of its widespread use in African traditional medicine. It is the solitary species in the *Kigelia* genus, which is part of the Bignoniaceae family (Atawodi et al., 2017) *K. africana* is native to tropical and sub-Saharan Africa, where it grows along riverbanks, forested savannahs, and floodplains, reaching heights of up to 20-25 meters. The tree is distinguished by its huge pinnate leaves, beautiful crimson bell-shaped blooms, and elongated, sausage-like woody fruits measuring up to 60 cm long and weighing up to 10 kg (Areces-Berazain, 2022).

Traditionally, many parts of the plant, such as the fruits, bark, leaves, and roots, have been employed in therapeutic formulations. Ethnomedicinal applications include treating dermatological illnesses (eczema, leprosy, fungal infections, wounds, and ulcers), digestive disorders (dysentery, ulcers), respiratory ailments, gynecological problems, malaria,

rheumatism, diabetes, and venereal diseases. The fruit pulp is widely used topically to enhance wound healing, reduce inflammation, and firm skin, as well as in cosmetic formulations. Aside from its medicinal value, the plant serves culinary, cultural, and ecological purposes, including traditional brewing (e.g., Kenyan muratina), emergency food (roasted seeds), and carpentry and dyeing. Elephants, baboons, and bats help pollinate and disperse the seeds (Abbas et al., 2023; Ojediran et al., 2024).

Among its many parts, the fruit has been prized for its therapeutic uses, including the treatment of joint pain, fungal infections, and wounds. The fruit's medicinal qualities are ascribed to its abundant phytochemical composition, which includes flavonoids, phenolic compounds, tannins, alkaloids, glycosides, and saponins. Many of these phytochemicals are known to have potent biological activities, such as anti-inflammatory, antimicrobial, and antioxidant effects. There is still little scientific research on the fruit, particularly when it comes to comparative solvent extraction techniques, despite its wide ethnopharmacological significance.

The objective of this study is to analyze the biological activities and phytochemical components of ethanol and acetone extracts of *Kigelia africana* fruit. This covers the in vitro evaluation of antioxidant, antibacterial, and anti-inflammatory qualities as well as qualitative phytochemical screening. The study aims to evaluate the fruit's traditional medical benefits and offer insight into its prospective applications in the development of plant-based medicines by comparing extracts based on solvents.

2. Materials and Methods

2.1 Collection and Preparation of Plant Material

The fresh fruits of *Kigelia africana* were collected from the roadside area near Zoo Park Road, Tirupati, Andhra Pradesh, India. The plant material was authenticated based on morphological features by a qualified botanist.

After collection, the fruits were thoroughly washed with tap water to eliminate dust and adhering particles, followed by rinsing with distilled water. The cleaned fruits were then sliced into smaller pieces to facilitate uniform drying. The pieces were shade-dried at room temperature (25–30 °C) for 10–15 days to preserve the bioactive compounds and prevent photodegradation.

Once completely dried, the fruit pieces were ground into a fine powder using a mechanical grinder. The powdered material was passed through a sieve to obtain uniform particle size and then stored in clean, dry, airtight glass containers. The containers were labelled and kept at room temperature in a cool, dark place to avoid moisture and light exposure until further use in phytochemical screening and biological assays.

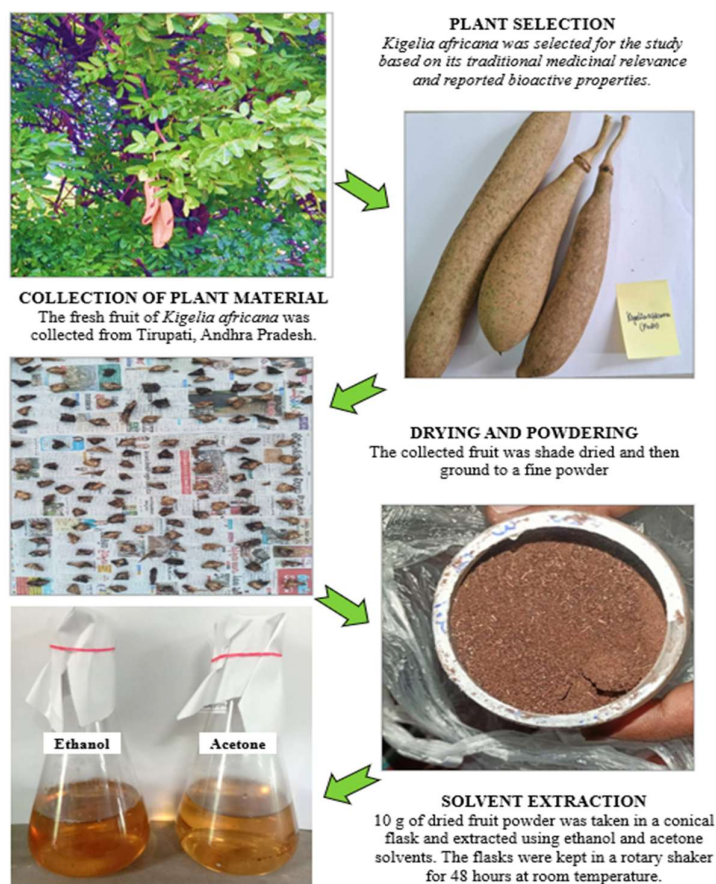
2.2 Preparation of Plant Extracts

The solvent extraction method is a widely adopted technique for isolating bioactive compounds from plant materials, utilizing suitable organic solvents to target specific phytochemical classes. In this study, ethanol and acetone were selected as extraction solvents due to their broad polarity range, which enables the efficient solubilization of both polar and semi-polar phytoconstituents.

For the extraction process, 10 grams of shade-dried and finely powdered *Kigelia africana* fruit were weighed and transferred into separate conical flasks containing 100 mL of ethanol and

acetone, respectively. The mixtures were subjected to continuous agitation on a rotary shaker at room temperature ($25 \pm 2^\circ\text{C}$) for 48 hours to ensure optimal solvent penetration and compound dissolution. Following maceration, the mixtures were filtered using Whatman No. 1 filter paper, and the filtrates were concentrated and stored at 4°C in airtight containers for subsequent phytochemical analysis and biological activity assays.

This method enhances the extraction of diverse phytochemicals, including flavonoids, phenolics, and iridoids, making it well-suited for comprehensive phytochemical profiling and functional bioassays of *K. africana* fruit extracts (Nabatanzi et al., 2020; Dzomba & Mhini,



2021).

Figure 1. Sequential steps involved in the preparation of *Kigelia africana* fruit extracts. The process includes (1) plant selection based on traditional medicinal value, (2) collection of fresh fruits from Tirupati, Andhra Pradesh, (3) shade drying and powdering of the fruits, and (4) solvent extraction using ethanol and acetone in a rotary shaker for 48 hours.

2.3 Phytochemical Screening

Qualitative analysis was conducted for *Kigelia africana* fruit extracts to detect the presence of various phytochemicals like alkaloids, flavonoids, tannins, saponins, glycosides, steroids/triterpenes using Shaikh & Patil (2020) and Maheshwaran et al. (2024) methods. The procedures for each test are listed below:

Test for Alkaloids**(a) Mayer's Test**

1 g of dried sample was extracted with 10 ml of ethanol or acetone and kept for 12–24 hours. A few ml of the filtrate was treated with 1–2 drops of Mayer's reagent along the side of a test tube. A cream or white-colored precipitate indicates the presence of alkaloids.

(b) Wagner's Test

1 g of dried sample was extracted with 10 ml of ethanol or acetone and kept for 12–24 hours. A few ml of the filtrate was treated with 1–2 drops of Wagner's reagent. A reddish-brown precipitate indicates the presence of alkaloids.

Test for Glycosides – Keller-Killiani Test

1 g of dried sample was extracted with 10 ml of ethanol or acetone and kept for 12–24 hours. To 2 ml of the filtrate, glacial acetic acid containing a trace of ferric chloride was added, followed by concentrated sulfuric acid along the test tube wall. A brown ring at the interface indicates the presence of glycosides.

Test for Flavonoids – Lead Acetate Test

1 g of dried sample was extracted with 10 ml of ethanol or acetone and kept for 12–24 hours. 1 ml of the filtrate was treated with a few ml of 10% lead acetate solution. A yellow precipitate indicates the presence of flavonoids.

Test for Tannins – 10% NaOH Test

1 g of dried sample was extracted with 10 ml of ethanol or acetone and kept for 12–24 hours. 0.4 ml of the extract was added to 4 ml of 10% sodium hydroxide and shaken well. A dark brown color indicates the presence of tannins.

Test for Phenolic Compounds – Ferric Chloride Test

1 g of dried sample was extracted with 10 ml of ethanol or acetone and kept for 12–24 hours. 1 ml of the extract was treated with a few drops of 5% ferric chloride solution. The formation of a deep blue, green, or black color confirms the presence of phenolic compounds.

Test for Saponins – Sodium Bicarbonate Test

1 ml of ethanol or acetone extract was taken in a test tube. Two ml of sodium bicarbonate solution were added, followed by a few ml of distilled water. Persistent frothing indicates the presence of saponins.

Test for Triterpenoids – Salkowski's Test

1.2 mL of ethanol or acetone extract was taken in a test tube. A few drops of concentrated sulfuric acid were added along the wall of the test tube. The mixture was shaken and left to stand. A reddish-brown coloration at the interface indicates the presence of triterpenoids.

Test for Phytosterols – Liebermann–Burchard Test

1 ml of ethanol or acetone extract was mixed with 2 ml of chloroform. Then, 1 ml of acetic anhydride was added, followed by concentrated sulfuric acid. A blue-green ring indicates the presence of phytosterols.

Test for Cholesterol – Salkowski's Modified Test

2 ml of ethanol or acetone extract was mixed with 2 ml of chloroform. Concentrated sulfuric acid was added slowly along the wall of the test tube. A red or pink color indicates the presence of cholesterol.

Test for Proteins – Biuret Test

2 ml of ethanol or acetone extract was mixed with 1 ml of 10% sodium hydroxide, followed by a few drops of 1% copper sulphate. A violet or purple color indicates the presence of proteins.

Test for Carbohydrates – Molisch's Test

2 ml of ethanol or acetone extract was taken in a test tube. Two drops of alcoholic α -naphthol were added. Then, 1 ml of concentrated sulfuric acid was added along the side of the test tube. A violet ring at the junction confirms the presence of carbohydrates.

2.4 Biological Activity Assays

2.4.1 Antioxidant Activity

To assess antioxidant activity of *Kigelia africana* fruit extracts, the phosphomolybdenum test technique described by Prieto *et al.* (1999) was used. A reagent solution was prepared by combining 0.588 ml of sulfuric acid, 0.049 g of ammonium molybdate, and 0.036 g of sodium phosphate, and the final volume was increased to 10 ml using distilled water. For the experiment, 10 mg of plant extract was dissolved in 1 ml of DMSO. 100 μ l of the prepared sample was combined with 1 ml of reagent solution. The mixture was incubated in a boiling water bath at 95°C for 90 minutes. After incubation, the solution's absorbance was measured at 695 nm with a spectrophotometer. Ascorbic acid (10 mg/ml in DMSO) served as the standard (Prieto *et al.*, 1999).

$$\%RSA = \left(\frac{Abs_{control} - Abs_{sample}}{Abs_{control}} \right) \times 100$$

2.4.2 Antibacterial Activity

The antibacterial activity of *Kigelia africana* fruit extracts was determined using the agar disc diffusion method as outlined in Balouiri *et al.*, (2016). Sterile nutrient agar was produced and placed into sterile Petri plates (20-25 mL per plate), then allowed to firm at room temperature for around 20 minutes. *Streptomyces erythraeus* and *Bacillus subtilis* bacterial suspensions were produced in sterile saline and adjusted to achieve a consistent inoculation density. A sterile L-shaped glass spreader was used to evenly distribute the bacterial cultures throughout the surface of the solidified agar.

Sterile Whatman No. 1 filter paper discs (6 mm diameter) were coated with increased concentrations of *K. africana* fruit extracts produced in ethanol and acetone, respectively, and carefully deposited on the inoculated agar surface with sterile forceps. A conventional

antibiotic disc (Amikacin) was employed as the positive control. The plates were incubated at $37 \pm 1^\circ\text{C}$ for 24 hours. Following incubation, the antimicrobial efficacy was assessed by measuring the diameter (in mm) of the clear zone of inhibition that surround each disc.

2.4.3 Anti Inflammatory Activity

The anti-inflammatory effect of *Kigelia africana* fruit extracts was tested in vitro using the Bovine Serum Albumin (BSA) denaturation method, which simulates the heat-induced denaturation of proteins seen during inflammation. In this approach, a 5 mL reaction mixture was generated by combining 2 mL of 1% aqueous BSA solution (pH adjusted to 6.4 using 1N HCl), 2 mL of plant extract (ethanol or acetone-based) at varied concentrations, and 1 mL of triple distilled water. A control solution was made with 2 mL of 1% BSA, 2 mL of distilled water, and 1 mL of the equivalent solvent without plant extract.

The mixtures were incubated at $37 \pm 2^\circ\text{C}$ for 20 minutes, then heated at $70 \pm 2^\circ\text{C}$ for 5 minutes in a water bath to produce protein denaturation. After cooling, the turbidity was measured at 660 nm with a UV-Visible spectrophotometer, using triple-distilled water as a blank. This method is extensively adopted as a simple to do, accurate and safe in vitro model for evaluating potential anti-inflammatory agents, consistent with standard protocols (Madhuranga & Samarakoon, 2023)

$$\% \text{ inhibition} = \left(\frac{\text{Absorbance of control} - \text{Absorbance of test sample}}{\text{Absorbance of control}} \right) \times 100$$

3. Results

3.1 Phytochemical Analysis

The phytochemical screening of *Kigelia africana* fruit extracts, using ethanol and acetone as solvents, revealed significant differences in the types of secondary metabolites present, indicating that solvent polarity affects phytochemical extraction efficiency.

A total of eleven phytochemicals were examined, with the acetone extract demonstrating a greater range of positive results, indicating a higher solubilizing potential for various bioactive compounds than the ethanol extracts as shown in table 1.

The acetone extract includes alkaloids, a type of nitrogenous molecule recognized for its pharmacological properties. This suggests that, as a moderately polar solvent, acetone is more effective at extracting alkaloids from *Kigelia africana* fruits. Flavonoids, which have strong antioxidant and anti-inflammatory effects, were also found only in the acetone extract, demonstrating acetone's ability to dissolve polyphenolic structures.

Similarly, tannins and phenolic chemicals, which have antibacterial and antioxidant properties, were found in the acetone extract alone. The absence of these chemicals in the ethanol extract further validates acetone's superior extraction performance for polyphenol-rich compounds. Triterpenoids, which have anti-inflammatory and anticancer characteristics, were also extracted using acetone, demonstrating their potential as a superior solvent for terpenoid compounds.

However, glycosides and saponins were only found in the ethanol extract. Glycosides are known for their cardiogenic and antibacterial characteristics, whereas saponins are antifungal

and immune-modulatory. The presence of these molecules in ethanol extract indicates that ethanol is better suited to extracting polar chemicals like sugar-linked secondary metabolites. Phytosterols and cholesterol were detected in both ethanol and acetone extracts. This implies that these lipophilic chemicals are fairly soluble in both solvents, reflecting their chemical composition as well as the solvents' compatibility for sterol extraction.

Interestingly, no proteins or carbohydrates were found in any extract. This could be due to their high polarity and solubility in aqueous solvents, or they could be present in trace amounts in the fruit pulp. The negative results for these macromolecules indicate that ethanol and acetone are ineffective solvents for their extraction, or that *Kigelia africana* fruits may contain insignificant amounts of these elements.

Kigelia africana's medicinal value is supported by the presence of a diverse range of phytochemicals, which are known to have a variety of pharmacological activities such as antioxidant, antimicrobial, anti-inflammatory, and anticancer properties.

Table 1. Phytochemical Analysis of *Kigelia africana* fruit Extracts

S. No	Phytochemical	Ethanol	Acetone
1.	Alkaloids	–	+
2.	Glycosides	+	+
3.	Flavonoids	–	+
4.	Tannins	–	+
5.	Phenolic Compounds	–	+
6.	Saponins	+	+
7.	Triterpenoids	–	+
8.	Phytosterols	+	+
9.	Cholesterol	–	+
10.	Proteins	–	–
11.	Carbohydrates	–	–

3.2 Antioxidant Activity

The results of this study showed that the antioxidant activity of both ethanol and acetone extracts increased in a concentration-dependent manner, as indicated by the percentage radical scavenging activity (% RSA) as shown in Table 2, Figure 2. The ethanol extract demonstrated 33% RSA at the lowest tested concentration (25 µg/ml), whereas the acetone extract showed somewhat more activity at 36%. There was not much of a difference at this concentration, as the ethanol extract reached 51% RSA and the acetone extract showed a similar activity of 50% as the concentration rose to 50 µg/ml. The ethanol and acetone extracts showed 69% and 72% RSA, respectively, at 75 µg/ml, indicating a more noticeable difference.

With the ethanol extract achieving 88% and the acetone extract displaying the highest value of 89%, the maximal antioxidant activity was measured at 100 µg/ml. These results imply that both extracts have potent antioxidant qualities, with the acetone extract performing slightly better at the majority of concentrations.

Table 2. Antioxidant activity (% RSA) of *Kigelia africana* fruit extracts

S. No	Concentration ($\mu\text{g/ml}$)	% Radical Scavenging Activity	
		Ethanol Extract	Acetone Extract
1	25	33%	36%
2	50	51%	50%
3	75	69%	72%
4	100	88%	89%

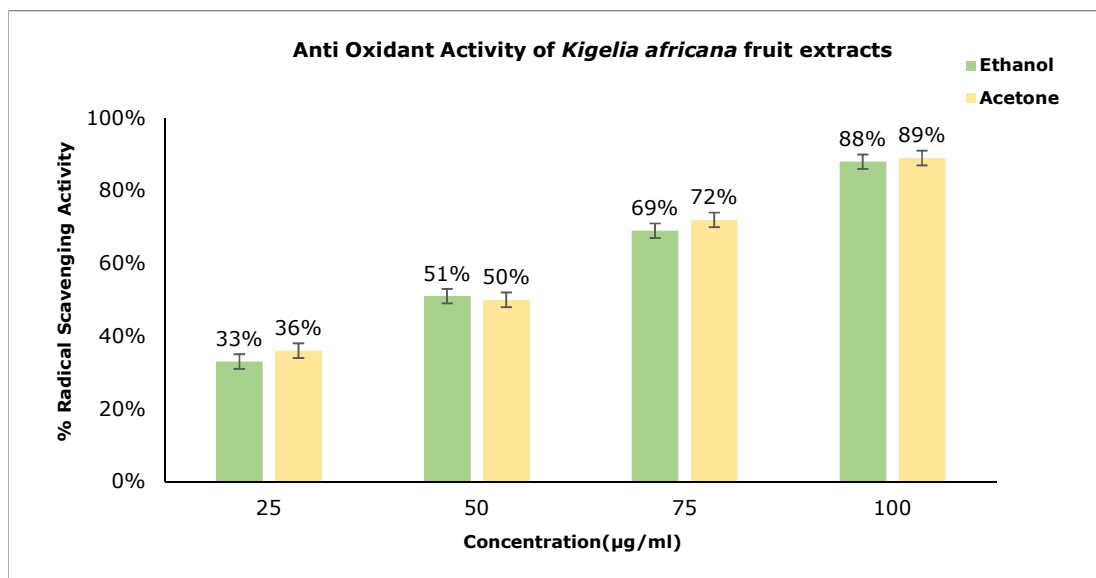


Figure 2. Percentage radical scavenging activity (% RSA) of *Kigelia africana* fruit extracts using the phosphomolybdenum assay at different concentrations (25–100 $\mu\text{g/ml}$). The graph compares the antioxidant activity of ethanol and acetone extracts. Acetone extract exhibited slightly higher activity across most concentrations. Error bars indicate standard deviation from triplicate measurements.

3.3 Antibacterial Activity

The antibacterial activity of *Kigelia africana* fruit extracts, produced using ethanol and acetone, was tested against *Streptomyces erythraeus* and *Bacillus subtilis* using the agar disc diffusion technique. A standard antibiotic disc was used as a control for comparison. The results showed that both extracts increased their antibacterial activity in a concentration-dependent manner as shown in Table 3, Figure3,4. The acetone extracts inhibited *Streptomyces erythraeus* more effectively, with zones ranging from 1.3 cm at 25 $\mu\text{g}/\mu\text{l}$ to 1.7 cm at 100 $\mu\text{g}/\mu\text{l}$, compared to the ethanol extract's range of 1.2 cm to 1.5 cm. Similarly, for *Bacillus subtilis*, the acetone extract revealed inhibitory zones ranging from 1.3 cm to 1.6 cm, whereas the ethanol extract showed zones ranging from 1.2 cm to 1.4 cm. The standard antibiotic disc (control) exhibited inhibition zones of 1.1 cm in both cases, suggesting that the plant extracts had antibacterial activity that was comparable to or marginally greater than that of the control. Overall, the acetone extract outperformed the ethanol extract, indicating that acetone could extract more powerful bioactive substances. The fruit of *Kigelia africana*, especially the acetone extract, has the potential to be a natural source of antibacterial compounds, according to these results.

Table 3. Antibacterial activity of *Kigelia africana* fruit extracts against test bacteria

S. No	Concentration ($\mu\text{g}/\mu\text{l}$)	<i>Streptomyces erythraeus</i>		<i>Bacillus subtilis</i>	
		Ethanol (cm)	Acetone (cm)	Ethanol (cm)	Acetone (cm)
1.	Control	1.1	1.1	1.1	1.1
2.	25	1.2	1.3	1.2	1.3
3.	50	1.4	1.6	1.3	1.5
4.	100	1.5	1.7	1.4	1.6

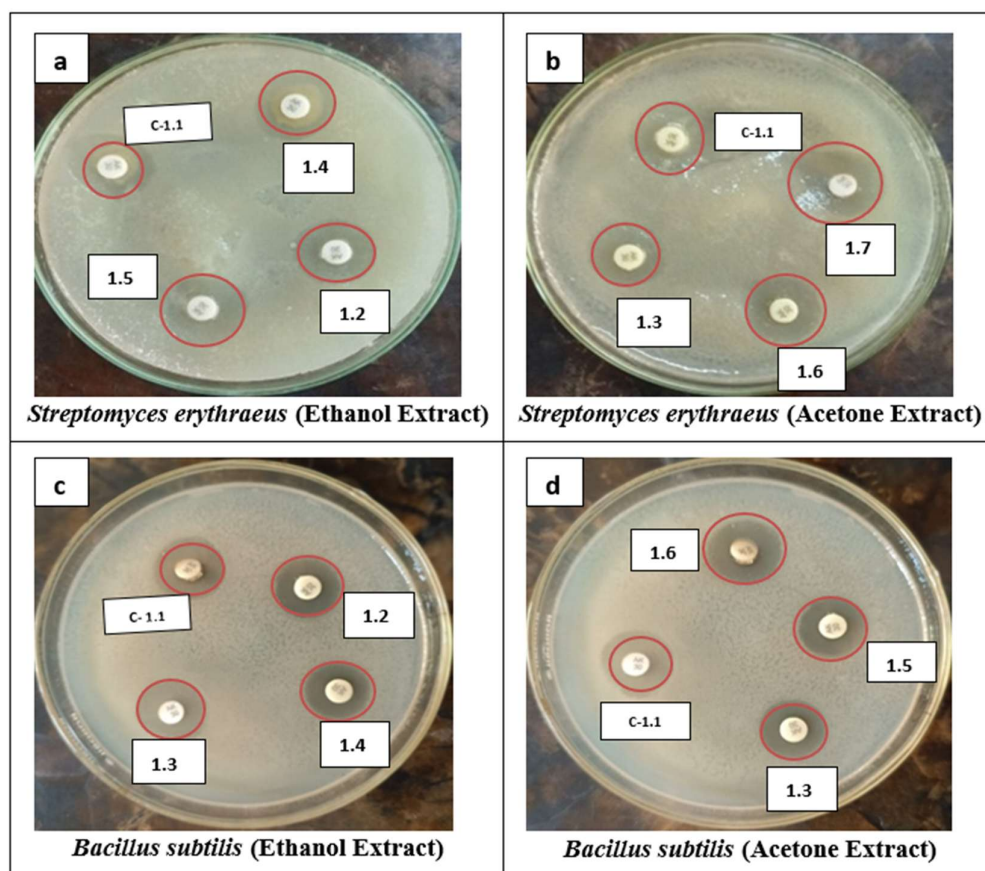


Figure 3a, b, c, d. shows the antibacterial activity of *Kigelia africana* fruit extracts against *Streptomyces erythraeus* and *Bacillus subtilis*. Ethanol and acetone extracts were tested for their inhibitory effects, with clear zones of inhibition observed around the discs. Panels (a) and (b) represent the activity against *S. erythraeus* using ethanol and acetone extracts, respectively, while panels (c) and (d) show the activity against *B. subtilis*. The labeled values indicate the diameter of the inhibition zones in centimeters (cm), and "c-1.1" denotes the control.

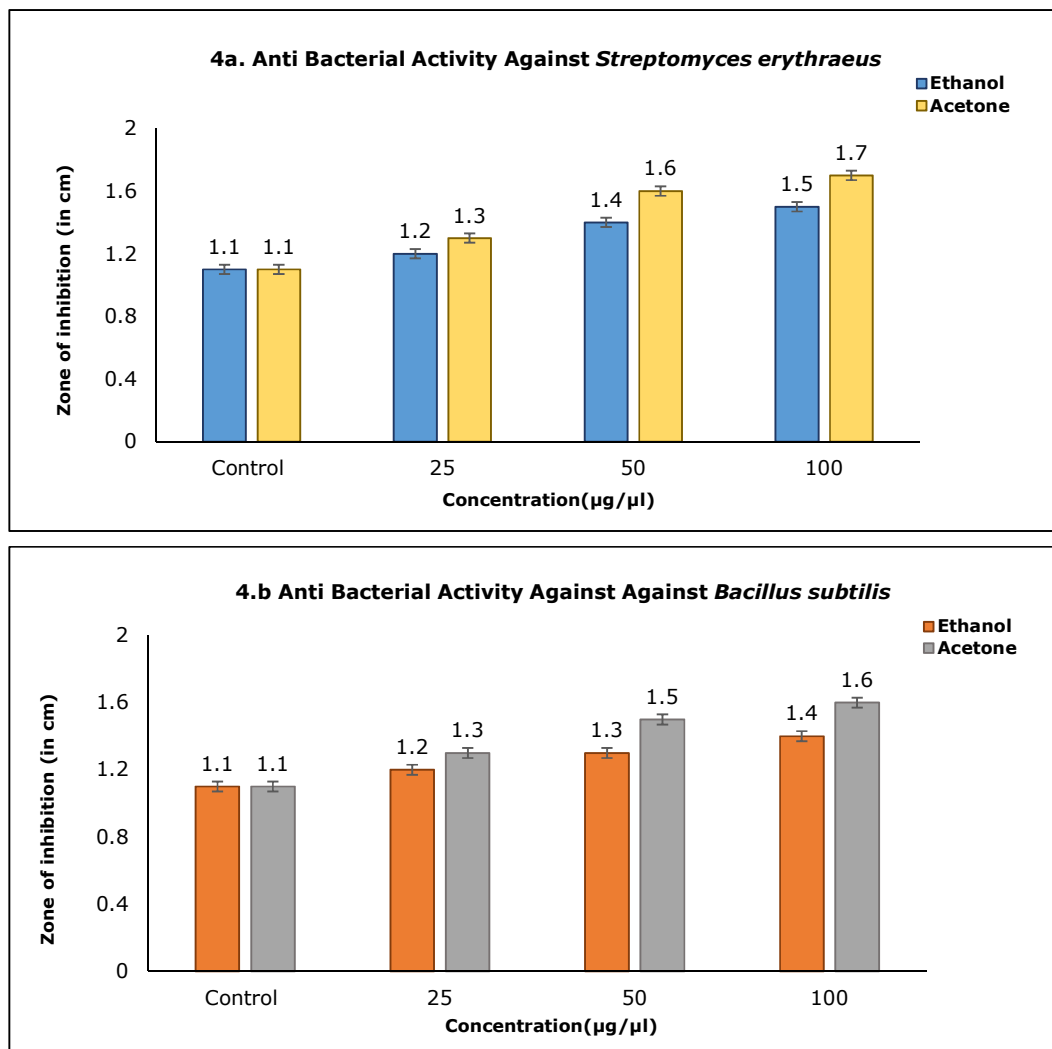


Figure 4.a, b Zone of inhibition (cm) exhibited by ethanol and acetone extracts of *Kigelia africana* fruit against *Streptomyces erythraeus* and *Bacillus subtilis* at different concentrations (25–100 µg/µl), evaluated using the agar disc diffusion method. Acetone extract showed consistently higher antibacterial activity compared to ethanol extract. The control used was a standard antibiotic disc.

3.4 Anti inflammatory

The anti-inflammatory properties of *Kigelia africana* fruit extracts were assessed using the Bovine Serum Albumin (BSA) protein denaturation assay, which simulates the inflammatory process. The results, shown as percentage suppression of protein denaturation, indicated clearly a concentration-dependent rise for both ethanol and acetone extracts.

At the lowest dosage (25 $\mu\text{g/ml}$), the ethanol extract demonstrated 25% inhibition, whereas the acetone extract showed somewhat higher activity (28%). At 50 $\mu\text{g/ml}$, activity climbed to 42% for ethanol and 47% for acetone. At 75 $\mu\text{g/ml}$, ethanol and acetone extracts exhibited 60% and 66% activity, respectively. At 100 $\mu\text{g/ml}$, ethanol extract had 80% anti-inflammatory efficacy, whereas acetone extract had a slightly higher rate of 82%. There was little variation between the ethanol and acetone extracts of *Kigelia africana* fruit in their ability to suppress protein denaturation at all tested concentrations. This implies that the amounts of bioactive anti-inflammatory compounds in the two extracts are comparable. The study indicates that both ethanol and acetone extracts have the potential to be used for the natural anti-inflammatory treatment.

Table 3. Anti-inflammatory activity of *Kigelia africana* fruit extracts

S. No	Concentration ($\mu\text{g/ml}$)	% Inhibition	
		Ethanol Extract	Acetone Extract
1	25	25%	28%
2	50	42%	47%
3	75	60%	66%
4	100	80%	82%

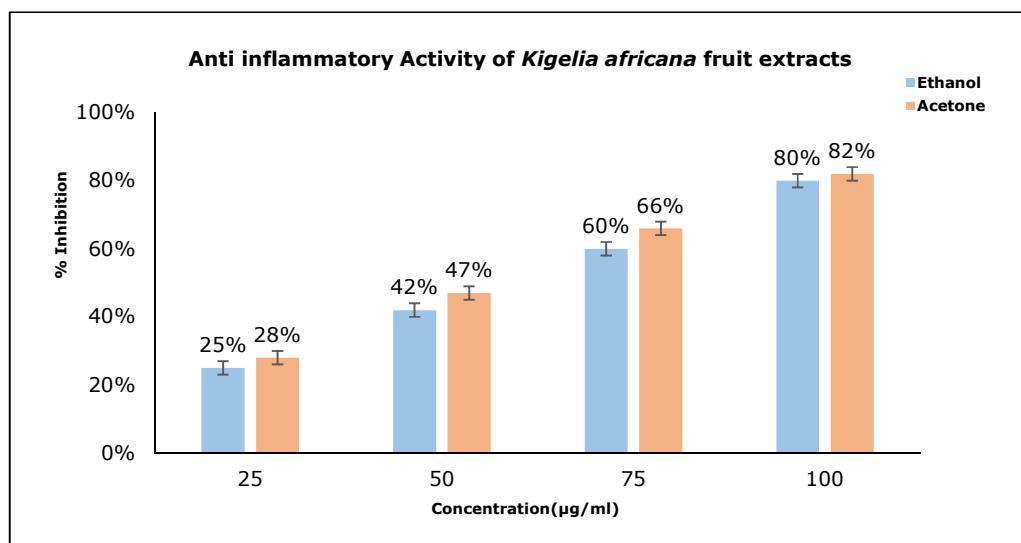


Figure 3. Anti-inflammatory activity of *Kigelia africana* fruit extracts evaluated using the Bovine Serum Albumin (BSA) method at different concentrations (25–100 $\mu\text{g/ml}$). The graph compares the percentage inhibition of protein denaturation by ethanol and acetone extracts. Acetone extract showed slightly higher activity at all tested concentrations. Error bars represent standard deviation from triplicate measurements.

4. Discussion

Significant differences in phytochemical profiles were found depending on the solvent used in the phytochemical screening of *Kigelia africana* fruit extracts using ethanol and acetone. While

the ethanol extract was more abundant in glycosides and sterols, the acetone extract displayed a wider range of phytochemicals, including alkaloids, flavonoids, phenolic compounds, tannins, triterpenoids, and saponins. These results are consistent with previous research by Ojediran et al. (2024) and Chauhan et al. (2014), which showed that acetone and ethanol solvents extract secondary metabolites differently depending on their polarity, with acetone being more effective in extracting alkaloids and bioactive polyphenols.

The therapeutic properties of these substances are extensively recognized. Alkaloids have proven antibacterial and anti-inflammatory properties, but flavonoids and phenolic compounds are powerful antioxidants due to their hydrogen-donating ability. Saponins and triterpenoids found in the acetone extract are known to have anti-inflammatory and anticancer properties (Sharma et al., 2016). The selective solubility of these bioactives emphasizes the need of selecting solvent systems that are compatible with the intended pharmacological activity during plant extract synthesis.

The study's antioxidant activity, which increased the percentage of RSA in a dose-dependent way, confirms earlier research showing that *Kigelia africana* fruits are abundant in chemicals that scavenge radicals (Sharma et al., 2016; Hussain et al., 2016). The acetone extracts outperformed ethanol by a small margin, indicating that there were more phenolic and flavonoid antioxidants present. Ojediran et al. (2024) reported similar findings, observing a notable antioxidant capacity in the fruit powder's acetone extracts.

Both extract's antibacterial activity, particularly that of acetone, supports previous findings by Agbo et al. (2022) and Sharma et al. (2016) that found *Kigelia africana* fruit extracts to have potent antibacterial efficiency against Gram-positive bacteria. In line with findings by Semwal (2014), who showed the bacteriostatic qualities of acetone-based plant extracts against a variety of pathogens, acetone extracts, which had higher concentrations of alkaloids and phenolics, had wider zones of inhibition than ethanol extracts.

The anti-inflammatory characteristics of both extracts, as evaluated by the BSA protein denaturation assay, were consistent with previous research demonstrating that *Kigelia africana* inhibits inflammatory mediators (Gunda, 2021; Nabatanzi et al., 2020). The acetone extracts again demonstrated slightly superior inhibition at all tested concentrations, most likely due to its higher flavonoid and triterpenoid content. These findings are consistent with Nabatanzi (2020), who found significant anti-inflammatory activity in both ethanol and aqueous extracts in in vitro studies.

The observed antioxidant activity is most likely due to the presence of flavonoids and phenolic acids. Kaurinovic and Vastag (2019) reported that flavonoids and phenolic acids can neutralize free radicals and prevent oxidative damage by donating electrons or hydrogen atoms. The acetone extract's slightly increased activity is supported by its higher concentration of such compounds, which have been shown to suppress oxidative stress by interrupting lipid peroxidation chains.

The antibacterial activity could be attributed to alkaloids and phenolic chemicals interacting with bacterial cell walls and proteins, resulting in cell lysis or membrane permeability

alteration. Tannins can also form compounds with bacterial enzymes, leaving them inert, whilst saponins are known to break lipid bilayers, causing bacterial death (Khameneh et al., 2019). According to Gunda (2021), the anti-inflammatory effect is thought to be mediated by inhibiting protein denaturation and potentially downregulating the cyclooxygenase (COX) and lipoxygenase (LOX) pathways. It has been demonstrated that triterpenoids and flavonoids reduce inflammation by preventing the release of pro-inflammatory cytokines and histamines. The current study provides strong scientific support for the traditional medicinal use of *Kigelia africana*, particularly in African ethnomedicine. Its fruits have been historically used to treat infections, skin conditions, inflammation, and wounds. The significant antibacterial, antioxidant, and anti-inflammatory effects observed here justify its traditional applications, as also noted in ethnobotanical surveys and earlier pharmacological studies (Agbo et al., 2022; Chauhan et al., 2014). By validating these traditional claims with biochemical evidence and quantifiable activity, this study not only strengthens the basis for using *Kigelia africana* in herbal formulations but also opens the possibility for future development of phytopharmaceuticals from its fruit extracts.

5. Conclusion

This study reveals the potential medical benefits of *Kigelia africana* fruit extracts, especially those made with acetone and ethanol. Numerous bioactive secondary metabolites, including as flavonoids, phenolics, tannins, saponins, and alkaloids, were found using phytochemical screening. These phytochemicals' many pharmacological functions, including their ability to scavenge free radicals, modulate inflammation, and have antibacterial properties, are well-established. The high concentration of flavonoids and phenolic compounds, which are known to neutralize reactive oxygen species and thereby mitigate oxidative stress, a major contributor to chronic diseases and cellular damage, is probably responsible for the notable antioxidant activity seen in the ethanol and acetone extracts. This antioxidant characteristic highlights *K. africana's* therapeutic potential in oxidative damage prevention and treatment approaches.

Further research also showed that the fruit extracts have antibacterial activity, specifically against *Bacillus subtilis* and *Streptomyces erythraeus*, two strains of Gram-positive bacteria, indicating that they may be used as natural antimicrobials. This is especially important given the rise in antibiotic resistance, as chemicals produced from plants may provide safer and more sustainable substitutes. The extracts' anti-inflammatory properties lend more credence to *K. africana's* traditional medical uses in the management of inflammation-related ailments like wounds, arthritis, and skin infections. to completely utilize this plant's medicinal potential.

Research in the future should focus on isolating and characterizing the active phytoconstituents that are responsible for the observed biological activities. Detailed in vivo pharmacological studies are required to confirm the therapeutic efficacy and safety profiles of these extracts in physiological settings. Comprehensive toxicity studies will aid in developing suitable dosage guidelines for possible clinical uses. Furthermore, formulation research, such as the creation of oral or topical administration methods, may aid in the conversion of these extracts into phytopharmaceutical drugs. Given *K. africana's* rich phytochemical makeup, future research should look into its anti-diabetic and anti-cancer potential, focusing on bioactive chemicals that may have glucose-lowering effects or cause cytotoxicity in cancer cells. These increased investigations may greatly broaden the therapeutic potential of this medicinal plant.

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Conflicts of Interest

“All authors declare no conflict of interest”.

Ethical Approval

Not Applicable

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