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***Garcinia kola*: A Scoping Review of its Benefits in Cardiometabolic Health**Kasimu Ghandi Ibrahim^{1,2,3*}, Kehinde Ahmad Adeshina^{1,4}, and Amina Yusuf Jega⁵

Department of Physiology, Faculty of Basic Medical Sciences, College of Health Sciences, Usmanu Danfodiyo University, PMB 2254, Sokoto, Nigeria¹, Department of Basic Medical and Dental Sciences, Faculty of Dentistry, Zarqa University, P.O. Box 2000, Zarqa 13110, Jordan², School of Physiology, Faculty of Health Sciences, University of the Witwatersrand, 7 York Road, Parktown 20193, Johannesburg, South Africa³, Department of Physiology, Faculty of Basic Medical Sciences, Federal University of Health Sciences, P.M.B. 45, Azare, Nigeria⁴, Department of Pharmaceutical and Medicinal Chemistry, Faculty of Pharmaceutical Sciences, Usmanu Danfodiyo University, P.M.B. 2254, Sokoto⁵.

Author for Correspondence*: gandi.kasimu@udusok.edu.ng / +234-803-504-6118.
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Abstract

Cardiometabolic disorders encompass a cluster of prevalent yet preventable conditions, such as obesity, insulin resistance, diabetes, non-alcoholic fatty liver disease, hypertension, and stroke. There is a worldwide surge in the prevalence of individuals who encounter one or more of these illnesses in their lives. Immediate public health actions are required to improve lifestyle behaviours and reduce the risk of cardiometabolic disease among young and old adults. Numerous plants are conventionally used to treat cardiometabolic conditions. The seeds, stem bark, and roots of *Garcinia kola* are components of these plants that are extensively utilized in traditional pharmacopoeia for the management of metabolic and cardiovascular conditions. A growing number of studies have demonstrated the potential of *Garcinia kola* in the management of cardiometabolic disorders. Here, we provide a comprehensive review of the traditional uses of *Garcinia kola*, its phytochemical composition, as well as its potential for treating cardiometabolic diseases. Thus, *Garcinia kola* and its phytochemical constituents offer beneficial effects on cardiometabolic health and could be an ideal candidate for the effective management of these health conditions.

Keywords: *Garcinia kola*, Cardiometabolic Health, Diabetes, Hypertension, Obesity

Introduction

Garcinia kola, commonly known as bitter kola, is a notable plant species belonging to the *Guttiferae*

family. The plant is indigenous to the rainforests of West and Central Africa, and it is a dicotyledonous tree that has garnered widespread attention due to its multifaceted significance in traditional medicine, phytochemistry, pharmacology, and economic realms (Dalziel, 1937; Iwu, 1993). *Garcinia kola* is identified by its evergreen nature, typically reaching a height of 15-17 meters with a relatively narrow crown. The leaves are simple in structure and measure between 6–14 cm in length and 2–6 cm in width, displaying a shiny surface adorned with resin glands (Iwu, 1993). The plant produces small flowers covered with short, red hairs, adding to its distinctive appearance. The fruit of *Garcinia kola* is a drupe measuring between 5–10 cm in diameter, and it weighs between 30–50 g and undergoes a colour transformation from green to orange during maturation with each fruit containing about 1–4 seeds within a yellow-red pulp (Agwu *et al.*, 2020).

In terms of geographical distribution, this species thrives in the lush forests of West and Central Africa, including countries such as Sierra Leone, Ghana, Cameroon, and Nigeria. In Nigeria, *Garcinia kola* is particularly prevalent in the South Western States and Edo State (Uko *et al.*, 2001). The plant's adaptability to these regions has contributed to its cultural and economic significance among local communities.

Ethnomedicinally, *Garcinia kola* has long been an integral component of traditional herbal medicine across Africa. Every part of the plant is utilized for its medicinal properties, as documented in historical references (Dalziel,

1937). The plant's diverse applications include treating various ailments such as respiratory conditions, and digestive issues, and even as an aphrodisiac. It has also been utilized in the treatment of diarrhoea, bronchitis, bacterial infection, cough, throat infection, hepatitis, gonorrhoea, laryngitis, skin infection, food poisoning, and liver and gastric diseases (Ahidjo *et al.*, 2021).

Exploring its chemical composition and potential therapeutic effects has revealed promising insights into its medicinal value (Dalziel, 1937). The phytochemical composition

of *Garcinia kola* includes bioactive compounds such as flavonoids, alkaloids, saponins, and tannins (Iwu, 1993). These constituents contribute to the plant's pharmacological properties, which encompass anti-inflammatory, antioxidant, antimicrobial, and anti-diabetic effects. Researchers have conducted extensive studies to elucidate the mechanisms through which *Garcinia kola* exerts its therapeutic actions, paving the way for the development of pharmaceutical applications (Iwu, 1993). Figures 1 A-C shows the tree, fruit, leaves and seeds of *Garcinia kola*.



Figure 1: Picture of *Garcinia kola* (a) Tree and fruits (b) Fruits and leaves (c) Seeds (Source: <https://leadership.ng/investing-in-bitter-kola/>)

Methodology

Search strategy for literature review.

The authors individually conducted a comprehensive literature search using PubMed, ScienceDirect, and Google Scholar for relevant studies. Using pairwise combinations of keywords, the authors performed a Boolean search with the following search strings: “*Garcinia kola* AND obesity”, “*Garcinia kola* AND inflammation”, “*Garcinia kola* AND dyslipidaemia”, “*Garcinia kola* AND diabetes”, “*Garcinia kola* AND hypertension”, “*Garcinia kola* AND cardiovascular disease”.

Inclusion and exclusion criteria

The retrieved articles were screened for eligibility. All relevant published original research articles until April 2024 were included in this review. Duplicate articles and review papers were excluded. Also, papers written in languages other than English were not considered by the authors.

Cardiometabolic health and its significance

Cardio-metabolic health is a term that encompasses the intricate relationship between

cardiovascular health and metabolic well-being. It refers to the optimal functioning of the cardiovascular system and the metabolic processes within the body (O'Hearn *et al.*, 2022). The significance of maintaining cardio-metabolic health extends far beyond mere physical well-being; it is intricately linked to overall health and longevity.

Cardiometabolic health components include cardiovascular and metabolic health: the latter comprises the heart and blood vessels and plays a pivotal role in maintaining circulation and delivering essential nutrients and oxygen throughout the body. Cardiovascular health is assessed through parameters such as blood pressure, cholesterol levels, and the overall efficiency of the heart in pumping blood. A healthy cardiovascular system is crucial for preventing conditions like heart disease, stroke, and peripheral vascular diseases (Lloyd-Jones *et al.*, 2022), while metabolic health involves the complex processes that convert food into energy, regulate blood glucose levels, and manage the body's energy balance (Galgani and Fernandez-Verdejo, 2021). Components of metabolic health include insulin sensitivity, blood

glucose regulation, lipid metabolism, and body composition. Maintaining metabolic health is essential for preventing metabolic disorders like type 2 diabetes, obesity, and metabolic syndrome (Patino-Alonso *et al.*, 2015).

Cardiovascular and metabolic health are interconnected in a bidirectional relationship (Thyfaut and Bergouignan, 2020). For instance, insulin resistance, a key component of metabolic

dysfunction, can contribute to endothelial dysfunction and inflammation in blood vessels, leading to cardiovascular complications (Wu and Ballantyne, 2020; Hill *et al.*, 2021). Similarly, cardiovascular diseases can impact metabolic health by influencing glucose metabolism and insulin sensitivity (Singh *et al.*, 2021).

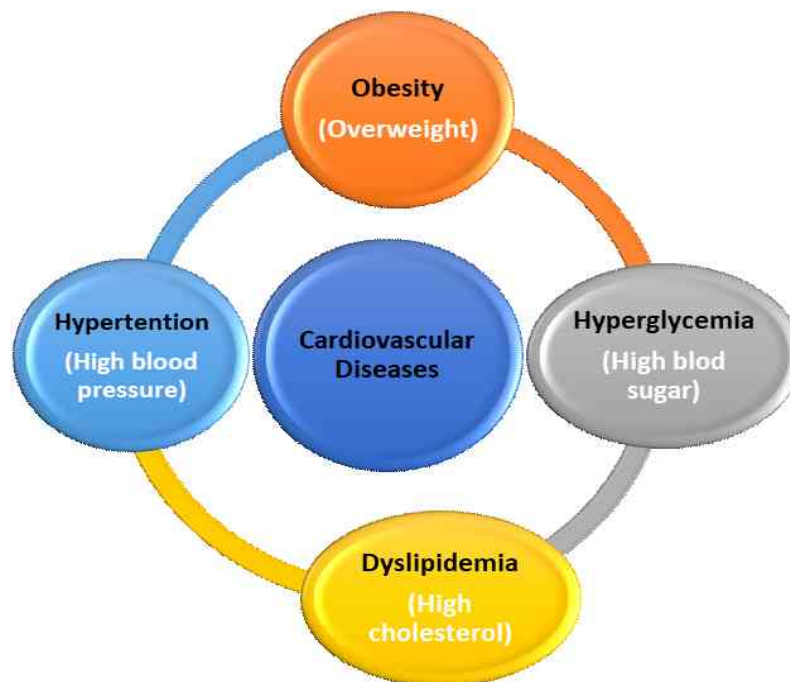


Figure 2: A schema of cardiometabolic diseases

Public Health Significance of Cardiometabolic Diseases

Cardiometabolic disorders, such as heart disease and type 2 diabetes, impose a significant burden on global health. By prioritizing and promoting cardio-metabolic health, individuals can mitigate the risk of developing these chronic conditions, consequently reducing the burden on healthcare systems (Stefan and Schulze, 2023). Optimal cardio-metabolic health is fundamental for maintaining a high quality of life. Individuals with good cardiovascular and metabolic health are more likely to experience increased energy levels, improved cognitive function, and a reduced risk of disability and premature mortality (Patino-Alonso *et al.*, 2015). Cardio-metabolic disorders contribute substantially to healthcare costs, workplace absenteeism, and

decreased productivity (Mela *et al.*, 2020; Seidu *et al.*, 2023). Promoting cardio-metabolic health can lead to economic benefits by reducing healthcare expenditures and fostering a healthier, more productive workforce (Adeomi *et al.*, 2019). Emphasizing cardio-metabolic health encourages a proactive approach to healthcare. Lifestyle interventions, including a balanced diet, regular physical activity, and stress management, play a crucial role in maintaining and improving cardio-metabolic well-being. Prevention and early intervention strategies can significantly impact long-term health outcomes.

The Rationale for Exploring *Garcinia Kola's* Potential in Cardiometabolic Health

Exploring the potential of *Garcinia kola* in cardiometabolic health is driven by traditional knowledge, anecdotal evidence, and emerging

scientific research. This rationale is grounded in the diverse phytochemical composition of the plant *Garcinia kola* and its historical applications in traditional medicine. Several factors contribute to the rationale for investigating the effects of *Garcinia kola* on cardiometabolic health viz:

Traditional Medicinal Use

Garcinia kola has a long history of use in traditional medicine across West and Central Africa. Ethnomedicinally, various parts of the plant have been utilized for treating respiratory conditions, and digestive issues, among other diseases for the general well-being of man (Yakubu and Muhammad, 2021). These uses include cough, hepatitis, gonorrhoea, laryngitis, food poisoning, diarrhoea, bronchitis, bacterial infection, and liver and gastric diseases (Emmanuel *et al.*, 2022). The plant's relevance in traditional remedies suggests that it may possess bioactive compounds with potential cardiovascular and metabolic benefits.

Phytochemical Composition of *Garcinia kola*

Phytochemical analysis of *Garcinia kola* has revealed the presence of diverse bioactive compounds, including flavonoids, alkaloids,

saponins, and tannins (Rufa'i *et al.*, 2023). These compounds have been associated with antioxidant, anti-inflammatory, and other pharmacological properties that could positively influence cardio-metabolic health (Adedapo *et al.*, 2016; Emmanuel *et al.*, 2022). Antioxidants, for example, play a crucial role in mitigating oxidative stress, a factor implicated in cardiovascular and metabolic diseases.

Chemical Composition of *Garcinia kola*

Key bioactive compounds

Garcinia kola contains various bioactive compounds that contribute to its medicinal and potential health-promoting properties. While the specific composition may vary, key bioactive compounds identified in the plant kola include:

Garcinol

Garcinol (Figure 3) is a polyisoprenylated benzophenone found in the seeds of *Garcinia kola*. It has been studied for its antioxidant and anti-inflammatory properties (Behera *et al.*, 2016). *Garcinol* is recognized for its potential in combating oxidative stress, which is implicated in various chronic diseases, including cardiovascular and metabolic disorders (Chantree *et al.*, 2023).

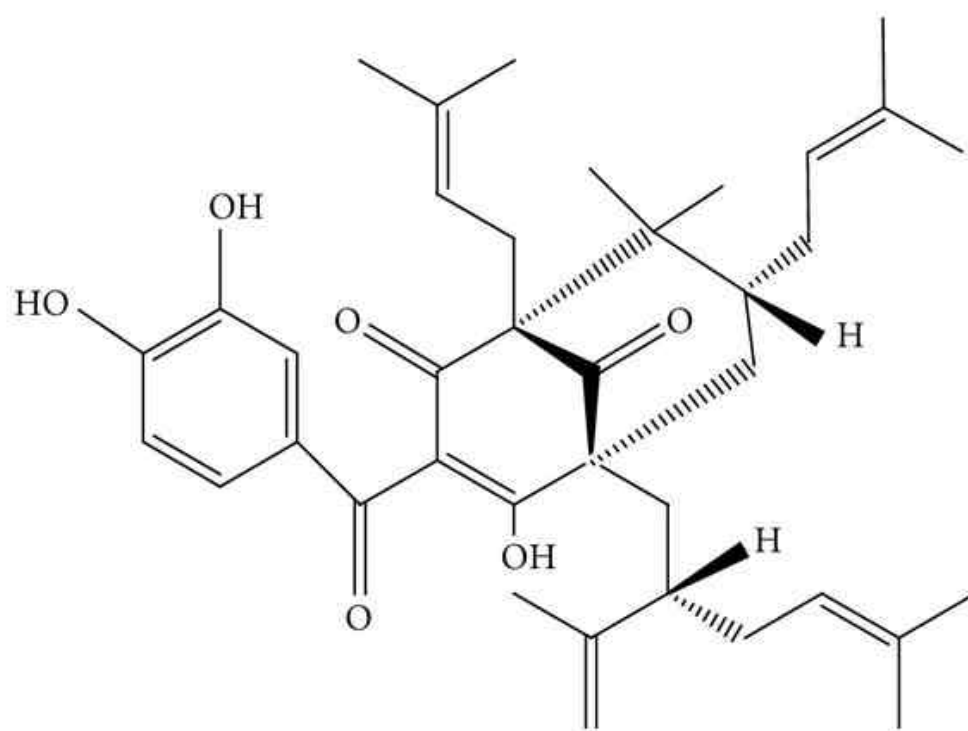


Figure 3: Chemical structure of Garcinol

Kolaviron

Kolaviron (Figure 4) is a complex mixture of bioflavonoids isolated from *Garcinia kola* seeds (Farombi *et al.*, 2002). It consists of flavonoids such as biflavonoids, catechins, and xanthenes. *Kolaviron* has demonstrated antioxidant, anti-

inflammatory, and hepatoprotective properties (Farombi *et al.*, 2002; Nwaneri-Chidozie *et al.*, 2014; Emmanuel *et al.*, 2022). Its potential impact on oxidative stress and inflammation makes it of interest in the context of cardio-metabolic health.

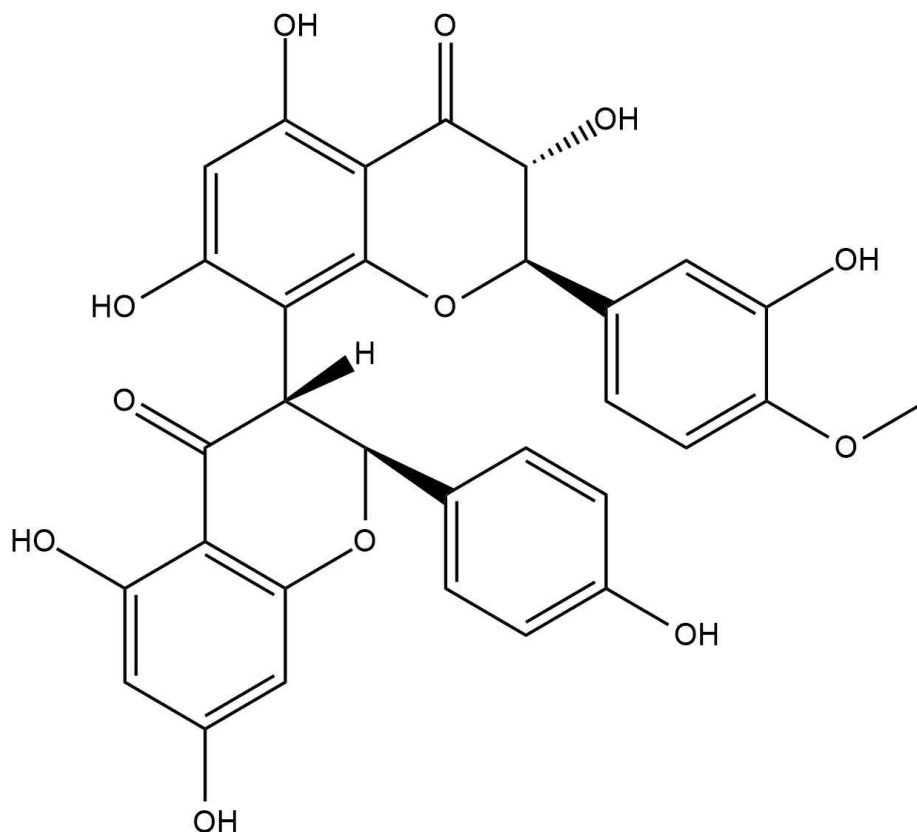


Figure 4: Chemical structure of Kolaviron

Xanthenes

Garcinia kola is known to contain various *xanthenes*, which are natural compounds with antioxidant and anti-inflammatory properties (Idris *et al.*, 2020; Emmanuel *et al.*, 2022). *Xanthenes* have been studied for their potential to modulate cellular processes and influence various metabolic pathways (Panda *et al.*, 2013); these compounds may contribute to the plant's overall health-promoting effects.

Biflavonoids

Biflavonoids are compounds that consist of two flavonoid units linked together (Samec *et al.*, 2022). These compounds have been identified in *Garcinia kola* and are known for their antioxidant and anti-inflammatory activities (Farombi *et al.*, 2002; Idris *et al.*, 2020; Emmanuel *et al.*, 2022). Biflavonoids may play a role in mitigating

oxidative damage and inflammation associated with cardio-metabolic disorders.

Alkaloids

Alkaloids are nitrogen-containing compounds that are commonly found in plants (Heinrich *et al.*, 2021). *Garcinia kola* contains alkaloids, and while their specific effects on cardio-metabolic health may vary, alkaloids, in general, have been studied for their diverse pharmacological activities, including cardiovascular and metabolic effects (Ebana *et al.*, 1991; Niemenak *et al.*, 2008).

Saponins

Saponins are glycosides with a soap-like structure found in many plant species (Juang and Liang, 2020; Sharma *et al.*, 2023). In *Garcinia kola*, saponins have been identified and are known for their potential anti-inflammatory and

antioxidant properties (Smith *et al.*, 2012). These compounds may contribute to the overall health benefits associated with *Garcinia kola*.

It is important to note that the levels of these bioactive compounds can vary depending on factors such as the plant's geographic location, environmental conditions, and cultivation methods (De Caralt *et al.*, 2013). While these compounds have shown promise in preclinical studies, further research, including clinical trials, is needed to better understand the specific mechanisms of action and the potential therapeutic applications of *Garcinia kola* in promoting cardio-metabolic health.

Pharmacological Properties Relevant to Cardiometabolic Health

Garcinia kola has been studied for various pharmacological properties that are relevant to cardiometabolic health. While research is ongoing and further clinical studies are needed, some of the observed pharmacological properties include:

Antioxidant Activity of *Garcinia kola*

The presence of bioactive compounds such as *Kolaviron* and *Garcinol* in *Garcinia kola* contributes to its antioxidant properties (Sang *et al.*, 2001; Farombi *et al.*, 2002; Padhye *et al.*, 2009). Antioxidants help neutralize free radicals, thus, reducing oxidative stress (Neha *et al.*, 2019).

Oxidative stress is implicated in the pathogenesis of cardiovascular diseases and metabolic disorders (Dubois-Deruy *et al.*, 2020; Hou *et al.*, 2023). *Garcinia kola*'s antioxidant activity (Farombi *et al.*, 2013; Ayofe *et al.*, 2017; Idris *et al.*, 2020) attributed to its phytochemical constituents, may help neutralize free radicals and reduce oxidative damage. This antioxidative potential is crucial in maintaining the health of blood vessels and preventing complications associated with metabolic disorders.

Anti-Inflammatory Effects of *Garcinia kola*

Compounds like *kolaviron* have demonstrated anti-inflammatory effects (Farombi *et al.*, 2013; Emmanuel *et al.*, 2022). Chronic inflammation is a key factor in the progression of cardio-metabolic diseases, and substances that can

modulate inflammatory responses may have the potential to prevent or manage these conditions (Lee and Olefsky, 2021).

Chronic inflammation is a common factor in both cardiovascular and metabolic disorders (Stenvinkel *et al.*, 2021). *Garcinia kola* has been investigated for its potential anti-inflammatory properties, with some studies suggesting that the plant's compounds may help modulate inflammatory responses (Idris *et al.*, 2020). *Kolaviron* and *Garcinoic acid* isolated from *Garcinia kola* exhibited anti-inflammatory activity in mice models (Onasanwo and Rotu, 2016; Wallert *et al.*, 2019). This anti-inflammatory potential is pertinent to addressing the underlying mechanisms of cardio-metabolic diseases.

Metabolic Effects of *Garcinia kola*

Preliminary research on *Garcinia kola* has indicated potential effects on metabolic parameters (Idris *et al.*, 2020). Some studies have suggested a role in modulating blood glucose levels and lipid metabolism (Udenze *et al.*, 2012). These metabolic effects are relevant to preventing and managing conditions such as type 2 diabetes and metabolic syndrome.

Hepato-protective Properties of *Garcinia kola*

Some studies suggest that *Garcinia kola* may have hepato-protective effects, protecting the liver from damage (Ayepola *et al.*, 2013; Farombi *et al.*, 2013). As the liver plays a crucial role in metabolic processes, maintaining its health is relevant to overall metabolic well-being.

Anti-Diabetic Potential of *Garcinia kola*

Research indicates that *Garcinia kola* may have anti-diabetic effects. Some studies have reported improved blood glucose levels and insulin sensitivity in animal models. In a recent study, *Garcinia kola* seed extract exhibited a marked anti-diabetic effect at doses of 50 and 100mg/kg in a rat model (Nkono *et al.*, 2022). A similar study also reported a significant anti-diabetic effect of a subfraction of *Garcinia kola* extract in streptozotocin-induced diabetic mice (Seke Etet *et al.*, 2022). The antidiabetic effects of *Kolaviron*, a biflavonoid from *Garcinia kola* seed have also been documented (Adaramoye and Adeyemi, 2006; Adaramoye, 2012). In most of these studies, *Garcinia kola* exerted its anti-

diabetic effects by lowering blood glucose levels and improving glucose tolerance (Nkono *et al.*, 2022; Seke Etet *et al.*, 2022). These effects could be beneficial in managing diabetes and related metabolic complications.

Cardioprotective Potential of *Garcinia kola*

Certain compounds found in *Garcinia kola* may have a cardioprotective impact. Research has explored the plant's potential to influence blood pressure, lipid profiles, and overall cardiovascular function (Nwaneri-Chidozie *et al.*, 2014; Oyagbemi *et al.*, 2018). These findings raise the possibility that *Garcinia kola* could contribute to maintaining cardiovascular health and preventing heart-related issues.

Anti-Hypertensive Effects of *Garcinia kola*

Certain studies have explored the impact of *Garcinia kola* on blood pressure regulation (Cetkovic-Cvrlje *et al.*, 2022; Seke Etet *et al.*, 2022). While findings are preliminary, there is some evidence to suggest that the plant may have anti-hypertensive properties, potentially contributing to cardiovascular health. Some research suggests that *Garcinia kola* may possess vasodilatory properties, contributing to the relaxation of blood vessels (Adaramoye and Medeiros, 2009). Vasodilation can enhance blood flow and may have implications for cardiovascular health, particularly in conditions like hypertension.

Anti-Lipidemic Effects of *Garcinia kola*

Garcinia kola has been investigated for its potential to influence lipid metabolism (Eze-Steven *et al.*, 2014). Some studies indicate that it may have lipid-lowering effects, impacting cholesterol levels. Maintaining healthy lipid profiles is crucial for cardiovascular health.

Anti-thrombotic Activity of *Garcinia kola*

Studies have explored the anti-thrombotic potential of *Garcinia kola*, indicating a possible role in preventing abnormal blood clot formation. This property may be relevant in reducing the risk of thrombotic events associated with cardiovascular diseases (Ahumobe and Braide, 2009; Olatoye *et al.*, 2024).

Holistic Health Approach

Given the multifaceted nature of cardiometabolic health, adopting a holistic approach that includes lifestyle interventions and natural remedies aligns with contemporary healthcare practices. *Garcinia kola's* potential in this context supports the exploration of complementary and alternative therapies to address cardiometabolic risk factors. The rationale for exploring *Garcinia kola's* potential in cardiometabolic health stems from a combination of traditional knowledge, phytochemical composition, and emerging scientific evidence. The plant's historical use in traditional medicine, coupled with its diverse bioactive compounds, makes it a promising candidate for further investigation. While research is ongoing, the potential cardiometabolic benefits of *Garcinia kola* highlight the importance of bridging traditional wisdom with modern scientific exploration in the pursuit of holistic health solutions.

Future perspectives for research

Research on *Garcinia kola* in cardiometabolic health is likely to continue its expansion, driven by growing interest in natural remedies and complementary medicine.

Future studies could delve deeper into the mechanisms through which *Garcinia kola* affects cardiometabolic health. This would involve studying and understanding the exact molecular pathways and their effects on lipid metabolism, glucose homeostasis, inflammation, oxidative stress, and vascular function affording precious insights into the development of targeted therapies. The identification and characterization of the bioactive compounds present in *Garcinia kola* that are responsible for its cardiometabolic effects will also remain a priority in future research. This might involve the isolation of individual compounds, an explanation of their pharmacological effects, and an investigation of the potential synergistic interaction of the various constituents. Research on the pharmacokinetics and pharmacodynamics of *Garcinia kola* preparations will be fundamental in the optimization of dosing regimens and the assurance of reproducible therapeutic effects.

Knowledge of factors such as absorption, distribution, metabolism, and excretion will inform dosage and reduce variability in treatment response.

The study of the synergism of *Garcinia kola* with conventional pharmacotherapies or other dietary supplements can lead to the establishment of new combination treatments for cardiometabolic disorders. Such combinations might exhibit more impressive efficacy with fewer side effects due to complementary action on multiple pathways. The accomplishment of larger and more rigorously designed clinical trials will be important in assessing the efficacy and safety of *Garcinia kola* in managing cardiometabolic conditions like hypertension, diabetes, dyslipidaemia, and obesity. Such trials must employ standardized protocols, adequate sample sizes, and long-term follow-up to assess both short-term and long-term outcomes.

The future may involve investigating the individual variability in response to *Garcinia kola* treatment, which could lead to the development of personalized approaches to cardiometabolic care. Genetic polymorphisms, gut microbiota composition, or other lifestyle factors could either enhance or deter the efficacy of treatment and may further guide interventions. Continuous assessment of the safety of *Garcinia kola* products will be required, especially during long-term or high dosages. This includes the evaluation of adverse effects, drug interactions, and adulteration or contamination. Long-term observational studies would serve as a useful tool for keeping track of safety in the real world. Similarly, studies may be conducted into the role that *Garcinia kola* will play in preventing cardiometabolic risk factors in high-risk populations. Epidemiological studies and intervention trials focusing on primary prevention may provide evidence for including *Garcinia kola* in dietary and lifestyle interventions aimed at reducing the burden of cardiovascular and metabolic diseases.

In general, future research on *Garcinia kola* in cardiometabolic health bears promise for novel therapeutic strategies and an understanding of natural remedies in the management of chronic

diseases. Collaboration of scientists, clinicians, and traditional healers will be of paramount importance in translating findings from research into clinical practice and health outcomes all around the globe.

Conclusion

Garcinia kola is a plant with multiple medicinal benefits and contributes to overall cardiometabolic health. Accumulating evidence indicates that *Garcinia kola* may have potential as a viable treatment option for cardiometabolic disorders. It is important to note that much of the research on *Garcinia kola's* pharmacological properties has been conducted in preclinical settings, often using animal models. While these findings are promising, clinical trials are necessary to validate the effectiveness and safety of *Garcinia kola* in humans, especially concerning cardiometabolic health. Additionally, individual responses may vary, and any potential therapeutic use of *Garcinia kola* should be approached with caution until further conclusive evidence is available.

Conflict of Interest

The authors declare no conflict of interest.

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