Pharmacological and Therapeutic Potentials of *Garcinia kola*

RESEARCH ARTICLE

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This article is part of a special issue titled Sustainability, innovation, and development: A Festschrift in honour of Rt. Rev. Prof. Obeka Samuel Sunday.

ABSTRACT

Garcinia kola is a flowering plant which produces brown, nut-like seeds and belongs to a family of tropical plants known as *Clusiaceae* or *Guttiferae*. It is native to Western and Central Africa and is commonly referred to as a "wonder plant" because all of its parts have been shown to have medicinal properties. Although various reports have documented uses for all parts of the plant (nuts/seed, leaf, stem, bark, and root), the nuts (bitter kola) are still the most commonly used part of the plant. According to ethnobotanical claims, traditional medical practitioners utilise the seed for preventive measures against menstrual pain, reflux, heart conditions, gastroenteritis, cough, dental and oral hygiene, and so on. The phytochemical constituents found in the *G. kola* plant, such as alkaloids, glycosides, tannins, saponins, phenols, sterols, proteins, and sugars, are reported to be responsible for the numerous pharmacological and therapeutic potentials of the plant. Based on numerous scientific reports, these potentials include anti-diabetic, hepatoprotective, anti-inflammatory, anticancer, antimicrobial, and anti-hypertensive activities, among others. The minerals found in bitter kola include phosphorus, iron, zinc, magnesium, potassium, and calcium. There are presently limited *in vivo* studies on some of the plant's pharmacological and therapeutic potentials, particularly its anticancer potentials. This review aims to provide information on the pharmacological and therapeutic potentials of *Garcinia kola*.

Wonder Plant

All parts of *Garcinia kola* have medicinal properties, with seeds being the most commonly used.

Key Compounds

Alkaloids, glycosides, tannins, saponins, phenols, sterols, and essential minerals.

Activities

Anti-diabetic, hepatoprotective, anti-inflammatory, anticancer, and antimicrobial properties.

Keywords: *Garcinia kola*, pharmacological potential, phytochemical constituents, minerals, wonder plant.

INTRODUCTION

Worldwide, medicinal plants are used to prevent and treat a wide range of ailments. Modern medicine cannot be considered a realistic treatment option for a substantial proportion of the world's population; for example, in Africa, 80 per cent of the population uses some form of traditional herbal medicine (WHO, 2008). Medicinal plants are a rich source of many possible therapeutic products that can be more affordable and safer than conventional drugs (Elujoba et al., 2005). *Garcinia kola* is a flowering plant found in Western and Central Africa, which produces brown, nut-like seeds and belongs to a family of tropical plants known as *Clusiaceae* or *Guttiferae* (Tauchen & Frankova, 2023). It is colloquially called bitter kola, false kola, or sometimes "wonder plant" because almost every part of this tree has been used in traditional medicine for a broad portfolio of ailments since ancient times. In Nigeria, it is found mostly in the Southern Nigerian rainforest area and is referred to as a "wonder plant" as all of its parts have been shown to have medicinal value. Though various ethnobotanical and pharmacological investigations have documented uses for all parts of the plant (nuts/seed, leaf, stem, bark, and root), the nuts are still the most commonly used part of the plant. This is most likely due to the nut's significant medicinal value.

01

Plant Characteristics

The *Garcinia kola* plant develops into an average-sized tree that can reach heights of 12-14 metres and widths of 1.5 metres. It bears orange or reddish-yellow fruits.

02

Regional Names

In Nigeria, *G. kola* is commonly referred to as bitter kola, male kola, and false kola (English); 'Orogbo' (Yoruba); 'Cida/mijin goro' (Hausa); various Igbo names; 'Efiari' (Efik); and other regional names.

03

Traditional Uses

Other ethnomedicinal uses include consumption of the seeds as stimulants in the management of diabetes, bronchitis, liver issues, and diarrhoea.

Garcinia kola plant typically produces its male and female flowers separately in December, March, and May through August. It additionally yields distinctively large fruits, about 6 cm in diameter, containing three to four brown-coloured seeds embedded in an orange pulp with branching lines and light kernels with resin pockets. When cut, the three-sided seeds, measuring up to 3.8 cm by over 1.3 cm, reveal a tiny resinous line. The taste of the seeds is often bitter with a hint of sweetness. Since *Garcinia kola* seeds have high caffeine content, people consume them as a snack and for their stimulant effects despite their bitter taste.

TRADITIONAL USES OF *Garcinia kola*

Traditional medicine primarily utilises practically all parts of *Garcinia kola* to treat a variety of human illnesses (Ethnobotanical Source 1, Year). While the seed coat is used as a stimulant, believed to cleanse the digestive system without causing adverse effects such as stomach problems, even when consumed in large quantities (Ethnobotanical Source 2, Year), the seed itself is applied as a sialagogue to increase salivary flow (Ethnobotanical Source 3, Year). To relieve coughs, the dried seed is also frequently ground and combined with honey (Ethnobotanical Source 4, Year). As a traditional claim, newborn babies are given a mixture of pulverised seed and water to alleviate stomach issues (Ethnobotanical Source 5, Year). Certain traditional medicine practitioners claim to manage hypertension with *Garcinia kola* seeds (Ethnobotanical Source 6, Year). In Cameroon, the seed is chewed as a preventative measure against menstrual pain, reflux, heart illness, gastroenteritis, and cough (Ethnobotanical Source 7, Year). It is also used for dental and oral cleanliness (Ethnobotanical Source 8, Year). In some parts of Western Nigeria, one seed per day is often recommended as a prophylactic measure against various illnesses (Ethnobotanical Source 9, Year). The bark is boiled with water, and two glasses are taken per day to cure stomach ache or indigestion in Cameroon (Ethnobotanical Source 10, Year).

Seed Uses

- Stimulant and digestive cleanser
- Cough relief with honey
- Stomach issues in newborns
- Hypertension management
- Dental and oral hygiene

Regional Applications

- Menstrual pain prevention
- Heart ailment treatment
- Gastroenteritis relief
- Daily prophylactic use
- Bark for stomach ailments

PHYTOCHEMICAL AND NUTRITIONAL CONSTITUENTS OF *GARCINIA KOLA*

Alkaloids, glycosides, tannins, saponins, phenols, sterols, starch, and triterpenoids are all present in *G. kola* seeds, with flavonoids making up the majority. The most abundant phytochemicals in *G. kola* seeds are flavonoids. The presence of saponins, tannins, phenols, glycosides, and alkaloids has also been confirmed by various authors. Kolaviron, quercetin, garcinoic acid, GB-1a, GB-1, GB-2, kolaflavone, benzophenone, xanthone, garcinia biflavonoid (GB)-1a-glucoside, coumarin, apigenin, and garcinianin are principal components of the plant (Mahanat et al., 1982; Iwu et al., 1987;

Farnsworth et al., 1989; Ajayi et al., 2014; and Kakjing et al., 2014). Hexadecanoic acid, methyl ester, linoleic acid, formaldehyde, 9-octadecenoic acid, N,N-Diethyl, n-tetradecanoic acid amide; 3,4,8-trimethyl-2-nonenal heptadecene-(8)-carboxylic acid, and carbohydrates have been isolated from the seeds of *Garcinia kola* (Seanago and Ndip 2012; Ukaoma et al., 2013).

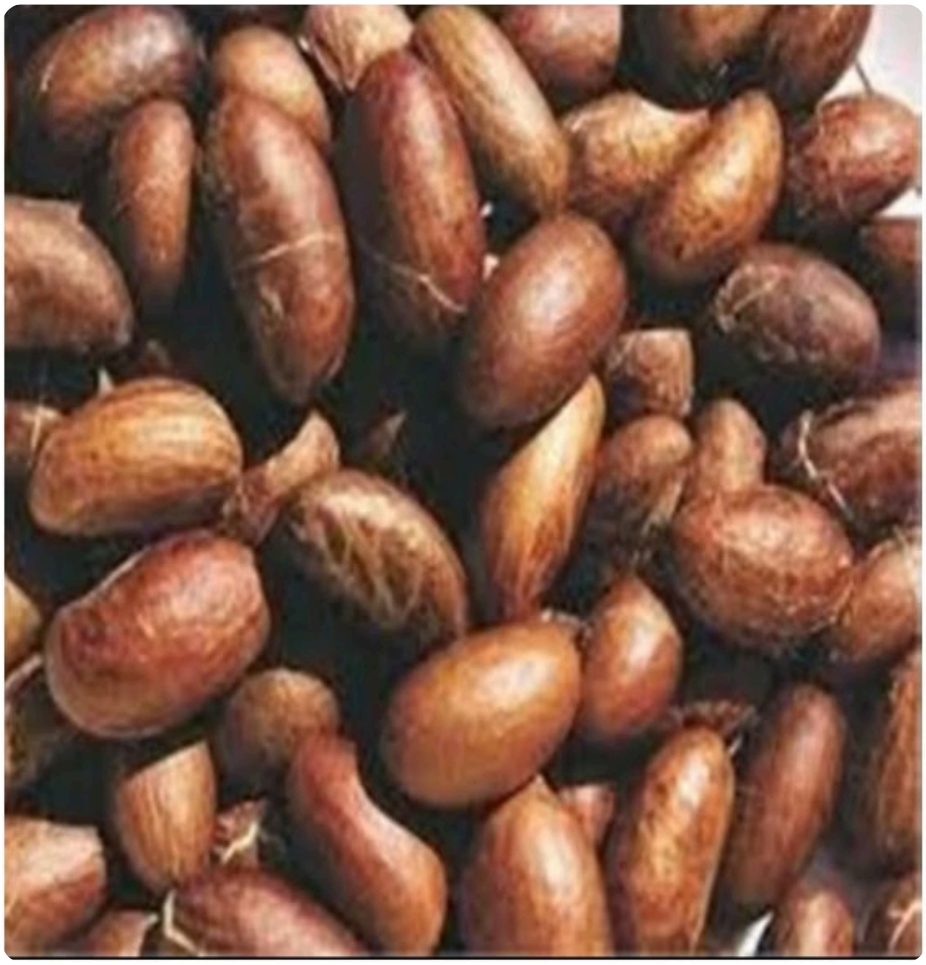

Plate 1: *G. kola* Seeds (Buba et al., 2016)

The phytochemical assay showed that tannin (0.347%), phenol (0.163%), caffeine (0.607%), saponin (0.680%), sterol (0.093%), flavonoid (2.130%), alkaloid (0.433%), and hydrogen cyanide (1.347 mg/kg) were found in significant amounts. The minerals found in bitter kola (mg/kg of dry matter) included the following: phosphorus (188.57±0.37), iron (6.010±0.43), zinc (6.010±0.43), magnesium (114.83±3.47), potassium (722.10±0.00), and calcium (67.07±0.1). Studies have revealed that bitter kola contains vitamins and minerals such as vitamin C, potassium, calcium, and phosphorus, all of which help build immunity. The most prevalent biological molecule was found to be carbohydrates (70.31%), followed by crude protein (11.27%), ash (4.17%), crude fibre (3.94%), moisture content (9.28%), and ether extract/fat (1.03%) in substantial levels. Potassium and phosphorus were discovered to be the most abundant minerals in *G. kola* seeds (Buba et al., 2016).

Primary Compounds

Kolaviron, quercetin, garcinoic acid, benzophenone, xanthone, and other bioactive compounds.

Essential Minerals

High levels of potassium, phosphorus, magnesium, calcium, iron, and zinc for immune support.

Nutritional Profile

Rich in carbohydrates (70.31%), protein (11.27%), and essential vitamins including vitamin C.

PHARMACOLOGICAL ACTIVITIES

Anti-diabetic Activity of *G. kola*

G. kola seed powder demonstrates anti-diabetic, anti-lipidemic, and anti-atherogenic qualities, with significant potential for preventing coronary heart disease (Adaramoye, 2012; Iwu et al., 1990). Early animal studies (Okwu et al., 2009) suggest kolaviron, found in bitter kola, may protect against complications related to diabetes. *G. kola* seed compounds, such as kolaviron, have demonstrated anti-diabetic activity in animal models. For example, Adaramoye (2012) showed that kolaviron significantly lowered fasting blood glucose and improved metabolic markers in STZ-induced diabetic rats. More recently, a 2024 study found that Garcinia biflavonoid 1 (GB1) improved hyperglycaemia, insulin resistance, and lipid dysregulation in diabetic db/db mice (Fu et al., 2024). Although these results are promising, human clinical trials are still needed to confirm therapeutic potential in type-2 diabetes.

Hepatoprotective Activity of *G. kola*

The anti-hepatotoxic efficacy of *G. kola* seed is attributed to its kolaviron content (Akpantah et al., 2017). In **rat studies**, kolaviron, a biflavonoid isolated from Nigerian *Garcinia kola* seeds, protected against carcinogen-induced liver damage, acting as an *in vivo* natural antioxidant and enhancing drug-detoxifying enzymes (Farombi et al., 2011; Adaramoye, 2012). An article (Olorunnisola et al., 2012) indicates *G. kola* seed protects rat hepatocytes against paracetamol-induced oxidative damage and glycogen degranulation. Kolaviron also protected against carcinogen-induced hepatotoxicity through metal chelation, activation of the detoxification system, and free radical scavenging (Farombi et al., 2011). However, human hepatoprotective effects still require clinical research for establishment.

Anti-inflammatory Activity of *G. kola*

In **mouse studies**, kolaviron, a defatted seed extract of *G. kola*, demonstrated a potent anti-inflammatory effect at a 150 mg/kg dose, significantly surpassing acetylsalicylic acid (aspirin), a common reference medication (Olaleye et al., 2000). Traditionally, bitter kola seeds have been chewed in Africa to combat inflammatory conditions like arthritis (Iwu et al., 1999). A 2008

randomised, placebo-controlled, double-blind human clinical trial involving 84 patients with knee osteoarthritis showed significantly reduced inflammation and WOMAC pain scores over 6 weeks with bitter kola consumption compared to placebo (Olayinka et al., 2008). Kolaviron's efficacy may be linked to its biflavonoid groups, which offer pharmacokinetic benefits over simple monomeric flavonoids and are pharmacologically active. Kolaviron interferes with lipopolysaccharide (LPS) signalling by decreasing the activation of multiple inflammatory transcription factors and signalling pathways (Farombi et al., 2011).

Anti-Hypertensive Activity of *G. kola*

G. kola may lower blood pressure by reducing total peripheral resistance, affecting vascular smooth muscle, and stabilising membranes (Tauchen & Frankova, 2023). A 2024 human clinical trial (Coker et al., *Journal of Biochemistry and Phytomedicine*) showed that 15g daily of *G. kola* significantly but transiently reduced systolic blood pressure in 22 normotensive individuals 60 minutes post-ingestion, providing initial human evidence. Further clinical validation in human subjects is required for these proposed mechanisms.

Anti-Cancer Activity of *G. kola*

Literature suggests tannins and *G. kola*'s apigenin have cancer-preventative activity. In vitro, apigenin induced cell cycle arrest, impeded invasion, and increased apoptosis in T24 human bladder cancer cells. Kolaviron successfully suppressed dimethyl hydrazine-induced colon cancer in rats. However, human clinical trials have not yet confirmed *G. kola*'s anti-cancer effects.

Antimicrobial Activity of *G. kola*

Crude methanol and ethanol extracts of *G. kola* seeds show in vitro antibacterial activity against Gram-positive and Gram-negative bacteria. Traditionally, bitter kola treats infections from the common cold to hepatitis (Iwu et al., 1999), with recent findings suggesting antibacterial, antiviral, and antitussive properties (Farombi & Olatunde, 2018). An in vitro study at 6 mg/ml showed extracts from *G. kola* stem, bark, and seed suppressed *Plasmodium falciparum* growth by over 60% (Braide et al., 2011). Antibacterial investigations also demonstrate bitter kola and ginger's antimicrobial activity against major respiratory pathogens like *Streptococcus pyogenes*, *Staphylococcus aureus*, *Streptococcus pneumoniae*, and *Haemophilus influenzae* (Oladunmoye, 2007). Seed and leaf extracts also inhibited clinical isolates of *Escherichia coli*, *Salmonella typhi*, *Streptococcus pyogenes*, and *Staphylococcus aureus* (Adegoke et al., 2010). While traditional uses and in vitro studies show promise, rigorous human clinical trials are necessary to determine efficacy and safety for infectious diseases.

In conclusion, while preclinical (in vitro and animal) studies indicate several promising pharmacological activities for *Garcinia kola* (anti-diabetic, hepatoprotective, anti-inflammatory, anti-hypertensive, anti-cancer, and anti-microbial effects), extensive human clinical trials are

critically needed. A comprehensive 2023 review by Tauchen & Frankova (*Phytochemical Reviews*) further emphasised this urgent need to establish therapeutic efficacy, appropriate dosages, and safety profiles for *G. kola*'s various pharmacological activities.

Anti-diabetic

Kolaviron protects against hypoglycaemia and lowers blood sugar levels in diabetic conditions.

Hepatoprotective

Acts as a natural antioxidant protecting the liver from toxins and enhancing detoxification enzymes.

Anti-inflammatory

More effective than aspirin in reducing inflammation, particularly beneficial for arthritis.

Anti-microbial

Effective against both Gram-positive and Gram-negative bacteria, viral, and parasitic infections.

TOXICOLOGICAL PROPERTIES OF *GARCINIA KOLA*

Toxicological studies have been conducted to assess the safety of *Garcinia kola* extracts. One study reported that when *Garcinia kola* ethanolic extract was administered to Wistar rats for six weeks at doses of 100 mg/kg and 200 mg/kg, no adverse effects on liver function were reported. According to another study, treatment-related changes in the biochemical indices were observed with doses of 25, 50, and 100 mg/kg. The FDA considers bitter kola generally safe to eat, but classifies it similarly to essential oils. Consequently, there is not much information available about serving sizes or nutritional data. Even though antinutrients such as oxalate and phytate were detected, the seeds are safe for consumption, and there are no reports of harmful overdosing so far.

CONCLUSION

Garcinia kola is a vast reservoir of various bioactive compounds, which are known to contribute to the numerous therapeutic potentials of the plant. Diverse pharmacological *in vivo* and *in vitro* investigations revealed that *G. kola* has anti-inflammatory, antimalarial, hepatoprotective, cardioprotective, anti-asthmatic, neuroprotective, antioxidant, and antidiabetic activities. The present study revealed that *G. kola* has preventive and therapeutic potentials against various diseases in both *in vivo* and *in vitro* studies and therefore can be utilised as a raw material in the pharmaceutical industry for the development of therapeutic products. As all parts of the plant possess medicinal properties, there are endless opportunities for further research. More findings can be made to ascertain the mechanisms of action of each of the phytochemical constituents in *Garcinia kola*, which will serve as a lead in drug development. The prediction of how the bioactive compounds present in the plant interact with target molecules, such as infectious agents, using molecular docking techniques, can be investigated in order to identify potential drug candidates.

01

Safety Profile

Generally recognised as safe by the FDA, with no reports of harmful overdosing documented.

02

Research Opportunities

Extensive research is needed on mechanisms of action and potential drug development applications.

03

Clinical Potential

Multiple therapeutic activities confirmed by *in vitro* and *in vivo* studies, indicating potential for pharmaceutical development.

04

Future Directions

Molecular docking studies are needed to identify potential drug candidates from bioactive compounds.

ACKNOWLEDGEMENT

Not applicable

CONFLICTS OF INTEREST

The author declares no conflict of interest.

FUNDING

This research received no funding from any agency.

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Received: July 1 2025

Accepted: August 26 2025

Published: November 19 2025

Citation:

Omoseyin,O. E., Mayomi,P. T., Olaolu,O. A. & Akinterinwa E. T. (2025). Pharmacological and Therapeutic Potentials of *Garcinia kola*. *SustainE*, 3(3), 284-295. In A. A. Atowoju, E. O. Oyekanmi, A. A. Akinsemolu, & D. M. Duyile (Eds.), Sustainability, innovation, and development: A Festschrift in honour of Rt. Rev. Prof. Obeka Samuel Sunday [Special issue]. https://doi.org/10.55366/suse.v3i3.14