Analysis of *Kigelia africana* (Lam.) Benth. fruit powder's antioxidant and phytochemical properties

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Abstract

The purpose of this study was to investigate the antioxidant and phytochemical properties of *Kigelia africana* fruit powder. Fresh *K. africana* fruit was air-dried and processed into powder. *K. africana* fruit powder contained saponins (35.86 mg/100 g^{-1}), tannins (106.1 mg/100 g^{-1}), phenols (1340.6 mg/100 g^{-1}), flavonoids (985.11 mg/100 g^{-1}), steroids (81.20 mg/100 g^{-1}), glycosides (18.32 mg/100 g^{-1}), triterpenes (90.65 mg/100 g^{-1}), and alkaloids (51.22 mg/100 g^{-1}). The study found that phenolic chemicals were the most concentrated, followed by flavonoids, tannins, triterpenes, steroids, alkaloids, saponins, and glycosides. The antioxidant activities of Kigella africana fruit meal revealed that it contains lipid peroxidation (71.80%), 2,2-diphenyl-1-picrylhydrazyl (DPPH) (56.02%), vitamin C (6.22%), 2,2'-Azino-bis(3-Ethylbenzothiazoline-6-Sulfonic acid) (ABTS) (26.11%), and hydroxyl radical inhibition (45.92%). Therapeutically, the phytochemicals revealed that *K. africana* fruit has antihelminthic, antidiarrheal, antimicrobial, antifungal, antimicrobial, immunomodulatory, hypoglycemic, antioxidant, hypocholesterolemic, hepatoprotective, hepatostimulatory, analgesic, and anticarcinogenic properties. The presence of lipid peroxidation, vitamin C, DPPH, and ABTS in *Kigelia africana* fruit indicates that it can be employed as an antioxidant supplement in animal diets.

Keywords: *Kigelia africana*, food safety, phytochemical, antioxidants, metabolites.

Análise das propriedades antioxidantes e fitoquímicas do pó da fruta *Kigelia africana* (Lam.) Benth.

Resumo

O objetivo deste estudo foi investigar as propriedades antioxidantes e fitoquímicas do pó da fruta *Kigelia africana*. A fruta fresca de *K africana* foi seca ao ar e transformada em pó. O pó da fruta *K. africana* continha saponinas (35,86 mg/100 g^{-1}), taninos (106,1 mg/100 g^{-1}), fenóis (1340,6 mg/100 g^{-1}), flavonóides (985,11 mg/100 g^{-1}), esteróides (81,20 mg/100 g^{-1}), glicosídeos (18,32 mg/ 100 g^{-1}), triterpenos (90,65 mg/100 g^{-1}) e alcalóides (51,22 mg/100 g^{-1}). O estudo descobriu que os produtos químicos fenólicos eram os mais concentrados, seguidos por flavonóides, taninos, triterpenos, esteróides, alcalóides, saponinas e glicosídeos. As atividades antioxidantes da farinha de fruta *K. africana* revelaram que contém peroxidação lipídica (71,80%), 2, 2-difenil-1-picrilhidrazil (DPPH) (56,02%), vitamina C (6,22%), 2,2'-Azino-bis(3-etilbenzotiazolina-6-sulfônico) (ABTS) (26,11%) e inibição do radical hidroxila (45,92%). Terapeuticamente, os fitoquímicos revelaram que a fruta *K. africana* possui propriedades anti-helmínticas, antidiarreicas, antimicrobianas, antifúngicas, antimicrobianas, imunomoduladoras, hipoglicemiantes, antioxidantes, hipocolesterolêmicas, hepatoprotetoras, hepatoestimulantes, analgésicas e anticarcinogênicas. A presença de peroxidação lipídica, vitamina C, DPPH e ABTS na fruta *Kigelia africana* indica que ela pode ser empregada como suplemento antioxidante em dietas animais.

Palavras-chave: *Kigelia africana*, segurança alimentar, fitoquímicos, antioxidantes, metabolitos.

1. Introduction

Because of the growth in antibiotic resistance, there is an ongoing need to develop new medications and alternative therapies for illnesses and infections (Vera, 2021). Numerous research teams have investigated medicinal herbs for their possible antibacterial properties (Vera, 2021; Alagbe, 2023). According to Nascimento et al. (2000) and Costa et al. (2015), plants used in conventional healthcare contain phytochemicals or secondary metabolites such as oxygenated terpenes, tannins, alkaloids, aldehydes, and cardiac glycosides, which are responsible for the plant's medicinal properties (antioxidant, antifungal, antiviral, immunostimulatory, hepato-protective, antimicrobial, antihelminthic, and antidiarrheal activity, among others). Many of these metabolites have medicinal properties, and the primary criterion for determining the quality and therapeutic potential of a specific herb is regarded to be its concentration in plant tissues (Wills et al., 2000; Alagbe, 2021). They include numerous natural chemicals with fascinating pharmacological characteristics (Edeoga et al., 2005; Singh et al., 2022).

The Bignoniaceae family includes *Kigelia africana*, one of the potentially underused medicinal plants. The tree, sometimes referred to as the "sausage tree", is found across South, Central, and West Africa as well as certain regions of Asia (Maïmouna et al., 2021; Ogunlakin; Sonibare, 2023). The plant is evergreen, with enormous, sausage-shaped, grey-green leaves that dangle on tree stalks at a length of 30 to 60 centimeters (Fagbohun et al., 2020). The gray stem bark of older trees peels off, revealing opposite or whorled leaves that are pinnately complex and up to 60 cm long (Abdulkadir et al., 2015).

Every component of the plant, including the fruit, bark, roots, and leaves, is used medicinally. For example, a decoction of the stem bark has been used to treat kidney disorders, diarrhea, cough, inflammation, renal ailments, fainting, epilepsy, rheumatism, sickle-cell anemia, psoriasis, eczema, and central nervous system depression (Halder; Sharma, 2017; Abbas et al., 2024). Leaves and stem bark have been used for treating dysentery, constipation, and fevers, and as an abortifacient. Leaves are also used to prepare a tonic for improved health and growth (Owolabi; Omogba, 2007; Bodiwala et al., 2024). The fruit, edible by several mammalian species, contains flavonoids, terpenes, tannins, steroids, saponins, and caffeic acid (Halder; Sharma, 2017). Furthermore, it was shown that a methanolic extract of *K. africana* inhibited the growth of *Staphylococcus aureus*, *Pseudomonas aeruginosa*, *Salmonella Typhi*, *Bacillus subtilis*, *Klebsiella pneumoniae*, and other pathogenic organisms (Weiss et al., 2000; Picerno et al., 2005; Orabi et al., 2023; Kumar et al., 2024).

Some medicinal plants contain a variety of phytochemicals that can have high antioxidant activity. Compounds that are accountable for reducing oxidative stress could be extracted from plants and then used for the development of drugs for the better management of several metabolic diseases in livestock (Alagbe, 2024). Evaluation of chemical compounds in these plants particularly *K. africana* will also help to reduce the increasing cases of antimicrobial resistance, reduce environmental pollution, and promote food safety.

Therefore, this study was undertaken to analyze *Kigelia africana* (Lam.) Benth. fruit powder's antioxidant and phytochemical properties.

2. Materials and Methods

2.1 Experimental laboratory

The study was conducted in the laboratory Unit of the Department of Animal Nutrition and Biotechnology, Ladoke Akintola University of Technology Ogbomoso, Oyo State, Nigeria in the derived savannah area, latitude (8o 08N) and latitude (4o 15E), at an altitude of 347 meters (Ojediran et al., 2021).

2.2 Sample preparation and processing

Fresh *K. africana* fruit was gathered at the Ladoke Akintola University Teaching and Research Farm in Ogbomoso and sent to the same institution's Department of Biological Sciences, where it was recognized and confirmed by a certified taxonomist and assigned the voucher specimen number TT/008A/2023. The harvested fruit was cut into smaller fractions and air-dried for 14 days until a consistent weight was achieved. Dried fruit was ground into powder with an automated blender, stored in a marked sealed nylon bag, and transported to the laboratory for further analysis.

200 g of *K. africana* fruit powder was measured into a conical flask holding 1000 mL water and stored for four days, stirring intermittently every four hours. The mixture was then filtered using a Whatman filter paper. *K. africana* fruit extract (CSE) was obtained by drying the extract in a rotary evaporator at 50 ºC with reduced

pressure.

2.3 Qualitative phytochemical screening of Kigelia africana fruit extract

Odebiyi and Sofowora's (1978) method for detecting saponins, tannins, phenolics, alkaloids, steroids, triterpenes, phlobatannins, glycosides, and flavonoids was used in the phytochemical analysis extract.

1. For alkaloids, add 1 cm^2 of 1% HCl to 3 cm^2 of extracts in a test tube. The mixture was cooked for 20 min then cooled and filtered. The filtrate was used for the following tests: 2 drops of Wagner's reagent were applied to 1 cm^2 of extract. A reddish-brown precipitate suggests the presence of alkaloids.

2. Tannins: Mix 1 cm^2 of freshly made 10% KOH with 1 cm^2 of extracts. A dirty white precipitate suggests the presence of tannins.

3. Phenolics: Add 2 drops of 5% $FeCl_3$ to 1 cm^2 of extract in a test tube. A greenish precipitate suggests the presence of phenolic compounds.

4. Glycosides: Mix 10 cm^2 of 50% H_2SO_4 with 1 cm^2 of extracts and heat in boiling water for fifteen minutes. Fehling's solution (10 cm^2) was added and heated. A brick-red precipitate suggests the presence of glycosides.

5. Saponins: Frothing test: Shake 2 cm^2 of extract in a test tube vigorously for 2 min. Frothing suggests the presence of saponins.

6. For flavonoids, add 1 cm^2 of 10% NaOH to 3 cm^2 of extracts. A yellow coloration suggests the presence of flavonoids.

7. Steroids: Salakowsti test: Add 5 drops of concentrated H_2SO_4 to 1 cm^2 of extracts. The red coloration suggests the presence of steroids.

8. Phlobatannins: 1 cm^2 of extract was added to 1% HCl. A red precipitate shows the presence of phlobatannin.

9. For triterpenes, add 5 drops of acetic anhydride to 1 cm^2 of extract. After adding a drop of concentrated H_2SO_4, the mixture was heated for a half-hour before being neutralized with NaOH and chloroform. A blue-green color suggests the presence of triterpenes.

10. Phytosterols (Finar 1986): the Liberman-Burchards test 50 mg is dissolved in 2 mL acetic anhydride. One or two drops of concentrated H_2SO_4 were carefully applied down the walls of the test tube. A variety of color changes indicate the presence of phytosterols.

11. Terpenoids: Mix 5 mL of the sample's aqueous extract with 2 mL of CHCl3 in a test tube. 3 mL of concentrated H_2SO_4 is gently added to the mixture to create a layer. When terpenoid constituents are present, an interface with a reddish-brown coloring forms.

12. Coumarin determination: Add 0.5 mL of 5N NaOH to the solution for 1 mL of extract (0.5 g in 1 mL of ethanol), heat at 80 ºC for 5 min, cool, add 0.75 mL of 5 N H_2SO_4, mix completely, add 0.25 g of anhydrous $NaHCO_3$, mix, and transferred to an extractor. Rinse the flask with distilled water before transferring it to the extractor. Make up to 50 mL. of extract with the pet for 3 h. Ether, replace the inner tube and pass the pet ether from the extractor to the extraction flask. Add 20 mL of water to the pet ether extract and carefully evaporate it in a water bath set to 50-55 ºC. Transfer the aqueous solution to a volumetric flask, adding up to 50 mL while continuously mixing. Pipette 25 mL into a flask, then add the 1% Na_2CO_3 mixture. Heat in a water bath at 85 ºC for 15 min and cool. Allow 5 mL of diazonium solution to stand for 2 h. Measure the absorbance at 540 nm against the reagent blank. Determine the coumarin content using a standard curve.

2.4 Quantitative analysis of phytochemicals in Kigelia africana fruit extract

2.4.1 Estimation of total phenolic content

The sample's total phenolic content was calculated using the Makkar et al. (1997) method. Aliquots of the extract were placed in a test tube and filled to a volume of 1 mL with distilled water. The test tube was then filled with 0.5ml of *Folin-Ciocalteu* reagent (1:1 with water) and 2.5 mL of sodium carbonate solution (20%) in sequential order. After vortexing the reaction mixture, the tubes were placed in the dark for 40 min, and the absorbance at 725 nm was measured against a reagent blank. A standard curve for gallic acid monohydrate was created.

2.4.2 Total flavonoid assay

Tolari et al. (2012) described a colorimetric technique using aluminum chloride to determine total flavonoid concentration. 1 mL of Quercetin extract or standard solution (500 µg/mL) was added to a 10 mL volumetric flask with 4 mL of distilled water. To the aforesaid mixture, 0.3 mL of 5% $NaNO_2$ was added. After 5 min, 0.3 mL of 10% $AlCl_3$ was added. At the sixth minute, 2 mL of 1 M NaOH was included, and the total volume was increased to 10 mL using distilled water. The solution was thoroughly combined before measuring absorbance at 510 nm against the prepared reagent blank.

2.4.3 Estimation of saponins

The spectrophotometric approach of Madhu et al. (2016) was utilized to analyze saponins. To summarize, 1 g of the finely powdered dried sample was weighed into a 250 mL beaker, and 100 mL of isobutyl alcohol was added. The mixture was shaken on a UDY shaker for 5 h to achieve even mixing. The mixture was then filtered through Whatman No. 1 filter paper into a 100 mL beaker with 20 mL of 40% saturated $MgCO_3$ solution. The resultant combination was filtered further to produce a clear, colorless solution. Pipette one milliliter of the colorless filtrate into a 50 mL volumetric flask. Add 2 mL of 5% $FeCl_3$ solution and fill up to the specified level with purified water. This was then left to stand for 30 min, allowing the blood-red color to develop. Saponin stock solution was used to create a standard of 0-10 ppm. The standard solutions were treated with 2 mL of 5% $FeCl_3$ solution, as previously described. The absorbance of the samples and standard saponin solutions was measured after color development with a Jenway V6300 spectrophotometer at 380 nm. The formula for calculating the percentage of saponin was as follows:

$$\% \text{ Saponin} = \frac{\text{Absorbance of sample} \times \text{Average gradient} \times \text{Dilution factor}}{\text{Weight of sample} \times 10{,}000}$$

2.4.4 Alkaloids content estimation

Alkaloids were quantitatively determined using distillation and titrimetric techniques, as reported by Madhu (2016). In brief, 2 g of finely ground sample was weighed into a 100 mL beaker, and 20 mL of 80% pure alcohol was added to form a smooth paste. The mixture was transferred to a 250 mL flask, and additional alcohol was added to bring the total to 1 g of magnesium oxide. The mixture was digested in a boiling water bath for an hour and a half under a reflux air condenser with occasional shaking. The mixture was filtered while hot through a *Buchner* funnel. The residue was poured back into the flask and re-digested for another thirty minutes with 50 mL alcohol after which the alcohol was evaporated.

To replace the alcohol that was lost, distilled water was added. When the alcohol had completely evaporated, 3 drops of 10% HCl were added. The entire solution was then transferred to a 250 mL volumetric flask, where 5 mL of zinc acetate solution and 5 mL of potassium ferricyanide solution were thoroughly mixed to form a homogeneous mixture. The flask was allowed to rest for a few minutes before being filtered through a dry filter paper. Ten milliliters of the filtrate were transferred to a separating funnel, and the alkaloids were aggressively extracted by shaking with five successive amounts of chloroform. The residue was diluted in 10 mL of hot distilled water before being transferred to a Kjeldahl tube and digested with 0.2 g of selenium to produce a clear, colorless solution. The clear colorless solution was used to quantify nitrogen using Kjeldahl distillation equipment. The distillate was back titrated with 0.01N HCl, and the titer value obtained was used to compute the percent nitrogen using the following formulas:

$$\%N = \frac{\text{Titre value} \times \text{Atomic mass of Nitrogen} \times \text{Normality of HCl} \times 100}{\text{Weight of sample (mg)}}$$

$$\% \text{ Alkaloid} = \% \text{ Nitrogen} \times 3.26$$

Where: 3.26 is a constant.

2.4.5 Tannins estimation

The quantity of tannins was determined using the Madhu et al. (2016) approach. 0.20 g of sample was measured into a 50 mL beaker. Add 20 mL of 50% methanol, cover with parafilm, and place in a water bath at 77-80 ºC for an hour. It was thoroughly shaken to ensure even mixing. The extract was filtered through a double-layered Whatman No. 41 filter paper into a 100-volumetric flask. Add 20 mL of water, 2.5 mL of *Folin-Denis* reagent, and 10 mL of 17% Na_2CO_3. Mix thoroughly. The combination was prepared to the mark with water, stirred

thoroughly, and allowed to stand for 20 min. The end of the range will produce a bluish-green color. 0-10 ppm was treated similarly to the 1 mL sample above. Percentage tannin was calculated using the formula:

$$\% \text{ Tannin} = \frac{\text{Absorbance of sample} \times \text{Average gradient} \times \text{Dilution factor}}{\text{Weight of sample} \times 10{,}000}$$

2.4.6 Glycosides analysis

The extract was pipetted into a 250 mL conical flask, 50 mL of chloroform was added, and the mixture was shaken on a Vortex Mixer for 1 h. The mixture was filtered into a conical flask, and 10 mL of pyridine and 2 mL of 2% sodium nitroprusside were added and shaken thoroughly for 10 min. 3 mL of 20% NaOH was later added to develop a brownish-yellow color. The Glycoside standard of concentrations ranging from 0-5 mg/mL^{-1} was prepared from a 100 mg/mL^{-1} stock glycoside standard.

10 mL of the extract was pipette into a 250 mL conical flask. 50 mL chloroform was added and shaken on a Vortex Mixer for 1 h. The mixture was filtered into a conical flask. 10 mL pyridine and 2 mL of 2% sodium nitroprusside were added and shaken thoroughly for 10 min. The absorbances of the sample as well as standards were read on a spectronic 21D Digital spectrophotometer at a wavelength of 510 nm. % Glycoside was calculated using the formula:

$$\% \text{ Glycoside} = \frac{\text{Absorbance of sample} \times \text{Average gradient} \times \text{Dilution factor}}{\text{Weight of sample} \times 10{,}000}$$

2.4.7 Analysis of Steroid components

0.05 g of extract sample was weighed into a 100 mL beaker. On a shaker, 20 mL of a chloroform-methanol (2:1) combination was added to dissolve the extract after 30 min of shaking. The overall concoction should be free of steroids. 1 mL of the filtrate was pipetted into a 30 mL test tube, followed by 5 mL of alcoholic KOH. The mixture was thoroughly shaken to ensure homogeneity. The mixture was then placed in a water bath heated to 37-40 ºC for 90 min. It was chilled to room temperature before 10 mL of petroleum ether was added, followed by 5 mL of distilled water. This was evaporated till dry in the water bath. 6 mL of Liebermann Buchard reagent.

$$\% \text{ steroid} = \frac{\text{Absorbance of sample} \times \text{Average gradient} \times \text{Dilution factor}}{\text{Weight of sample} \times 10{,}000}$$

2.4.8 Triterpenes analysis

0.50 g of sample was weighed into a 50 mL conical flask, and 20 mL of a 2:1 chloroform-methanol mixture was added, mixed vigorously, and left to stand for 15 min. The supernatant was discarded, and the precipitate was washed again with 20 mL of chloroform-methanol combination before centrifugation. The precipitate was then dissolved in 40 mL of 10% sodium dodecyl sulfate (SDS) solution 1 mL of 0.01M ferric chloride solution was added to the above at 30-second intervals, agitated thoroughly, and left to stand for 30 min. Standard concentrations of triterpenes. The absorbance of the sample and standard triterpene concentrations was measured at 510nm using a digital spectrophotometer. The percentage of triterpenes was calculated using the formula:

$$T = \frac{\text{Absorbance of sample} \times \text{Average gradient} \times \text{Dilution factor}}{\text{Weight of sample} \times 10{,}000}$$

2.5 Determination of antioxidant properties of Kigelia africana fruit extract

2.5.1 DPPH assay

The DPPH radical scavenging method was evaluated according to Chandra & Goyal's (2014) report. The extract's free radical scavenging activity was evaluated using 2,2-diphenyl-1-picrylhydrazyl (DPPH). A 0.1 mM solution of DPPH in ethanol was produced and mixed with 3 mL of the extracts. The combination was vigorously mixed and left to stand at room temperature for 30 min. The absorbance was then measured at 520 nm with a spectrophotometer. The proportion of the DPPH scavenging effect was estimated using the following equation: Percentage inhibition% = absorbance of control reaction minus absorbance in the presence of test or standard sample divided by absorbance of control reaction, multiplied by 100.

2.5.2 Vitamin C estimation

The vitamin C content of the *K. africana* fruit extract was determined using the procedures described by Benderitter et al. (1998). A solution of 2 g dinitrophenyl hydrazine, 270 mg copper sulfate, and 230 mg thiourea in 100 mL of 5 mL/L H_2SO_4 was mixed with 300 µL of *K africana* fruit extract diluted with 13.3% (*v/v*) trichloroacetic acid and water. The reaction mixture was then incubated at 37 °C for 3 h before adding 0.5 mL of sulphuric acid to the medium and using a spectrophotometer to measure absorbance at 520 nm.

2.5.3 Lipid peroxidation inhibition

The analysis was carried out according to the method outlined by Oloruntola et al. (2022). 2 mL of *K. africana* fruit extract was added to 1 mL iron (III) chloride, 50 µL of bovine brain phospholipids, 1mM ascorbic acid in 20 mM phosphate buffer. It was incubated at 37 ºC for 1 h and the spectrophotometer was set at an optical density of 456 nm to determine lipid peroxidation inhibition assay.

2.5.4 2,2'-Azino-bis(3-Ethylbenzothiazoline-6-Sulfonic acid) (ABTS) assay

2 mL of *K. africana* fruit extract was added to 1 mL of 2,2'-Azino-bis(3-Ethylbenzothiazoline-6-Sulfonic acid) and mixed. Absorbance was assessed after 30 min at different concentrations (10, 20, 30, 40, and 50 mg/mL^{-1}). The radical scavenging percentage was determined with a blank that had no scavenger following methods outlined by Turkoglu et al. (2010).

2.5.5 Hydroxyl radical inhibition

Hydroxyl radical inhibition assay was ascertained according to the procedure outlined by Tijani et al. (2012). 2 mL of *K. africana* fruit extract was mixed with deoxyribose, hydrogen peroxide, and ascorbic acid at 3.0 mM, 0.1 mM, and 0.2 mM respectively. The mixture was incubated at 37 ºC for 60 min and the spectrophotometer was set at an optical density of 625 nm to determine hydroxyl inhibition assay.

2.6 Statistical analysis

All analysis was carried out in triplicates and results obtained were expressed as the mean value ± standard deviation. Statistical Package for Social Science (SPSS) software.

3. Results and Discussion

Tables 1 and 2 show the qualitative and quantitative constituents of *K. africana* fruit powder. The sample had saponins (35 $mg/100\ g^{-1}$), tannins (106 $mg/100\ g^{-1}$), phenols (1340 $mg/100\ g^{-1}$), flavonoids (985 $mg/100\ g^{-1}$), steroids (81 $mg/100\ g^{-1}$), glycosides (18 $mg/100\ g^{-1}$), triterpenes (90 $mg/100\ g^{-1}$), and alkaloids (51 $mg/100\ g^{-1}$). The study found that phenolic chemicals were the most concentrated, followed by flavonoids, tannins, triterpenes, steroids, alkaloids, saponins, and glycosides. Previous research has found flavonoids, tannins, anthocyanins, and phenols in *Kigelia pinnata* fruit at 398.7 $mg/100\ g^{-1}$, 35.17 $mg/100\ g^{-1}$, 171 $mg/100\ g^{-1}$, and 0.61 $mg/100\ g^{-1}$, respectively (Khaled et al., 2022).

However, the results are consistent with Fitriyani's (2018) claims. The differences in their outcomes can be related to variances in species, plant age, and geographical location, among other factors (Singh et al., 2022). The leaf of Kigella africana fruit has been shown to have a variety of beneficial pharmacological effects, including antimicrobial, antifungal, antimicrobial, immunomodulatory, hypoglycemic, antioxidant, hypocholesterolemic, hepatoprotective, and hepatostimulatory properties (Alagbe, 2022; Adewale et al., 2021). The favorable benefits Kigella africana fruit contains one or more types of phyto-constituents or bioactive substances that often work together (Musa et al., 2021; Wills et al., 2000).

These chemically different but frequently overlapping types of phyto-constituents are primarily terpenoids (such as sesquiterpenes and saponins), phenols (such as tannins), and their glycosides (flavonoids, glucosinolates) (Singh et al., 2022; Alagbe, 2024). They are also commonly employed in the culinary, pharmaceutical, and cosmetic industries (Wilasrusmee et al., 2002). Saponins are a diverse group of water-soluble triterpenoids found across the plant kingdom (Macrae et al., 1993) and recognized for their bitter, astringent taste (Cowan, 1999;

Daniel; Alagbe, 2023). They have also been proposed to have antidiarrheal effects and be beneficial in the treatment of respiratory disorders (Davendran; Balasubramanian, 2011; Shittu et al., 2021).

Tannins have antibacterial, anti-inflammatory, and immunostimulant effects (Simlai; Roy, 2012). Excessive tannin intake can interfere with calcium and iron absorption in the body (Edeoga et al., 2015). Flavonoids have sparked interest as potential antioxidants, both for reducing oxidative deterioration of foods (Rauha et al., 2000) and for delivering positive metabolic effects in animals (Harris et al., 2001; Alagbe, 2022). Phenols are powerful antioxidants that may scavenge free radicals, which are the leading cause of sickness and infection in animals (Mamza et al., 2012). Steroids, terpenoids, and steroids show many pharmacological activities, such as antibacterial, antiviral, anti-inflammatory, antifungal, antioxidant, analgesic (painkiller), and anti-carcinogenic properties (Gupta et al., 1999).

Table 1. Result of qualitative analysis of *Kigelia africana* fruit powder.

Phytochemicals	**Results**
Saponins	+
Tannins	+
Phenols	+++
Steroids	+
Coumarin	+
Flavonoids	++
Glycosides	+
Terpenoids	+
Triterpenes	-
Anthocyanin	-
Phlobatanin	-
Amino acids	-
Alkaloids	+

Note: (+) Present; (++) Moderately present; (+++) Highly present, and (-) Absent. Source: Authors, 2024.

Table 2. Quantitative analysis of the phytochemicals in *Kigelia africana* fruit powder.

Parameters	**Composition (mg/100 g^{-1})**
Saponins	35.86 ± 2.07
Tannins	106.1 ± 1.55
Phenols	1340.6 ± 0.99
Flavonoids	985.11 ± 0.17
Steroids	81.20 ± 0.00
Glycosides	18.32 ± 0.10
Triterpenes	90.65 ± 1.16
Alkaloids	51.22 ± 0.09

Source: Authors, 2024.

The antioxidant properties of *K. africana* fruit are presented in (Table 3). The sample contained lipid peroxidation (71%), DPPH (56%), vitamin C (6%), ABTS (26%), and hydroxyl radical inhibition (45%). The content of lipid peroxidation, vitamin C, DPPH, and ABTS in *K. africana* fruit suggests that it can be used as an antioxidant supplement in livestock diet (Atolani et al., 2011).

Antioxidants are substances that slow or prevent the oxidation of lipids or other molecules by suppressing

oxidizing chain processes. The antioxidant activity of phenolic compounds is mostly owing to their redox characteristics, which play a key role in neutralizing free radicals and degrading peroxides (Zheleva, 2012). Dietary antioxidants are defined as any chemical that, when present in low concentrations relative to the oxidizable substrate, considerably slows or inhibits its oxidation. According to Mohammed et al. (2013); and Alagbe et al. (2024), the overall phenolic concentration of a plant extract is related to antioxidant capacity, which is also influenced by phenolic compound structure.

Phenolic antioxidants (PPH) reduce lipid peroxidation by rapidly donating a hydrogen atom to the peroxyl radical (ROO), resulting in the creation of alkyl (aryl) hydroperoxide (ROOH). Vitamin C is necessary because it has the potential to scavenge radicals, neutralizing the harmful effects of lipid peroxidation and DNA damage produced by free radicals (Oloruntola; Ayodeji, 2022). Additionally, they can improve cell defenses against oxidative damage (Dudonnd et al., 2009; Ojediran et al., 2024). Plant-derived antioxidants have been linked to a reduced risk of degenerative diseases such as cancer, coronary atherosclerosis, and Alzheimer's disease (Oloruntola, 2021; Biswas et al., 2020).

Table 3. Antioxidant composition of *Kigelia africana* fruit powder.

Parameters	Composition
2, 2-diphenyl-1-picrylhydrazyl (DPPH) (%)	56.02 ± 0.01
Lipid peroxidation (%)	71.80 ± 0.00
Vitamin C (mg/g^{-1})	6.22 ± 0.00
[1]ABTS (%)	26.11 ± 0.02
Hydroxyl radical inhibition (%)	45.92 ± 0.04

Note: [1]2,2'-Azino-bis(3-Ethylbenzothiazoline-6-Sulfonic acid). Source: Authors, 2024.

4. Conclusions

The presence phytochemicals such as phenolic compounds, flavonoids, tannins, triterpenes, steroids, alkaloids, saponins and glycosides showed that *Kigella africana* fruit has antihelminthic, antidiarrheal, antimicrobial, antifungal, antimicrobial, immunomodulatory, hypoglycemia, antioxidant, hypocholesterolemia, hepatoprotective, hepatostimulatory, analgesic and anti-carcinogenic properties. The content of lipid peroxidation, vitamin C, DPPH, and ABTS in *Kigella africana* fruit suggests that it can be used as an antioxidant supplement in livestock diet.

5. Acknowledgments

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6. Authors' Contributions

Ojediran Taiwo Kayode: compiling results, statistical analysis, and reading of the manuscript. *Adewale Emiola*: compiling results, statistical analysis, and reading of the manuscript. *Olujimi John Alagbe*: compiling results and writing of the manuscript. *Durojaye Victor*: compiling results.

7. Conflicts of Interest

No conflicts of interest.

8. Ethics Approval

Not applicable.

9. References

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