

Nutritional Composition, Phytochemical Characteristics and Antimicrobial Activity of *Azanza garckeana* (Goron Tula) Fruit Pulp from Lafia, Nasarawa State, Nigeria

Ajegena, Yakubu Sunday¹, Angbas, Asheazi E.O¹, Bilyamin, Ummulkulsum Muhammad¹, Namu, Akawu Anthony¹, Achuku Theophilus Eggah²

Department of Science Laboratory Technology, Isa Mustapha Agwai I, Lafia, Nasarawa State, Nigeria¹

²Department of Forestry and Environmental Technology, Isa Mustapha Agwai I Polytechnic, Lafia, Nasarawa State

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ABSTRACT

Indigenous wild edible fruits are valuable sources of essential nutrients and bioactive plant compounds with potential health benefits. One example is *Azanza garckeana*, commonly known as Goron Tula, which is widely consumed in northern Nigeria but has not been thoroughly studied for regional ecological variation. This research assessed the nutritional profile, phytochemical content, and antibacterial properties of the fruit pulp of *Azanza garckeana* collected from Nasarawa State, Nigeria. Standard AOAC procedures were used to analyse proximate composition, and chromogenic reagents were used to qualitatively detect phytochemicals. Antibacterial activity was tested against *Staphylococcus sp.* and *Escherichia coli* using the agar well diffusion method. The results indicated that available carbohydrates were the most abundant component (56.97%), followed by crude fibre (20.08%), crude protein (10.01%), crude fat (6.30%), moisture (4.07%), and total ash (2.57%). Phytochemical analysis confirmed the presence of alkaloids, phenolics, tannins, and glycosides, though flavonoids and phytosterols were not detected. The fruit extract demonstrated antibacterial effects, producing inhibition zones of 18–25mm and 10–20mm against *Staphylococcus sp.* and *E. coli*, respectively, on Nutrient and MacConkey agar. These findings suggest that *Azanza garckeana* pulp is rich in nutrients and bioactive compounds, supporting its potential use in functional foods and plant-based medicines. Future research into compound isolation, antioxidant capacity, minimum inhibitory concentrations, and elemental composition could further enhance its application in nutraceutical and functional food development.

Keywords: *Azanza garckeana* Fruit Pulp, Nutritional Composition, Phytochemical Characteristics and Antimicrobial Activity

INTRODUCTION

Indigenous and semi-wild fruits play a vital role in traditional African diets, supporting household food security, dietary variety, and the intake of essential micronutrients. Numerous native tree species that remain underutilised are rich sources of nutrients, offering diverse profiles of dietary fibre, minerals, and beneficial bioactive compounds. Promoting the study and use of these neglected and underutilised species is crucial for strengthening both biodiversity and food security, especially across sub-Saharan Africa (Mabhaudhi et al., 2019; Padulosi et al., 2019; Chivenge et al., 2022). At the same time, rising interest in functional foods, especially those delivering health advantages beyond basic nutrition, has spurred research at both global and local levels into wild edible fruits. These fruits contain a broad spectrum of primary and secondary metabolites with positive effects on human health (Cory et al., 2018; Kumar and Goel, 2019). Proximate analysis helps identify nutritional elements of food. For example, carbohydrates in these fruits supply energy necessary for daily bodily functions. Non-starch polysaccharides and dietary fibre contribute to digestive health, help regulate blood cholesterol, and support stable blood sugar levels (Makki et al., 2018; Barber et al., 2020).

Proteins and lipids, meanwhile, aid cellular metabolism and enhance the sensory qualities of meals (Saini et al., 2021). Additionally, fruits contain secondary metabolites like phenolics, tannins, alkaloids, and glycosides, which exhibit anti-inflammatory, antimicrobial, antiprotozoal, and antioxidant properties. Some of these compounds, such as alkaloids and phenolics, can interact with microbial cell membranes, interfering with enzyme function, pathogen attachment to host cells, and subsequent infection processes (Bouarab-Chibane et al., 2019; Khameneh et al., 2019; Saini et al., 2021).

Azanza garckeana (Malvaceae family) is a plant native to Africa, commonly found in the continent's hot, dry savanna regions (Burkill, 2000; Orwa et al., 2009). Known locally as Goron Tula in Hausa, its fruit is eaten as a snack in northern Nigeria and is valued for its sweet flavour and sticky, chewy consistency. Early studies suggest that the fruit pulp is used in traditional medicine to address infertility, reproductive challenges, cough, skin sores, and dysentery (Ajao et al., 2018; Bello et al., 2021). However, further investigation is needed to fully understand its nutritional profile, phytochemical makeup, and antimicrobial activities.

Furthermore, the production and concentration of many plant-based nutritional and medicinal compounds vary depending on environmental factors such as climate, geography, preservation method, and local growing conditions (Saxena et al., 2013; Kumar et al., 2022). Data on the nutritional and phytochemical properties of *Azanza garckeana* fruits from Lafia in the Southern Guinea Savanna of Nasarawa State, Nigeria, remain scarce. Therefore, this study sought to analyze the proximate composition, identify key phytochemicals, and evaluate the antimicrobial activity of *Azanza garckeana* fruit pulp collected from Lafia, Nasarawa State, Nigeria. Such findings are essential for assessing the potential of this species in developing functional foods and pharmaceutical products.

MATERIALS AND METHODS

Study Area

This research was conducted in Lafia, the capital city of Nasarawa State in central Nigeria. The region lies within the southern Guinea savanna ecological zone, which features a tropical climate with a single annual rainy season. This distinct rainfall pattern plays a significant role in shaping plant physiological activities, the production of secondary metabolites, and overall adaptive responses in vegetation (Odekunle, 2004; Abdullahi et al., 2020).

Sample Collection and Preparation

Fresh, mature *Azanza garckeana* (Goron Tula) fruits were sourced from local markets in Lafia, Nasarawa State, Nigeria. Healthy fruits free from insect infestation, physical abrasions, and microbial damage were selected. The fruits were transported to the laboratory and washed thoroughly with distilled water to remove extraneous surface particulates. The edible fleshy pulp was manually separated, dried under ambient conditions, and pulverized into a homogeneous powder using an electric blender. The powdered samples were stored in airtight, moisture-proof containers until further analyses.

Determination of Proximate Composition

The proximate analysis of *Azanza garckeana* fruit pulp was conducted following the official methods outlined by the Association of Official Analytical Chemists (AOAC, 2019). The study assessed several components: moisture, ash, crude protein, crude fat, crude fibre, and carbohydrates. All determinations were expressed on a percentage dry weight basis (% w/w)..

Moisture Content

The moisture content was assessed using the oven-drying technique. 2.000g of *Azanza garckeana* fruit pulp powder was placed in a hot air oven at 105⁰c and dried until it reached a constant weight. The percentage was then calculated from the difference in weight before and after drying.

Ash Content

To determine the ash content, 2.000g of the sample was completely incinerated in a muffle furnace at 505⁰c to burn off all organic material until grey/white ash was obtained. The remaining inorganic residue was cooled in a desiccator and weighed.

Crude Protein Content

Determined via the micro-Kjeldahl method using 1.000 g of the powdered sample. The sample was digested with concentrated H₂SO₄ and a catalyst tablet, followed by distillation of released ammonia into boric acid and titration with standardised HCl. Nitrogen content was multiplied by the empirical conversion factor of 6.25

Crude Fat Content

2.000g sample was taken from the dried material and placed in an extraction thimble and was extracted by continuous extraction with analytical petroleum ether in a Soxhlet apparatus for 6 to 8 hrs until the solvent ran through the extract free of fat.

Crude Fibre Content

A 2.000 g portion of the defatted sample was serially digested with boiling 1.25% (w/v) H₂SO₄ and 1.25% (w/v) NaOH solutions for 30 minutes each. The insoluble residue was filtered, dried at 105 °C, weighed, and ashed at 550 °C to determine fibre loss on ignition

Carbohydrate Content

Carbohydrate content was estimated by subtracting the sum of other components from 100, using the formula:
Carbohydrate (%) = 100 – (Moisture + Ash + Protein + Fat + Fibre)

Phytochemical Screening

A qualitative analysis of phytochemicals in the *Azanza garckeana* fruit pulp extract was conducted using conventional methods adapted from Harborne (1998) and Trease and Evans (2001), with modifications aligned with recent protocols for preliminary screening of plant extracts (Sarker et al., 2018; Sasidharan et al., 2021). The test identified key secondary metabolites: alkaloids, phenolic compounds, flavonoids, tannins, glycosides, and phytosterols, compounds often linked to biological activity in plants. Detection was based on visible reactions, including color changes, precipitation, or other observable chemical responses.

- i. **Alkaloids:** Detected using Mayer's and Dragendorff's reagents.
- ii. **Phenolic Compounds and Tannins:** Identified via the ferric chloride (FeCl₃) and lead acetate precipitation tests.
- iii. **Flavonoids:** Evaluated using alkaline reagent (NaOH) and Shinoda colorimetric tests.
- iv. **Glycosides:** Assayed via Fehling's and Keller-Kiliani reduction assays.
- v. **Phytosterols:** Evaluated using the Salkowski and Liebermann-Burchard reaction tests.

Antimicrobial Activity

The antibacterial activity of the fruit pulp extract was assessed using the agar well diffusion assay (Eloff, 1998; Balouiri et al., 2016). Bacterial Strains: The study utilised pure cultures of Staphylococcus species (Gram-positive) and Escherichia coli (Gram-negative) bacteria.

Microbial suspensions were prepared to give a 0.5 McFarland turbidity standard. ~ 1.5 × 10⁸ CFU/mL and uniform spray onto sterile Nutrient Agar and MacConkey Agar plates. Wells (6 mm in diameter) were bored aseptically into the agar and filled with uniform aliquots of the reconstituted extract. Following incubation at 37 °C for 24 hrs, antibacterial activity was quantified by measuring the diameter of the clear inhibition zones around the wells in millimeters (mm)

RESULTS AND DISCUSSION

Proximate Composition of *Azanza garckeana* Fruit Pulp

Table 3.0: Proximate composition of *Azanza garckeana* fruit pulp

Proximate Parameter	Percentage Composition (%)
Moisture	4.07
Ash	2.57
Crude fat	6.3
Crude fiber	20.08
Protein	10.01
Carbohydrate	56.97

The proximate composition of *Azanza garckeana* fruit pulp is presented in Table 1. The results showed that carbohydrate was the major component (56.97%), followed by crude fibre (20.08%), protein (10.01%), fat (6.30%), and ash (2.57%), with moisture content at 4.07%. The high content of carbohydrate coupled with the presence of appreciable amounts of fibre and protein signifies the nutritional value of the pulp of *Azanza garckeana*.

The carbohydrate content of the fruit pulp (56.97%) suggests that the fruit could be a source of energy. Carbohydrate is the main energy constituent of plant foods and significantly contributes to the caloric value of fruits (Mabhaudhi et al., 2019; Saini et al., 2021). The high content of this nutrient in the current finding aligns with the reports that indicated carbohydrate dominance in various indigenous tropical fruits (Mabhaudhi et al., 2019; Saini et al., 2021). Moreover, the finding reflects the typical patterns of indigenous fruits, where carbohydrate is accumulated in high amounts in various plant parts, including roots, tubers, and fruits (Odeny et al., 2021).

The high crude fibre content (20.08%) is an attractive attribute for the pulp, as fibre is beneficial to human health. The inclusion of fibre in food products helps reduce the risk of developing various metabolic diseases, including obesity, type 2 diabetes, and cardiovascular complications (Anderson et al., 2009; Makki et al., 2018). In addition, fibre facilitates normal gastrointestinal function and promotes satiety (Anderson et al., 2009). The reported value is lower than the 28.05% crude fibre previously recorded by Kabiru Sirajo et al. (2022). However, the value is comparable to those of other indigenous plant foods. Generally, the high fibre content demonstrates the potential of the pulp of *Azanza garckeana* to be an important ingredient in food products due to its contribution to daily fibre intake.

The protein content of 10.01% shows that *Azanza garckeana* fruit pulp could be a viable plant source of protein. Protein is an essential dietary component that plays critical roles in bodily functions (Saini et al., 2021). Although the recorded value is lower than the protein content of legumes, it is considerable for fruits. The finding is consistent with a previous record on *Azanza garckeana*.

The fat content of the fruit pulp (6.30%) is moderate and is a good source of lipids. Fat serves fundamental functions in the body, including being an energy source and a carrier of fat-soluble vitamins (Saini et al., 2021). Although lower than the levels of carbohydrates and fibre, the presence of fat in the pulp is desirable for the development of food products, as it often enhances the palatability and organoleptic properties of food (Saini et al., 2021).

The moisture content of the fruit pulp (4.07%) suggests that the fruit has the potential to be developed into a dried snack food product, as the content is low enough to inhibit microbial growth (Adepoju et al., 2020). However, it is essential to consider the effects of packaging and storage conditions on the quality of the dried pulp.

The ash content of the fruit pulp (2.57%) suggests the potential of the fruit to be a source of minerals. Ash is a constituent obtained from the incineration of a sample at high temperatures and indicates the presence of minerals in food (AOAC, 2019). Further assessment of the mineral content of the pulp is required to establish its composition and the contribution of each mineral to the daily intake.

The variations in the reported values for the proximate composition of *Azanza garckeana* fruit pulp and those previously recorded for *Azanza garckeana* and other indigenous fruits could be due to various factors. The differences could be attributed to genetic makeup, geographical location, and agro-climatic conditions of the plants at the time of harvesting, as well as differences in specimen collection and sample preparation before analysis (Saxena et al., 2013).

Phytochemical Characteristics of *Azanza garckeana* Fruit Pulp Extract

Table 3.1: Qualitative phytochemical screening of *Azanza garckeana* fruit pulp extract

Phytochemical Constituents	Observation
Alkaloids	Present
Flavonoids	Absent
Phenols	Present
Tannins	Present
Glycoside	Present
Sterols	Absent

The qualitative phytochemical screening revealed the presence of alkaloids, phenols, tannins, and glycosides, whereas flavonoids and sterols were absent (Table 3.2). The presence of alkaloids, phenolics, tannins, and glycosides identified in this study supports earlier phytochemical findings by Ajao et al. (2018) and Bello et al. (2021), who reported similar compounds in stem bark and pulp extracts of *Azanza garckeana*, confirming the plant's abundance in bioactive secondary metabolites. Polyphenols and tannins act as natural antioxidants and antimicrobial agents; research shows they can suppress pathogens by disrupting cell wall proteins and adhesion mechanisms, ultimately leading to membrane depolarization and interference with proton gradients (Daglia, 2012; Bouarab-Chibane et al., 2019).

Similarly, the detection of alkaloids aligns with Cushnie et al. (2014), indicating their role in combating bacterial infections through interference with DNA replication, respiratory enzymes, and protein production. Glycosides, meanwhile, serve as versatile metabolic precursors linked to a broad spectrum of pharmacological effects (Albuquerque et al., 2021). However, flavonoids and phytosterols were not detected in this study, which contrasts with Bello et al. (2021), who found trace amounts in *Azanza garckeana* samples from different agro-ecological regions. These discrepancies in phytochemical profiles may stem from factors such as geographic origin, plant maturity, and variations in extraction solvents and methods (Saxena et al., 2013; Kumar et al., 2022).

Antimicrobial Activity of *Azanza garckeana* Fruit Pulp Extract

Table 3.2: Antimicrobial activity of *Azanza garckeana* fruit pulp extract

Test Organism	MacConkey Agar – Zone of Inhibition	Nutrient Agar – Zone of Inhibition
<i>Staphylococcus</i> sp.	25 mm	18 mm
<i>Escherichia coli</i>	10 mm	20 mm

The in vitro antibacterial effects of a crude extract from the fruit pulp of *Azanza garckeana* were evaluated against selected bacterial strains, with results presented in Table 3.3. The extract showed broad-spectrum activity, inhibiting both Gram-positive (*Staphylococcus* sp.) and Gram-negative (*Escherichia coli*) bacteria, though the size of the inhibition zones varied depending on the organism and growth medium. The largest

inhibition zone (25mm) was observed against *Staphylococcus sp.* when grown on MacConkey agar, while *E. coli* exhibited its greatest sensitivity on Nutrient agar, with a 20mm zone.

These findings agree with those of Dikko et al. (2016), who reported that an ethyl acetate extract of *Azanza garckeana* fruit pulp inhibited *Staphylococcus aureus* and *E. coli* with zones of 26mm and 27mm, respectively, and a minimum inhibitory concentration (MIC) of 0.625mg/mL for *E. coli*. In contrast, Iyen et al. (2021) found that a methanol fraction of the same plant material produced a 24mm inhibition zone against *E. coli*, but no effect on *S. aureus*, a result that differs from the strong inhibition (25mm) seen against *Staphylococcus sp.* in the current study. Additionally, Aliyu et al. (2026) observed that *Azanza garckeana* extracts were effective against clinical methicillin-resistant *S. aureus* (MRSA), with inhibition concentrations ranging from 1.25 to 5mg/mL and minimum bactericidal concentrations between 2.5 and 10mg/mL. Collectively, these studies indicate variability in antibacterial outcomes, likely due to differences in extraction methods, extract concentrations, bacterial strains tested, and experimental procedures (Cushnie et al., 2014)

The antimicrobial properties of *Azanza garckeana* are generally linked to bioactive compounds such as phenolics, tannins, and alkaloids. These components may act by disrupting microbial cell walls and membranes or by interfering with essential cellular processes. Phenolics and tannins can denature proteins and disrupt enzyme function, while alkaloids may hinder DNA replication and protein synthesis (Cushnie et al., 2014; Bouarab-Chibane et al., 2019; Khanene et al., 2019).

The differing susceptibility between *Staphylococcus sp.* and *E. coli* can be partly explained by structural differences in their cell envelopes. Gram-negative bacteria like *E. coli* possess an outer lipopolysaccharide membrane that limits the entry of hydrophobic substances and certain drugs (Nikaido, 2003). In contrast, Gram-positive bacteria such as *Staphylococcus sp.* lack this outer barrier, making them more permeable to antimicrobial agents, including plant-derived compounds (Nikaido, 2003; Bouarab-Chibane et al., 2019).

CONCLUSION

The study confirms that the fruit pulp of *Azanza garckeana* (Goron Tula) from Lafia, Nasarawa State, Nigeria, is rich in macronutrients and phytochemicals. It contains high levels of carbohydrates, crude fibre, and protein, along with a moderate amount of fat. Qualitative analysis revealed the presence of bioactive compounds—including alkaloids, phenolics/tannins, and glycosides known for their therapeutic effects, which may explain the observed antibacterial activity against *Staphylococcus sp.* and *Escherichia coli*. These findings back up traditional claims regarding the plant's nutritional and medicinal value. To further validate its nutraceutical potential, additional research is needed, including quantitative phytochemical profiling, compound isolation and identification, and mineral composition analysis. In vitro studies assessing antioxidant and antimicrobial properties are also recommended.

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