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Chemical Constituents and Bioactivities of *Azanza garckeana:* A Review

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Abstract

Azanza garckeana, commonly known as "Goron Tula," is a medicinal plant widely recognized in Southern Africa for its traditional applications in treating infertility, respiratory issues, and liver disorders. Recent studies have explored its bioactive compounds, revealing significant therapeutic potentials, such as antiplasmodial, antioxidant, anti-inflammatory, and uterotonic effects. Key phytochemicals like flavonoids, tannins, and alkaloids have been identified, contributing to its diverse pharmacological activities. This review compiles current knowledge on the chemical constituents and bioactivities of *Azanza garckeana*, providing a foundation for future research on its medicinal and nutritional applications. The plant's role in enhancing health, with potential uses in modern medicine, is also highlighted.

Keywords: *Azanza garckeana*, Bioactivities, Traditional Medicine, Phytochemicals, Goron Tula

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INTRODUCTION

Azanza garckeana (F. Hoffm.) Exell et Hillc., belongs to the Malvaceae family (Ikechi-Nwogu and Egere, 2024). it is a widely recognized plant indigenous to various regions of Africa, particularly in countries like Zambia (Chanda *et al*., 2024), Nigeria (Iyojo *et al*., 2022), and South Africa and Botswana (Nko *et al*., 2025). Traditionally, different parts of this plant, including the leaves, roots, and fruits, have been utilized in herbal medicine to address various ailments, such as infertility, respiratory issues, and liver problems (Chanda *et al.,* 2020; Ibrahim *et al.,* 2023). The plant's extensive ethnomedicinal applications have sparked scientific interest, leading to the exploration of its bioactive compounds and their potential therapeutic effects (Gaobotse *et al*., 2023).

This review aims to compile and synthesize current knowledge on the bioactivities and chemical constituents of *Azanza garckeana*, and their potential roles in contemporary medicine. Through a comprehensive examination of existing literature.

Chemical Constituents

Flavonoids

Active Compound	Method of Identification	Plant Part	Reference
Quercetin	HPLC	Leaves	Ibrahim *et al.* (2024)
Kaempferol	HPLC	Leaves	Ibrahim *et al.* (2024)
Rutin	HPLC	Leaves	Ibrahim *et al.* (2024)
Apigenin	HPLC	Leaves	Ibrahim *et al.* (2024)
Luteolin	HPLC	Leaves	Ibrahim *et al.* (2024)
Catechin	LC-MS	Fruit pulp	Lawal *et al.* (2022)
Catechin Hydrate	LC-MS	Fruit pulp	Lawal *et al.* (2022)
Nonyl Flavanone	LC-MS		Lawal *et al.* (2022)
6-(Benzyloxy)-4,4-Dimethyl-2-Chromanone	LC-MS		Lawal *et al.* (2022)

Phenolics

Active COmpound	Method of Identification	Plant Part	Reference
Caffeic Acid	HPLC	Leaves	Ibrahim *et al.* (2024)
Gallic Acid	HPLC	Leaves	Ibrahim *et al.* (2024)
Chlorogenic Acid	HPLC, LC-MS	Leaves, Fruit pulp	Ibrahim *et al.* (2024); Lawal *et al.* (2022)
Chlorogenic Acid O-Quinone	LC-MS		Lawal *et al.* (2022)
Ferulic Acid	HPLC	Leaves	Ibrahim *et al.* (2024)
Protocatechuic Acid	HPLC	Leaves	Ibrahim *et al.* (2024)
Phlobatannins	GC-FID	Fruit pulp	Nkwocha *et al.* (2024)
Protocatechuic Acid			

Alkaloids

Active Compound	Method of Identification	Plant Part	Reference
Berberine	HPLC	Leaves	Ibrahim & Bisallah (2024)
Quinine	TLC	Roots	Jada *et al.* (2024)
Morphine	GC-MS	Roots	Ahmed *et al.* (2024)

DISCUSSION

Lawal *et al.* (2022) reported LC-MS analysis of the crude methanol extract of *A. garckeana* revealing a diverse range of phytoconstituents, each with potential bioactive properties that contribute to the therapeutic uses of the plant. The first compound identified is 2-Hexadecen-1-ol, 3,7,11,15-tetramethyl-, (2E,7 R,11 R), a long-chain alcohol that likely belongs to the class of phytol derivatives. Long-chain alcohols such as this are known for their roles in essential oils, often exhibiting antimicrobial and antioxidant properties (Mudge, 2005). This suggests that *Azanza garckeana* may have applications in natural therapies for infections and oxidative stress-related conditions (Lawal *et al.,* 2022). Another significant compound is Mansonone N, a quinonoid derivative. Quinones are widely studied for their role in oxidative stress management and as potential anticancer agents (Rajendran, 2016); Dong *et al.*, 2024). The presence of this compound in *Azanza garckeana* aligns with previous studies on plant-derived quinones, highlighting their ability to disrupt cancer cell proliferation and induce apoptosis (Dehelean *et al.*, 2021; Esmeeta *et al.*,

2022). Furthermore, their antimicrobial activity enhances the therapeutic potential of this plant extract in treating microbial infections (Lawal *et al.,* 2022). The extract also contains D-Glucosamine, a well-known amino sugar that is widely used in the treatment of osteoarthritis (Varagani *et al*., 2024). Glucosamine plays a critical role in the formation and repair of cartilage, suggesting that *Azanza garckeana* could have applications in joint health and the management of degenerative joint disorders (McCarty *et al*., 2019). This supports the ethnomedicinal use of this plant in treating musculoskeletal ailments

Betulin, a triterpene, is another phytoconstituent identified in the extract. Triterpenes like betulin have been documented for their anti-inflammatory, antiviral, and anticancer properties (Virginia *et al*., 2024). Betulin is known to enhance immune responses and induce apoptosis in cancer cells, making it a compound of interest for further investigation in cancer therapeutics. Its presence in *Azanza garckeana* suggests the plant's potential role in both immune modulation and cancer treatment (Lawal *et al.,* 2022).

Additionally, the extract contains Nonyl Flavanone, a type of flavonoid. Flavonoids are well-documented for their antioxidant, anti-inflammatory, and cardiovascular protective effects (El Oirdi, 2024). Nonyl flavanone, in particular, may help neutralize free radicals and reduce oxidative stress, contributing to the plant's protective effects against chronic diseases such as cardiovascular and neurodegenerative disorders.

The identification of 6-(Benzyloxy)-4,4-Dimethyl-2-Chromanone adds to the extract's pharmacological profile. Chromanone derivatives are known to possess antioxidant activities, which are essential in protecting cells from oxidative damage. This compound's benzyloxy group further enhances its biological activity, potentially contributing to the extract's overall antioxidant capacity (Lawal *et al.,* 2022).

Chlorogenic Acid O-Quinone, an oxidized form of chlorogenic acid, was also found in the extract. Chlorogenic acid is widely recognized for its antioxidant, anti-inflammatory, and antidiabetic effects (Yin *et al*., 2024). The quinone form may possess distinct bioactivities, including enhanced redox cycling capabilities, which could further boost the plant's potential in treating metabolic disorders and inflammation (Mucha *et al*., 2021).

The extract also contains Catechin and Catechin Hydrate, which are both flavonoids with strong antioxidant properties (Veiko *et al*., 2021). Catechins are abundant in tea and known for their ability to neutralize free radicals, support heart health, and prevent

certain types of cancer. The presence of both forms in *Azanza garckeana* adds to its potential health benefits, particularly in reducing oxidative stress and inflammation (Mokwena, 2024).

Testolactone, an antineoplastic agent, was identified as well. It is known to inhibit the enzyme aromatase, reducing estrogen production and making it useful in the treatment of hormone-sensitive cancers like breast cancer (Janowska *et al.*, 2024). This suggests that *Azanza garckeana* could have potential applications in cancer therapy, especially in hormone-driven cancers.

The identification of L-Tryptophan, an essential amino acid, further adds to the plant's medicinal potential. Tryptophan is a precursor to serotonin, a neurotransmitter critical for mood regulation, sleep, and mental well-being (Nayak *et al.*, 2022). The presence of L-tryptophan indicates that *Azanza garckeana* may have neuroprotective effects, potentially aiding in the treatment of depression and other mood disorders (Souza *et al.,* 2024).

Also, 3alpha,12alpha-Dihydroxy-5beta-Chol-8-En-24-Oic Acid, a bile acid derivative, was detected. Bile acids play an essential role in fat digestion and cholesterol metabolism, and they also act as signaling molecules in metabolic pathways. This compound's presence suggests that *Azanza garckeana* may have metabolic regulatory effects, which could be beneficial in treating metabolic disorders such as diabetes or obesity (Lawal *et al.,* 2022).

In the study by Nkwocha *et al.* (2024), the hexane extract of *Azanza garckeana* was analyzed for its phytochemical composition, focusing on the presence of flavonoids, steroids, phlobatannins, alkaloids, and saponins. These phytochemicals are bioactive compounds that contribute to the plant's medicinal properties and potential therapeutic uses. The study identified various bioactive compounds in the leaves of *Azanza garckeana* through phytochemical screening and GC-FID analysis:

Proanthocyanin is a type of flavanol known for their antioxidant properties, helping to scavenge free radicals and protect cells from oxidative damage (Ngcobo *et al.*, 2024). They are also associated with cardiovascular health benefits (Nkwocha *et al.,* 2024). Also, Lunamarin a quinoline alkaloid was identified compounds. Alkaloids like lunamarin often exhibit bioactive properties such as antimicrobial and anti-inflammatory effects, making them significant in medicinal research (Gaur *et al.*, 2024).

Cardiac glycosides are classified as steroid alkaloids and are known for their effects on heart muscle contractions. These compounds have been widely utilized in the treatment of heart failure and arrhythmias due to their ability to enhance cardiac output (Nkwocha *et al.*, 2024).

Anthocyanins are responsible for red, purple, and blue pigmentation in plants. They exhibit strong antioxidant, anti-inflammatory, anticancer, and cardiovascular protective properties (Ma *et al.*, 2021). Flavan-3-ols a well-known for their antioxidative and cardiovascular benefits (El Rayess *et al.*, 2024). Rutin is noted for its antioxidant and anti-inflammatory effects, with potential roles in strengthening blood vessels and reducing capillary permeability (Madkour *et al.*, 2024). Naringenin has demonstrated antioxidative, anti-inflammatory, and anticancer activities, making it an essential compound in therapeutic research (Asghariazar *et al.*, 2024). Kaempferol was also one of the identified compounds, possessing antioxidant, anti-inflammatory, and anticancer properties, with significant implications in chronic disease prevention (Kaur *et al.*, 2024). Epicatechin is well known for its cardiovascular benefits, particularly in improving blood flow and reducing blood pressure. Resveratrol is extensively studied for its antioxidant and anti-inflammatory properties, as well as its potential role in cancer prevention and anti-aging applications.

Alkaloids are another important class of bioactive compounds identified. Ribalinidine, a quinoline alkaloid exhibits notable medicinal properties, including antibacterial and antimalarial activities, making it a key candidate for drug development. Spartein, another quinoline alkaloid, is known for its neuroactive effects and potential applications in neurological disorders (Nkwocha *et al.*, 2024).

Steroids compounds play essential roles in regulating inflammation and immune responses and are widely used in medical treatments. Similarly, sapogenins belong to the saponin class of compounds known for their cholesterol-lowering, immune-boosting, and anticancer properties (Jolly *et al.*, 2024).

Laz-Okenwa *et al.* (2024) conducted a comprehensive evaluation of the phytochemical constituents in the hydroethanolic extract of *Azanza garckeana* fruit pulp. Their study identified the presence of alkaloids, triterpenoids/steroids, and carbohydrates, which contribute to its therapeutic, anti-inflammatory, and nutritive benefits. However, the absence of flavonoids, phenolic constituents, and saponins in the extract suggests that its antioxidant and cholesterol-lowering properties may be limited.

Gas Chromatography-Mass Spectrometry (GC-MS) analysis further identified key chemical compounds, including bicyclo [3.1.1] heptane, hexadecanoic acid ethyl ester, and 9,12-octadecadienoic acid ethyl ester. These compounds exhibit a broad range of biological activities, including antioxidant, antimicrobial, anti-inflammatory, and anticancer properties. Notably, hexadecanoic acid ethyl ester was associated with significant antioxidant and hypocholesterolemic effects, while 9,12-tetradecadien-1-ol acetate exhibited cardioprotective and neuroprotective potential.

Bioactivities Activities

Azanza garckeana, commonly known as the "wild pear," exhibits a range of pharmacological activities and traditional uses. Its root bark extract demonstrates significant antiplasmodial effects, achieving 88.17% chemosuppression in Plasmodium berghei-infected mice at 300 mg/kg, comparable to Artemether's efficacy (Jada *et al.,* 2024). The plant also possesses uterotonic properties, with its hot aqueous root extract mobilizing calcium in uterine smooth muscles to induce contractions, a feature traditionally leveraged during childbirth (Chanda *et al.,* 2020). Additionally, the aqueous fruit extract enhances hematological parameters by increasing hemoglobin, red and white blood cell counts, and platelets, suggesting potential benefits for individuals with blood disorders (Ahmed *et al.,* 2024). These pharmacological effects are attributed to its phytochemical composition, which includes flavonoids, tannins, and alkaloids, known for their antioxidant, anti-inflammatory, and antimicrobial properties (Ibrahim *et al.,* 2023).

The plant also impacts liver function, as its aqueous fruit extract elevates enzymes like ALT, AST, and ALP, yet keeps them within normal ranges, indicating minimal toxicity (Ahmed *et al.,* 2024). Its safety profile is further reinforced by studies showing no adverse effects on the liver, kidneys, or blood (Ahmed *et al.,* 2024). Traditionally, *Azanza garckeana* is employed to treat ailments such as coughs, infertility, and liver disorders across African regions like Nigeria, Kenya, and Malawi. Its roots are especially valued for their uterotonic properties, aligning with ethnobotanical practices for reproductive health and labor induction (Chanda *et al.,* 2020). The plant is also recognized for its antimalarial activity, offering a natural remedy in regions where malaria remains a significant health challenge (Jada *et al.,* 2024).

The nutritional and agricultural applications of *Azanza garckeana* further enhance its value. The fruit, rich in vitamin C, iron, and dietary fiber, supports immune health and combats anemia, while its leaves and fruits serve as nutritional supplements for livestock (Danbature *et al.,* 2024). In farming, the plant improves soil health through nutrient cycling and potentially deters pests due to its bioactive compounds (Aliyu *et al.,* 2023). Despite these benefits, challenges such as limited agronomic knowledge and market access require attention to optimize its use. Future research should focus on its mechanisms of action, postharvest management, and expanded commercial applications to maximize its medicinal, nutritional, and agricultural potentials.

CONCLUSION

Azanza garckeana is a plant rich in a diverse array of bioactive compounds, including phenolic compounds, flavonoids, alkaloids, saponins, tannins, carotenoids, and pectin, all of which contribute to its broad pharmacological potential. The combination of these compounds provides antioxidant, anti-inflammatory, antimicrobial, and wound-healing properties that support its traditional use in African medicine. Phenolic compounds and flavonoids, in particular, exhibit strong antioxidant activities, while alkaloids and saponins contribute to the plant's antimicrobial and cholesterol-lowering effects. The discovery of bioactive lipids and the isolation of betulinic acid further highlight the plant's potential for developing novel treatments for inflammatory diseases, infections, and even cancer.

The presence of essential minerals such as potassium, calcium, magnesium, and iron enhance the plant’s nutritional value, making it an important dietary component, especially in regions where deficiencies are common. Its role in managing diabetes is particularly noteworthy, with saponins and other compounds demonstrating significant hypoglycemic activity in both in vitro and in vivo studies. This suggests that *Azanza garckeana* could be developed into natural therapies for diabetes and metabolic disorders, potentially offering a safer alternative to conventional drugs.

Additionally, the industrial potential of *Azanza garckeana*-derived pectin is promising, especially in food processing and pharmaceuticals, where its gelling properties could be harnessed for a variety of applications. The plant's versatility, ranging from its medicinal uses to its nutritional benefits and industrial applications, makes it a valuable indigenous resource. Further research into the plant’s bioactive constituents could unlock

new therapeutic avenues, particularly for the treatment of chronic diseases such as diabetes, cardiovascular diseases, and cancer.

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