

The Therapeutic Potential of *Cola nitida* in Health and Disease: A Review

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Abstract

Cola nitida, also known as Kola nut, is a tropical plant native to West Africa and has a rich history of traditional medicinal use. In this narrative review, we aim to provide an overview of the protective effects of *Cola nitida* in various health and disease states. *Cola nitida* has been traditionally used for its medicinal properties, and its bioactive compounds include caffeine, alkaloids, tannins, flavonoids, and phenolics. These compounds contribute to its potential therapeutic effects. Here, we examine the potential benefits of *Cola nitida* in several areas of health, discussing its role in cognitive function, cardiovascular health, immune system function, gastrointestinal health, and metabolic and endocrine health. Relevant original articles available from PubMed, African Journals Online (AJOL), SCOPUS, and Google Scholar were retrieved using the keywords “cola” AND “nitida” without date restriction until July 17, 2023. Evidence suggests that *Cola nitida* may have positive effects on health, with indications of adverse effects only from its chronic usage. However, more research is needed to establish its efficacy and safety. *Cola nitida* holds promise as a natural remedy for various health conditions. Understanding the benefits and limitations of *Cola nitida* will contribute to its effective utilization in health and disease management.

Keywords: bioactive compounds; *Cola nitida*; Kola nut; therapeutic effects; traditional medicine.

INTRODUCTION

Cola nitida is among the major *Cola* species commonly known as Kola nut. It is a tropical plant native to the west coast of Africa (Lim, 2012). It has a long history of traditional use in various cultural practices and is renowned for its medicinal properties (Lim, 2012). The Kola nut is rich in bioactive compounds such as alkaloids, tannins, flavonoids, and phenolics, which have been shown to possess a range of therapeutic effects (Ekalu & Habila, 2020).

The exploration of natural products with potential health benefits has gained significant attention in recent years, as they offer alternative approaches to promote wellness and prevent diseases. *Cola nitida* is one such natural product that has attracted interest due to its reported protective effects in various health and disease states.

This narrative review aims to provide an overview of the current scientific understanding of the protective effects of *Cola nitida* in health and disease states. By examining the existing literature and research studies, this review will explore the potential benefits of *Cola nitida* in maintaining cardiovascular health, enhancing

cognitive function, supporting gastrointestinal health, boosting immune system function, and improving metabolic and endocrine health.

Owing to its wide cultural availability, assessing the protective effects of *Cola nitida* could have significant implications for public health and disease management. It may provide valuable insights into the development of novel therapeutic interventions and preventive strategies. By highlighting the potential benefits of *Cola nitida*, this review seeks to encourage further research and exploration of its therapeutic applications.

HISTORICAL AND TRADITIONAL USE OF *Cola nitida*

Cola nitida has a rich history of traditional use in various cultures across West Africa. For centuries, indigenous communities have recognized and utilized the medicinal properties of *Cola nitida*. It holds cultural and symbolic significance and is often used in social, religious, and medicinal contexts (Adega, 1970; Lim, 2012; Ottuh, 2021). It has also attracted scientific interest across the globe. Figure 1 highlights the spread of scientific enquiry related to *Cola nitida* as obtained from PubMed database.

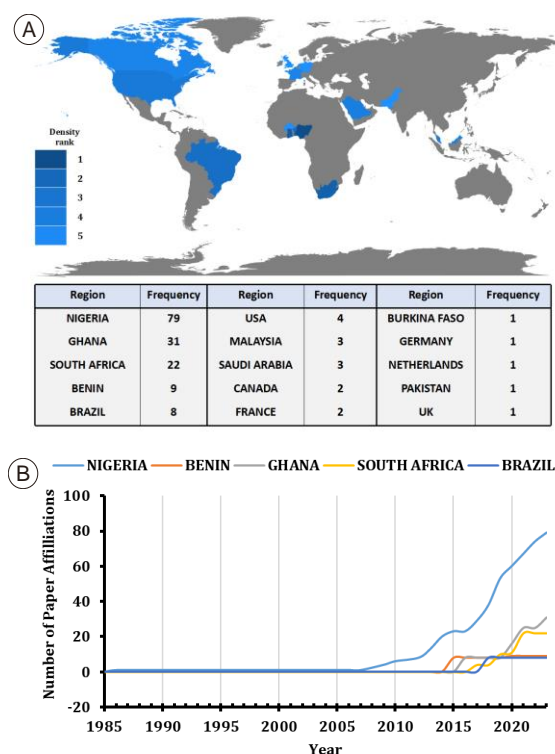


Figure 1. (A) Country-specific scientific contribution based on number of affiliations related to *Cola nitida*. The color intensity for each country is proportional to the number of author affiliations per country in 56 articles (retrieved from PubMed Search on Date = 15th July, 2023, Search string = ("cola"[All Fields] AND "nitida"[All Fields]). Higher blue intensity refers to greater number of affiliations (i.e. dark blue = high productivity; grey = no affiliation). (B) Top 5 country-based scientific contribution over time. Bibliometric analysis was conducted using R package (Biblioshiny) (Aria & Cuccurullo, 2017). (Caveat: data obtained from AJOL, SCOPUS, and Google Scholar could not be incorporated into the analysis due to the peculiarities of the software).

In traditional medicine, *Cola nitida* has been employed as a stimulant to combat fatigue and increase energy levels (Weckerle et al., 2010). Its high caffeine content has contributed to its use as a natural energizer and mood enhancer. Additionally, it has been utilized as an appetite suppressant, aiding in weight management and controlling hunger (Easton & Morton, 1999; Weckerle et al., 2010).

Beyond its medicinal use, *Cola nitida* holds cultural significance and is often incorporated into traditional rituals and ceremonies. In some communities, the Kola nut is considered a symbol of hospitality and is offered as a sign of respect and friendship to guests (Unya, 2021). It is also used in divination practices, believed to possess spiritual properties and the ability to enhance intuition and connection with higher realms (Abah, 2016).

In many West African cultures, *Cola nitida* is a central component of social gatherings and communal activities. It is often chewed or consumed in the form of a beverage to stimulate conversation, foster social interaction, and promote a sense of unity among individuals (Kwame, 2019; Unya, 2021).

The historical and traditional use of *Cola nitida* highlights its cultural importance and its deep-rooted presence in the lives of West African communities. The recognition of its medicinal properties and the incorporation of the Cola nut in various cultural practices have contributed to its enduring popularity and widespread use. While traditional use provides valuable insights into the potential benefits of *Cola nitida*, it is important to conduct empirical experiments to validate and justify these claims.

BIOACTIVE COMPOUNDS OF *Cola nitida* AND THEIR BENEFITS

Cola nitida is a rich source of various bioactive compounds that contribute to its potential therapeutic effects (see figure 2). Its chemical composition can vary due to differences in extraction methods and research protocols. As a result, varying amounts of proximate composition, minerals, and amino acids have been reported in *Cola nitida* (Mbembo et al., 2022). One of the most well-known major components of *Cola nitida* is caffeine, a natural stimulant that can enhance alertness and cognitive function (Adesanwo et al., 2017; Okoli et al., 2012). The occurrence of caffeine in the seed of *Cola nitida* could potentially contribute to its utilization in the production of carbonated beverages (Asogwa et al., 2006; Jayeola, 2001; Ogotuga, 1975).

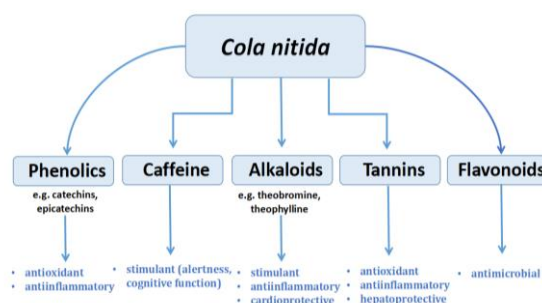


Figure 2. Bioactive compounds in *Cola nitida*.

In addition to caffeine, *Cola nitida* contains other alkaloids such as theobromine and theophylline, which contribute to its stimulating properties (Adesanwo et al., 2017; Ekalu & Habila, 2020; Ogotuga, 1975). Alkaloids have gained recognition for their therapeutic properties, notably their effectiveness as anesthetics, cardioprotective agents, and anti-inflammatory substances (Heinrich et al., 2021).

Cola nitida also contains a variety of phytochemicals, including tannins, flavonoids, and phenolics, which have been associated with potential health benefits (Dewole et al., 2013; Ekalu & Habila, 2020). Tannins are a class of compounds known for their antioxidant and anti-inflammatory properties. They have been reported to have a hepatoprotective effect, helping to reduce

oxidative stress and inflammation (B. Lawal et al., 2017; Sarr et al., 2022).

Flavonoids, another group of phytochemicals found in *Cola nitida*, have been studied for their antimicrobial properties. These compounds have shown potential for antibacterial activity by inhibiting the growth of test isolates, suggesting that it could be used as an alternative remedy for oral infections and other bacterial infections (Afolabi et al., 2020; Muhammad & Fatima, 2014; Odonye et al., 2021).

Phenolic compounds present in *Cola nitida*, such as catechins and epicatechins, have also been associated with antioxidant and anti-inflammatory effects (Ogunlade et al., 2014). These compounds have been investigated for their potential to protect against chronic diseases such as hepatotoxicity, cancer and diabetes (Atawodi et al., 2007; Erukainure et al., 2017; Oboh et al., 2014).

The combination of caffeine, alkaloids, tannins, flavonoids, and phenolic compounds in *Cola nitida* contributes to its potential protective effects in various health and disease states.

EFFECTS OF *Cola nitida* IN VARIOUS HEALTH AND DISEASE STATES

Cola nitida, with its rich history of traditional use and its diverse bioactive compounds, has shown promise in promoting various aspects of health, as highlighted in Table 1.

Nervous Function and Mental Health

The stimulating properties of *Cola nitida*, primarily attributed to its caffeine content, have been associated with potential cognitive benefits (Ogutuga, 1975). Caffeine acts as a central nervous system stimulant and can enhance alertness, focus, and cognitive performance. Research conducted on animals has demonstrated that *Cola nitida* and caffeine have the potential to enhance memory and nervous function in healthy and diabetic states (Imam-Fulani et al., 2016, 2018, 2019). It may also have a positive impact on mood, reducing feelings of fatigue and enhancing overall mental well-being (Persad, 2011).

The study on ocular effect of *Cola nitida* demonstrated its notable enhancements in the near point of convergence and an increase in the amplitude of accommodation (Igwe et al., 2007). Additionally, they observed that *Cola nitida* can alleviate existing heterophorias. Thus, it was suggested that the stimulative effects of *Cola nitida* have the potential to alleviate asthenopic symptoms commonly associated with convergence insufficiency, thereby enabling individuals to perform near work tasks without experiencing stress (Igwe et al., 2007).

Moreover, *Cola nitida* has also been examined as a therapeutic agent with functional capacity against pain

(Adedayo et al., 2021). The presence of bioactive compounds, such as tannins and flavonoids, in *Cola nitida* may contribute to its neuroprotective effects. These compounds possess antioxidant and anti-inflammatory properties that can help mitigate neuronal damage and support cognitive function.

However, possible adverse effects on the human brain due to excessive consumption of kola nuts have also been reported (Atiba et al., 2021). The study provides evidence that repeated administration of kola nuts at specific doses to pregnant dams can interfere with the typical postnatal development of the cerebellum in their offspring (Atiba et al., 2021). Therefore, further investigations are necessary to gain a comprehensive understanding of the broader implications for human brain development.

Cardiovascular Health

Studies have suggested that *Cola nitida* may have beneficial effects on cardiovascular health (Adeosun et al., 2017; Erukainure et al., 2021; Omorogiuwa & Eiya, 2019; Salahdeen et al., 2014). The antioxidant properties of *Cola nitida*'s phytochemicals, such as flavonoids and phenolics, may help reduce oxidative stress and inflammation, which are key factors in the development of cardiovascular diseases.

Cola nitida has been reported to have potential cardioprotective effects by improving blood lipid profiles, reducing cholesterol levels, and inhibiting the oxidation of low-density lipoprotein (LDL) cholesterol (Abou et al., 2016). Similarly, in rats with diabetic cardiomyopathy (Erukainure et al., 2021), *Cola nitida* resulted in a reduction in lipase activity and a depletion of cardiac lipid metabolites associated with diabetes. These effects may contribute to a reduced risk of atherosclerosis and cardiovascular events.

Furthermore, the vasodilatory properties of alkaloids, including theobromine and theophylline, present in *Cola nitida*, may help relax blood vessels and improve blood flow, thereby supporting overall cardiovascular function (Awuchi, 2019; Ejuh et al., 2020).

Immune System Function

Cola nitida contains various bioactive compounds that may have immunomodulatory properties. Flavonoids and phenolics found in *Cola nitida* have been shown to exhibit antioxidant and anti-inflammatory effects (Adedayo et al., 2019; Adesanwo et al., 2017; Oboh et al., 2014), which can help support immune system function. They can scavenge free radicals and reduce oxidative stress, which is implicated in the development of various diseases. Additionally, these compounds possess anti-inflammatory properties, helping to alleviate inflammation, a key contributor to chronic diseases.

Moreover, some studies suggest that *Cola nitida* may have antimicrobial properties, inhibiting the growth of certain pathogens (Afolabi et al., 2020; Muhammad & Fatima, 2014; Odonye et al., 2021). This antimicrobial

activity has been attributed to various bioactive compounds present in *Cola nitida*, including alkaloids, tannins, flavonoids, and phenolic compounds. Extracts of *Cola nitida* have demonstrated inhibitory effects against a wide range of bacteria, including both Gram-positive and Gram-negative strains. These include common pathogens such as *Staphylococcus aureus*, *Escherichia coli*, *Salmonella species*, and *Pseudomonas aeruginosa* (Afolabi et al., 2020; Muhammad & Fatima, 2014; Odonye et al., 2021). This suggests a potential role in supporting the body's defense against infections.

Gastrointestinal Health

Owing to the phytochemical contents such as flavonoid, tannin, saponin, which possess gastroprotective effects, it is expected that consumption of *Cola nitida* will be beneficial to the gastrointestinal health. Tannins have been reported to provide a protective effect on the gastric mucosa, reducing the risk of gastric ulcers and supporting overall gastrointestinal health by regulating inflammation and oxidative stress (de Veras et al., 2021; Demarque et al., 2018).

However, animal studies have demonstrated that *Cola nitida* stimulates gastric secretion and erodes mucosa epithelial lining (Ibu et al., 1986; A. Lawal et al., 2022; Osim et al., 1991; Tende et al., 2011; Umoh et al., 2019). Moreover, high doses of *Cola nitida* have been observed to induce gastric lesions in animals, and these lesions can worsen with prolonged administration (Ojo et al., 2010). It is advised to consume *Cola nitida* with caution to minimize the risk of gastric complications, particularly for individuals with ulcers who may consider avoiding it.

Metabolic and Endocrine Health

Research has indicated that *Cola nitida* may have effects on metabolic and endocrine health. Some studies have suggested that *Cola nitida* may help regulate blood glucose levels, potentially beneficial for individuals with diabetes or metabolic disorders (Dorathy et al., 2014;

Erukainure et al., 2019). More so, findings have highlighted the therapeutic potential of *Cola nitida* in alleviating diabetic hepatotoxicity in rats (Erukainure et al., 2020). The study demonstrated significant increases in antioxidant enzyme activity and effective inhibition of lipid peroxidation, myeloperoxidase, acetylcholinesterase, and ATPase activities in the liver tissues of diabetic rats following the administration of *Cola nitida* (Erukainure et al., 2020).

In addition, the phenolic extract of *Cola nitida* demonstrated inhibitory effects on α -amylase and α -glucosidase, crucial enzymes associated with type 2 diabetes mellitus (Obboh et al., 2014). This inhibitory activity was attributed to the extract's high flavonoid content, including flavonoids such as apigenin, naringenin, and catechins. Furthermore, the presence of caffeine and theobromine in *Cola nitida* has been associated with improved metabolism and fat oxidation in diabetic rat model, which may contribute to weight management and overall metabolic health (Erukainure et al., 2019).

However, a recent study by Igbinoia and colleagues revealed that normal weight male and female subjects who consumed *Cola nitida* experienced a notable reduction in serum progesterone levels in females and serum testosterone levels in males (Igbinoia et al., 2023). Their findings suggest that administering *Cola nitida* at a specific dosage could potentially impair fertility in both male and female individuals with normal weight (Igbinoia et al., 2023).

The protective effects of *Cola nitida* in various health and disease states are believed to be mediated through multiple mechanisms. The bioactive compounds present in *Cola nitida*, such as caffeine, alkaloids, tannins, flavonoids, and phenolics, play a crucial role in these effects. Further research will help elucidate these mechanisms and provide a stronger scientific basis for the use of *Cola nitida* in health and disease management.

Table 1. Potential Effects of *Cola nitida* on Health and Disease.

S/N	Health and Disease State	Effects of <i>Cola nitida</i>	References
1	Nervous Function and Mental Health	May improve cognitive function, mood, and pain relief. May also enhance ocular accommodation. However, may alter offspring brain development.	(Adedayo et al., 2021; Atiba et al., 2021; Igwe et al., 2007; Imam-Fulani et al., 2016, 2018, 2019; Ogotuga, 1975; Persad, 2011).
2	Cardiovascular Health	May reduce cholesterol levels, improve blood lipid profiles, and protect against atherosclerosis. May also have vasodilatory properties.	(Abou et al., 2016; Adeosun et al., 2017; Awuchi, 2019; Ejuh et al., 2020; Erukainure et al., 2021; Omorogiuwa & Eiya, 2019; Salahdeen et al., 2014).
3	Immune System Function	May have antioxidant and anti-inflammatory effects, and may inhibit the growth of certain pathogens.	(Adedayo et al., 2019; Adesanwo et al., 2017; Afolabi et al., 2020; Muhammad & Fatima, 2014; Obboh et al., 2014; Odonye et al., 2021).
4	Gastrointestinal Health	May have gastroprotective effects, but may also stimulate gastric secretion and erode mucosa epithelial lining	(Ibu et al., 1986; A. Lawal et al., 2022; Ojo et al., 2010; Osim et al., 1991; Tende et al., 2011; Umoh et al., 2019).
5	Metabolic and Endocrine Health	May help regulate blood glucose levels, improve metabolism, and fat oxidation. May also have hepatoprotective effects. However, may potentially impair fertility.	(Dorathy et al., 2014; Erukainure et al., 2019, 2020; Igbinoia et al., 2023; Obboh et al., 2014).

LIMITATIONS

Most of the existing research on the protective effects of *Cola nitida* is based on preclinical studies. The number of well-designed clinical trials investigating its therapeutic potential in humans is limited. Therefore, further clinical studies are needed to validate the reported benefits and establish safe and effective dosage guidelines.

In addition, there exist variability in preparation and quality of *Cola nitida* extracts across different studies. This makes the study comparison challenging. The standardization of *Cola nitida* extracts and rigorous quality control measures may be necessary to ensure consistency and reliability in research outcomes.

Moreover, there is paucity of data on long-term studies evaluating the effects of *Cola nitida* on health outcomes. Many of the reported benefits are based on short-term observations. Therefore, the long-term safety and efficacy of *Cola nitida* require further investigation.

CONCLUSIONS

While the existing research suggests potential protective effects of *Cola nitida* in various health and disease states, further research is needed to overcome the limitations and address gaps in current knowledge. Well-designed clinical trials, in-depth mechanistic studies, standardization efforts, and safety assessments will contribute to a better understanding of *Cola nitida*'s therapeutic potential and its application in health and disease management. It is important to exercise caution in the routine consumption of *Cola nitida*, particularly for individuals with underlying medical conditions. Continued scientific investigation and evidence-based practice will contribute to a better understanding of the true therapeutic potential of *Cola nitida* in promoting overall health and well-being.

Competing Interests: The authors declare that there are no competing interests.

Authors' Contribution: KOS and AOI contributed to the study conception and design. Material preparation, data collection and analysis were performed by all authors. The first draft of the manuscript was written by KOS. All authors have accepted responsibility for the entire content of this manuscript and approved its submission.

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