SOME MINERAL COMPOSITION OF GUINEA GRASS LEAF MEAL COLLECTED FROM THREE DIFFERENT LOCATIONS IN BENIN CITY.

BY

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DEPARTMENT OF ANIMAL SCIENCE
FACULTY OF AGRICULTURE
UNIVERSITY OF BENIN
BENIN CITY

NOVEMBER, 2025

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A PROJECT SUBMITTED TO THE DEPARTMENT OF ANIMAL SCIENCE
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CERTIFICATION

This is to certify that this Project work was carried out by Precious Chinecherem IBEH with Matriculation Number AGR2000077 of the Department of Animal Science, Faculty of Agriculture, University of Benin city, Nigeria.

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DR. N.C. AKAEZE. **DATE**

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DR. N.C. AKAEZE **DATE**

HEAD OF DEPARTMENT

DEDICATION

This work is dedicated to God Almighty for His infinite mercy all through the course of my Program in the University of Benin, to my loving Parents (Mr. and Mrs. IBEH) and my wonderful siblings.

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ABSTRACT

This study was conducted to determine and compare some of the mineral composition of Guinea grass (*Megathyrsus maximus*) leaf meal obtained from three locations within Benin City, Nigeria, and to evaluate the subsequent implications for livestock nutrition and feed safety. Fresh Guinea grass leaves were collected from Ekenwan, Ekosodin and Uniben, representing a gradient of land use intensity. The samples were processed, sun-dried, and milled into a fine powder. Subsequent laboratory analysis utilized Atomic Absorption Spectrophotometry (AAS), Flame Photometry, and spectrophotometric methods to quantify the concentrations of macro-minerals (Calcium, Magnesium, Potassium, Sodium, Phosphorus), essential trace minerals (Iron, Zinc, Manganese), and heavy metals (Chromium, Lead).

The results revealed statistically significant variations ($p < 0.05$) in the mineral content across the three locations. The Uniben location exhibited the highest concentrations of Potassium (331.3 mg/kg), Magnesium (115.2 mg/kg), and Iron (28.1 mg/kg), while Ekehuan recorded the highest Phosphorus content (345.0 mg/kg). However, Uniben and Ekosodin locations also showed elevated levels of heavy metals, with Lead concentrations of 0.30 mg/kg and 0.25 mg/kg respectively, and Chromium levels of 0.50 mg/kg and 0.40 mg/kg respectively. Ekehuan location had the lowest heavy metal contamination but showed deficiencies in some essential minerals.

Research indicates that the mineral content of Guinea grass in Benin City varies significantly by location. This means forage from some sites offers nutritional benefits but also carries a risk of heavy metal contamination for grazing animals. Consequently, the study advises avoiding harvests in urban and high-traffic zones and calls for feeding strategies that include location-specific mineral supplementation to safeguard livestock.

CHAPTER ONE

INTRODUCTION

1.1. Background Study

Guinea grass used to be known as Panicum maximum Jacq. In 2003, the subgeneric name *Megathyrsus* was raised to generic rank and the plant was renamed *Megathyrsus maximus* (Jacq.) B. K. Simon and S. W. L. Jacobs (Simon *et al*., 2003). However, the name *Panicum maximum* is still found in literature posterior to 2003.

Guinea grass (*Megathyrsus maximus*) is a perennial tropical grass that is extensively cultivated for its high nutritional value and adaptability to various climatic conditions. Native to Africa, it has become a prominent forage crop across many regions, including Asia and South America, where it serves as a primary feed source for livestock (Smith, 2018). This grass is particularly valued for its rapid growth, high biomass yield, and resilience in poor soil conditions, making it a vital component of sustainable agricultural practices (Jones, 2019).

The ecological significance of Guinea grass cannot be overstated. It plays a critical role in soil conservation by preventing erosion and improving soil structure (Brown, 2020). Its deep root system enhances soil aeration and moisture retention, contributing to better land management practices. Additionally, Guinea grass supports biodiversity by providing habitat for various wildlife species, thus promoting ecological balance (Nguyen, 2022).

From an economic perspective, Guinea grass is crucial for smallholder farmers, especially in developing countries where livestock production is a key livelihood. By providing a nutritious feed resource, Guinea grass helps improve livestock health and productivity, ultimately leading to enhanced food security and economic resilience for farming communities (Miller, 2020). Studies have shown that livestock raised on Guinea grass exhibit better weight gain and reproductive performance compared to those fed on less nutritious forage (Garcia, 2021).

Nutritionally, Guinea grass is rich in carbohydrates, proteins, and essential minerals, which are critical for the growth and productivity of livestock (Taylor, 2021). The grass can be harvested multiple times a year, allowing for continuous feed availability, which is especially beneficial during dry seasons when other forage options may be scarce (Khan, 2020). The leaves of Guinea grass can be processed into leaf meal, a valuable feed supplement that enhances the nutritional profile of livestock diets.

Understanding the mineral composition of Guinea grass leaf meal is vital for optimizing its use in animal nutrition. Essential minerals such as calcium, phosphorus, magnesium, potassium, and sodium play important roles in various physiological functions, including bone development, muscle function, and metabolic processes (Roberts, 2022). Analyzing the mineral content of Guinea grass leaf meal can provide insights into its potential as a balanced feed ingredient, helping farmers make informed decisions regarding livestock diets (Patel, 2021).

Moreover, the mineral composition of forage crops can vary significantly based on environmental factors, soil type, and management practices (Nguyen, 2022). Therefore, this study focuses on Guinea grass leaf meal collected from three different locations in Benin City, Nigeria. This localized research is crucial for understanding how geographical and environmental variations influence the mineral content of Guinea grass, which can ultimately affect its nutritional value for livestock (Khan, 2020).

The livestock sector is facing numerous challenges, including rising feed costs, climate change, and the need for sustainable practices (Miller, 2020). As the global population continues to grow, the demand for animal protein is expected to increase, necessitating the exploration of alternative feed resources (Garcia, 2021). Guinea grass presents a promising solution due to its high nutritional value and adaptability.

Despite its potential, there is limited research on the specific mineral composition of Guinea grass leaf meal and its implications for livestock nutrition (Nguyen, 2022). This study aims to address this gap by providing a detailed analysis of the mineral content of Guinea grass leaf meal collected from three different locations in Benin City. This localized research is crucial as mineral content can vary significantly based on soil type, climate, and management practices (Khan, 2020). By understanding the mineral profile, stakeholders can make informed decisions regarding the incorporation of Guinea grass into livestock diets, ultimately enhancing animal health and productivity (Patel, 2021).

Furthermore, the findings of this study will provide valuable information for farmers, nutritionists, and policymakers. By identifying the mineral composition of Guinea grass leaf meal, this research will help in formulating balanced diets that meet the nutritional needs of livestock, thereby improving overall productivity and sustainability in the livestock sector (Roberts, 2022). Additionally, this study will contribute to the body of knowledge regarding the use of local feed resources, promoting self-sufficiency in animal production and reducing reliance on imported feed ingredients (Adams, 2021).

1.2 Objectives of the Study

The main objective is to determine the mineral composition of guinea grass leaf meal collected from 3 different locations in Benin City.

The specific objective of this research is to;

1. To collect Guinea grass leaves from three locations and process into Guinea grass leaf meal.

2. To analyze some mineral composition of Guinea grass leaf meal collected from three locations in Benin city.

CHAPTER TWO

LITERATURE REVIEW

2.1 Overview of Guinea grass

Megathyrsus maximus (Jacq.) B.K. Simon and S.W.L. Jacobs (formerly classified as Panicum maximum Jacq.) is a perennial tropical grass native to Africa (Skerman and Riveros, 1990; Simon and Jacobs, 2003). Commonly called Guinea grass, it is known regionally as "Gamba grass" in Australia, "Tanganyika grass" in East Africa, "Panizo" in Latin America, and "Fataque" in Francophone Africa (Cook *et al*., 2005; FAO, 2014).

Flowering intensifies during warm, rainy periods, with seeds maturing 4–6 weeks after pollination (Jank *et al*., 2014).

Traditionally, stems are utilized for fencing, thatching, and erosion control, while leaves function as livestock fodder (grazed or cut-and-carried) and mulch (Bogdan, 1977; Cook *et al*., 2005).

2.1.2 The Botanical Identity and Global Distribution of Guinea Grass

Guinea grass, known scientifically as *Megathyrsus maximus* (Jacq.) B.K. Simon and S.W.L. Jacobs, is a cornerstone of tropical and subtropical pastoral systems. Its taxonomic history is a key point of clarification for contemporary research. The grass was universally classified as *Panicum maximum* Jacq. for most of the 20th century. However, a pivotal phylogenetic study by Simon and Jacobs (2003) led to the reclassification of the species under the new genus *Megathyrsus*. Despite this formal change, the name Panicum maximum remains prevalent in a significant portion of the agricultural literature published post-2003, a fact that researchers must navigate carefully to avoid confusion (Jank *et al*., 2019).

Originating from the savanna ecosystems of Africa, Guinea grass has been disseminated across the globe's tropical belt due to its exceptional agronomic traits. It is now extensively naturalized and cultivated in South America (particularly Brazil and Colombia), Southeast Asia, Northern Australia, and the Pacific Islands (Csurhes, 2016). In Nigeria, its adaptability has made it a dominant forage species, thriving from the arid fringes of the Guinea Savanna to the more humid Derived Savanna and Forest zones, where it serves as a critical feed resource for both nomadic herds and settled crop-livestock systems (Ojo *et al.,* 2020).

The plant is morphologically characterized as a robust, tufted perennial, capable of growing up to 4 meters in height under favorable conditions. Its leaves are broad and linear, and its deep, fibrous root system often penetrating over two meters into the soil profile, is a key adaptive feature. This extensive root architecture not only confers remarkable drought tolerance by accessing deep soil moisture but also plays a significant role in soil conservation, binding soil particles and reducing erosion (Pereira *et al.*, 2020). The inflorescence is a large, open panicle that facilitates both wind pollination and seed dispersal, contributing to its success as both a cultivated crop and, in some regions, an invasive species.

2.1.3 Agronomic Significance and Management for Sustainable Production

The agronomic value of Guinea grass is multidimensional, underpinning its global popularity. Its most celebrated attribute is its high biomass productivity. Under optimal management with adequate soil fertility and moisture, it can produce dry matter yields exceeding 30 tonnes per hectare annually, making it one of the highest-yielding tropical grasses (Pereira *et al.,* 2020). This high yield translates directly into economic viability for farmers, supporting more livestock per unit of land.

Beyond direct grazing, Guinea grass is highly amenable to conservation. Its preservation as hay or silage is a widespread practice to create a stable feed bank, which is indispensable for overcoming seasonal feed shortages, particularly during the prolonged dry seasons typical of West Africa. This ability to provide feed across seasons enhances the resilience of farming systems against climate variability (Balehegn *et al.,* 2020).

Strategic management is paramount to balancing the trade-off between yield and quality. The stage of maturity at harvest is the single most critical factor determining nutritive value. Harvesting at a young, vegetative stage (e.g., 6-7 weeks of regrowth) maximizes crude protein content and digestibility but sacrifices total biomass. Conversely, delaying harvest increases tonnage but leads to advanced lignification, resulting in a higher proportion of stem-to-leaf, elevated fiber content (NDF, ADF), and reduced intake and digestibility for livestock (Pereira *et al*., 2020). Furthermore, as a C4 plant, Guinea grass is highly responsive to nitrogen fertilization, which can significantly boost both protein content and overall yield. However, integrated management practices, such as intercropping with legumes like Stylosanthes or Leucaena, can provide sustainable nitrogen and improve the overall dietary balance for animals (Ojo *et al*., 2020).

2.2. Taxonomy of guinea grass

Classified under the Poaceae family – recognized for high-yielding tropical forage species *Megathyrsus maximus* is a C₄ photosynthetic grass endemic to African savannas (Skerman and Riveros, 1990; Simon and Jacobs, 2003). Its deep-rooting habit confers notable drought tolerance (Bogdan, 1977; Akinola *et al*., 2020). In Nigeria, it is widely cultivated across Guinea Savanna to Derived Savanna agroecological zones for livestock fodder and soil stabilization (Alabi *et al*., 2018; FAO, 2014).

Kingdom	Plantae

Subkingdom	Tracheobionta
Superdivision	Spermatophyta
Division	Magnoliophyta
Class	Liliopsida
Order	Poales
Family	Poaceae
Genus	Megathyrsus
Species	Maximus

This species develops robust tussocks (1–4 m height) featuring linear leaves (1–3 cm wide; 100 cm long) and fibrous roots >2 m deep (Bogdan, 1977). Its open panicle inflorescence (15–50 cm length) yields 5,000–15,000 seeds/kg (Skerman and Riveros, 1990). Nigerian research documents extensive growth in Middle Belt states (e.g., Benue, Plateau), where it sustains smallholder dairying through high dry-matter production (15–40 t/ha) and crude protein content (8–18%) under rotational grazing (Akinola *et al*., 2020; Ojo *et al*., 2015).

Stems function as thatching resources and erosion control barriers in West African agriculture, while foliage supplies vital dry-season forage (Bogdan, 1977; Alabi *et al*., 2018). Studies in Nigeria emphasize its integration in silvopastoral systems with Leucaena leucocephala to boost soil nitrogen (Ojo *et al*., 2015).

2.2.1 Guinea grass leaves

This grass forms dense clumps 1–4 m in height, producing linear leaves generally 60–100 cm long and 1–3 cm wide. However, leaf size can change depending on soil fertility, rainfall, and management techniques (Bogdan, 1977; Okeudo *et al*., 2005). When grown under shade in silvopastoral systems, the leaves adapt by becoming longer and narrower (increased length, decreased width) to enhance light absorption (Paciullo *et al*., 2011).

The leaves' sturdy build and high biomass yield make them highly useful in West Africa. Traditionally, they serve as thatching for roofs, fencing material, and barriers against soil erosion in Nigerian agriculture (Alabi *et al*., 2018; FAO, 2014). In Southwestern Nigeria, particularly in cities like Ibadan and Lagos, woven leaf mats are employed as sustainable packaging for market products (Adeyemi *et al*., 2020).

Within Nigerian traditional medicine, leaf poultices are used topically to speed wound healing, while leaf infusions treat fever and inflammation (African Journal of Traditional Medicine, Anonymous, 2012). The antimicrobial properties of leaf extracts against livestock pathogens support their application in ethnoveterinary practices (Njidda and Nasiru, 2010; Ukwubile *et al*., 2019).

Nutritionally, the leaves offer 8–18% crude protein and 40% cellulose, along with bioactive compounds such as the flavonoids luteolin and apigenin, which have antioxidant effects (Hassan *et al*., 2018). Nigerian research confirms their richness in calcium (0.8%) and phosphorus (0.3%), beneficial for livestock bone development (Ojo *et al*., 2015). These qualities justify their use as supplementary feed during dry periods, boosting ruminant productivity (Akinbamijo *et al*., 2004).

2.2.2 Guinea grass flowers and seeds

Megathyrsus maximus is a tufted perennial grass reaching heights of 1–4 m. Which produces large, open panicles (20–60 cm long) with purple-tinged spikelets (Faruqi *et al*., 1969; Clayton *et al*., 2006). Its flowers exhibit protogyny (stigmas mature before anthers), facilitating wind-mediated cross-pollination (Silva *et al*., 2013). Each panicle yields 1,000–2,000 small seeds (approximately 1.5–2 mm long), which range from pale brown to purplish and possess awns (bristles) that assist wind dispersal (Skerman and Riveros, 1990; Cook *et al*., 2005). The seeds display innate dormancy, necessitating exposure to light or physical scarification to germinate (Martínez-Ghersa *et al*., 1997).

The grass's substantial annual seed yield (200–500 kg/ha) contributes to both its agricultural utility and ecological invasiveness (Moore *et al*., 2004). Its seeds are vital for establishing pastures in tropical regions, where scarified seeds are planted for forage (Hopkinson, 1995). Due, long-lived soil seed banks (persisting up to 5 years) allow rapid invasion of disturbed sites, outcompeting native plants (Dias-Filho, 2002; CABI, 2018).

Ecologically, the flowering phase indicates peak nutritional value for grazing, as crude protein levels diminish after seed formation (Moore *et al*., 2004). Agriculturally, the seeds' high crude protein content (8–18%) makes them valuable as supplementary dry-season feed to sustain ruminant productivity (Akinbamijo *et al*., 2004; Hassan *et al*., 2018).

2.3 Comprehensive Nutritive Profile of Guinea Grass

2.3.1 Proximate Composition and Its Variability

The nutritional value of Guinea grass is not static but is a function of genetics, environment, and management. The crude protein (CP) content is highly variable, ranging from as low as 6-8% in over-mature, stem-dominated stands to a high of 16-18% in young, leafy, and well-fertilized forage (Bamikole *et al*., 2016). This protein is essential for rumen microbial protein synthesis, which in turn supports animal growth, milk production, and reproduction.

The fiber components are equally critical. Neutral Detergent Fiber (NDF), which represents the total cell wall content, typically ranges from 60% to 75%. While NDF is necessary for maintaining healthy rumen function and stimulating salivation, levels above 65% can begin to physically limit the animal's voluntary feed intake. Acid Detergent Fiber (ADF), representing the less digestible components like cellulose and lignin, increases with plant maturity and is inversely correlated with digestibility (Silva *et al*., 2022). Dry Matter Digestibility (DMD) 55–65% (Bamikole and Babayemi, 2008). Metabolizable Energy (ME),8–10 MJ/kg DM (Akinlade *et al*., 2005). Decline with

Maturity, (Akinfemi and Adesina 2010) noted a 10–15% drop in DMD in older grass, positioning Guinea grass as a good energy source for maintaining and productive ruminants.

2.3.2 The Critical Role of Minerals in Livestock Physiology

Minerals are inorganic elements that are indispensable for a vast array of structural, physiological, catalytic, and regulatory functions in livestock. A deficiency or imbalance can impair virtually every production metric, from growth and feed efficiency to fertility and immune competence (Sultan *et al*., 2021).

- Macro-minerals: Required in gram quantities per day.

- Calcium (Ca) and Phosphorus (P): 0.3–0.8% of Calcium (Ca), (Akinlade *et al*. 2005), 0.15–0.3% of Phosphorus (P) (Bamikole *et al*. 2004), The primary minerals of the skeletal system. They are crucial for bone strength and development. A deficiency or a wide Ca:P ratio can cause rickets, osteomalacia, and poor productivity. Phosphorus is also a key component of ATP, the energy currency of the cell.

1.5–3.5% of Potassium (K) (Olanite *et al*. 2010): A major intracellular electrolyte, vital for nerve transmission, muscle contraction, and maintaining acid-base balance.

0.2–0.5% of Magnesium (Mg) (Aderinola *et al*. 2012): Essential for enzyme activity and, critically, for nervous system stability. Hypomagnesemia (grass tetany) is a fatal condition in lactating animals grazing on lush, rapidly growing grass.

Sodium (Na): The main extracellular electrolyte, crucial for fluid balance and nerve function.

Trace Minerals: Required in milligram or microgram quantities, but no less critical.

100–500 mg/kg of Iron (Fe) (Akinfemi 2009). Central to oxygen transport as a component of hemoglobin and myoglobin.

Zinc (Zn): Involved in over 300 enzyme systems, playing key roles in immune function, protein synthesis, and wound healing.

Manganese (Mn) Important for bone formation, carbohydrate metabolism, and antioxidant defense.

(Aderinola *et al*. 2012) Emphasized on mineral deficiencies (e.g., P, Na) in some Nigerian soils affecting grass quality. Flavonoids, Luteolin, apigenin, (Hassan *et al*., 2018). Phenolic acidic, Chlorogenic, caffeic acids, (Ukwubile *et al*., 2019). Present of Terpenoids (Njidda and Nasiru, 2010). Lignin, 5–8% (Moore *et al*., 2004).

2.4. Functional Properties of Guinea grass

Megathyrsus maximus (Guinea grass) possesses valuable functional properties underpinning its use in ethnoveterinary practices and phytomedicine. These properties include antimicrobial, antioxidant, growth-promoting, and probiotic effects (Bello *et al*., 2021). Adeyemi *et al*. (2022) note that medicinal grasses like Guinea grass are attracting renewed attention in sustainable agriculture and nutraceutical sectors because of their safety and multiple benefits. Tropical ethnopharmacological records document over 120 grass species, with M. maximus being particularly significant in West African and Latin American traditions for managing livestock health and metabolic issues (Oliveira *et al*., 2020). Even with progress in synthetic veterinary pharmaceuticals, natural grasses remain essential components of agroecological healthcare, especially in areas with limited resources. Consequently, major agricultural research institutions now emphasize studying grass phytochemistry as a key resource for creating feed additives and alternatives to antimicrobials (Mbakwe *et al*., 2023; Zhou and Rahman, 2019).

2.4 Folkloric and ethno medicinal uses of guinea grass

Forage grasses have long been incorporated into West African agricultural and medicinal practices (Adeoye *et al*., 2021). Native to tropical Africa, Guinea grass (*Megathyrsus maximus*) possesses substantial ethnoveterinary and economic importance in Nigeria. Communities in the Niger Delta region traditionally apply its leaves and stems to treat livestock digestive issues and wounds, with extracts serving as anti-parasitic treatments for cattle (Ogbemudia *et al*., 2018; Nigerian Journal of Animal Science, 2020).

Nutritional and Ethnoveterinary Values according to researchers, it has Essential high crude protein (12–18%) and carotenoids for animal development (Akinbamijo *et al*., 2017; Federal University of Agriculture Abeokuta). Demonstrated antimicrobial activity against cattle pathogens (Okafor *et al*., 2019; University of Nigeria, Nsukka). Topical leaf poultices used on cattle wounds in Ebony State lower infection incidence (Eze *et al*., 2021).

This grass significantly contributes economically and environmentally to Nigeria's livestock sector through; Silage production, alleviating dry-season forage shortages, generating 25–40% income increases for dairy farmers (Bamikole *et al*., 2016; Obafemi Awolowo University). Erosion mitigation via deep root systems that reinforce degraded soils (Osun State Ministry of Agriculture, 2020). Bioenergy suitability due to high biomass yields (30–50 t/ha) for biofuel applications (International Journal of Renewable Energy, 2022). Craft and construction, African (Nigerian, Kenya, Tanzania), used it for rural roofing due to durability (Bamikolo *et al*., 2003), used in fibers woven into fishing nets in coastal communities (Ezealor *et al* 2001)

2.5 Biological and pharmacological activities of guinea grass

2.5.1 Antioxidant activities

Guinea grass serves not only as a vital forage crop but also as a significant source of natural antioxidants. Bioactive compounds in its leaves, stems, and roots neutralize free radicals, mitigating oxidative stress in humans and animals.

Monteiro *et al*. (2021) demonstrated that supplementing sulfur (2.8–3.7 mM) in Tanzania guinea grass under barium toxicity significantly boosted superoxide dismutase (SOD) and guaiacol peroxidase (GPX) activity, reducing malondialdehyde (MDA) by 17% in culms/sheaths and increasing proline production 3.1-fold, confirming sulfur's role in mitigating oxidative stress via antioxidant induction. Malafaia *et al*. (2023) reported that low concentrations of zinc oxide nanoparticles (ZnO NPs) enhanced SOD and catalase (CAT) activity in guinea grass, improving stress tolerance, whereas higher doses caused oxidative damage, revealing a dose-dependent antioxidant response. Hare *et al*. (2021) identified Mombaça and Tanzania cultivars as drought-resilient in North Africa due to heightened SOD/CAT activity, which suppressed oxidative stress markers and maintained growth in arid conditions. Fontanilla (2024) found that silage composed of 70% guinea grass and 30% mulberry leaves elevated lactic acid production (an antioxidant preservative) by 89%, improving nutrient retention and antioxidant stability during fermentation. Monteiro *et al*. (2017–2023) showed sulfur supplementation amplified glutathione (GSH) synthesis and CAT/SOD activity in cadmium-stressed guinea grass, while ammonium/nitrate ratios fine-tuned cadmium uptake and antioxidant responses for optimized detoxification. An unspecified 2021–2023 study revealed that guinea grass meal (5 g/kg diet) lowered liver inflammation markers (AST/ALT) in broilers, indicating systemic antioxidant and anti-inflammatory effects attributable to phenolics and flavonoids. A 2023 study noted that heat-treating guinea grass fibers (110°C, 15 min) enhanced diesel absorption (22.33 mL efficiency) via lignocellulosic properties, though this application targeted environmental remediation, not biological antioxidants. Adejoro *et al*. (2020) observed that supplementing guinea grass with 20% African yam bean (AYB) increased in vitro organic matter digestibility (IVOMD) and gas production, but boiling/soaking was necessary to reduce tannins that limit antioxidant bioavailability. A 2021 Ecuador study inferred elevated antioxidant activity in guinea grass within silvopastoral systems, correlating improved dry-season forage quality and stress resilience with efficient resource use.

2.5.2 Effect of guinea grass on weight of treated livestock

Guinea grass serves as a perennial forage crop with high biomass productivity and adaptability. Its role in enhancing weight gain across livestock species cattle, sheep, and goats is well-supported by agronomic and nutritional studies.

Guinea grass promotes weight gain through exceptional biomass output (reaching 33 t/ha/year under optimal conditions) and a nutrient-rich profile, including crude protein (CP: 8–18%) and digestible organic matter (53–79%). However, lignification at maturity reduces CP from 13.2% (60-day growth) to 8.9% (120-day growth). Harvesting at 90 days balances yield and quality, achieving 11.48% CP and a leaf-to-stem ratio of 1.74.

In Brazil, steers grazing N-fertilized Guinea grass (300 kg/ha) attained 660 g/day average daily gain 28% higher than low-N systems. Soybean hull supplementation during dry seasons further increased gains to 0.982 kg/day by improving fiber digestion. Colombian rotational grazing systems (variable rest periods) boosted steer weight gain to 990 kg/ha due to optimized leaf biomass South American dairy systems yielded 10–12 kg milk/day when grazing Guinea grass at 2.5 animals/ha. Legume or concentrate supplementation elevated milk output by 15–20%. Inadequate protein in sole Guinea grass diets necessitates legume supplementation (e.g., *Desmodium*), raising weight gain by 25–35% in Fijian and South African systems. Urea-treated hay also enhanced feed efficiency. Nigerian West African Dwarf goats fed Guinea grass–Verano stylo mixes achieved 32 g/day daily gains 44% higher than grass-only diets—due to improved nitrogen utilization. Vietnamese studies confirmed similar benefits from legume supplementation. Bamikole *et al*. (2001) reported that goats fed grass–legume intercrops (e.g., Verano stylo, CP 18–22%) showed superior daily gains (32 g/day) and nitrogen retention versus N-fertilized monocultures.

Guinea grass consistently enhances livestock weight when paired with targeted harvesting, moderate N-fertilization, and legume supplementation. Nigerian research validates its suitability for smallholder systems but underscores risk from environmental contaminants and seasonal nutrient fluctuations. Strategic management is essential to maximize its potential in sustainable livestock production.

2.5.3 Antimicrobial activities of guinea grass

Research confirms that guinea grass possesses antimicrobial properties, largely due to its bioactive plant compounds. The evidence is carried out by Gothandam *et al*. (2010) Who studied ethanol extracts from guinea grass leaves. They found these extracts significantly inhibited the growth of bacteria including Escherichia coli, Pseudomonas aeruginosa, and Bacillus subtilis, identifying flavonoids as the primary active components, Doss *et al*.

(2011) focused on flavonoid-rich extracts. Their research demonstrated potent activity against Staphylococcus aureus and E. coli, particularly in leaf extracts, which performed similarly to standard antibiotics in inhibition tests. It targeted Pathogens Gram-positive (S. aureus, B. subtilis) and Gram-negative (E. coli, P. aeruginosa) bacteria. Kanife *et al*. (2012) investigated methanol extracts from different parts of guinea grass (leaves, stems, florets). Their results showed inhibition against fungi such as *Aspergillus niger*, *Candida albicans*, and *Fusarium oxysporum*, with leaf extracts being the most effective (achieving 70–80% inhibition). Phenolic compounds and terpenoids in the grass are thought to disrupt fungal cell membranes.

2.6. Phytochemistry of guinea grass

Guinea grass displays a rich and varied phytochemical profile, encompassing both primary metabolites such as proteins and fibers, and specialized secondary metabolites like flavonoids and tannins, with their composition being shaped by genetic factors, environmental conditions, and management practices (Pereira *et al*., 2017; Gomes *et al*., 2021). A key characteristic is the fluctuation in its crude protein content depending on harvest maturity; levels peak at approximately 13.2% when harvested at 60 days but decrease significantly to around 8.9% by 120 days, primarily due to increased lignification (Pereira *et al*., 2017). Furthermore, Guinea grass demonstrates significant capabilities in heavy metal remediation, effectively accumulating pollutants like cadmium (Cd), arsenic (As), and chromium (Cr) through mechanisms enhanced by sulfur, such as the synthesis of glutathione which helps mitigate associated oxidative stress (Li *et al*., 2015; Gomes *et al*., 2021). The nutritional quality of the grass is also notably influenced by specific agronomic approaches; for example, cultivating it within silvopastoral systems can increase crude protein content by about 4% compared to monocultures, a benefit attributed to enhanced nutrient cycling (Chará *et al*., 2019). Additionally, symbiotic endophytic bacteria, including *Azospirillum brasilense*, play a role by boosting the production of phytohormones like auxins, which in turn stimulate root development and improve nutrient acquisition (Fukami *et al*., 2018). Under stress conditions such as cadmium exposure, the plant responds by elevating levels of antioxidant metabolites, notably flavonoids and tannins, which provide protection against damaging reactive oxygen species (Andrade *et al*., 2020). Moreover, siderophores released by associated microbes, such as Pseudomonas fluorescens, contribute to the plant's resilience by improving iron solubility and availability (Tapia-García *et al*., 2020). Collectively, these dynamic phytochemical responses underscore Guinea grass's remarkable adaptability, allowing it to effectively balance high forage value with environmental resilience across a wide range of ecosystems.

2.6. Phytochemical characteristics of guinea grass

Guinea grass possesses a dynamic phytochemical composition shaped by environmental and management factors. Its nutritional value stems from primary metabolites, with crude protein levels varying between 8% and 18%, heavily dependent on harvest time and nitrogen fertilization. Research by Wolele *et al*. (2025) in Ethiopia showed protein content at 90-day regrowth reached 11.48%, dropping to 8% by 120 days. Fiber components such as Neutral Detergent Fiber (NDF) and Acid Detergent Fiber (ADF) rise with plant maturity, reducing digestibility. However, younger regrowth (60-90 days) maintains a better leaf-to-stem ratio (1.74) and higher organic matter digestibility (53-79%) due to increased water-soluble carbohydrates. Mineral content presents both opportunities and risks; Fakayode and Onianwa (2002) in Nigeria documented concerning accumulations of cadmium (0.73 mg/kg), lead (2.9 mg/kg), and chromium (2.3 mg/kg) in grass near Lagos industries, while nitrogen fertilization boosts beneficial minerals like potassium, calcium, and magnesium in uncontaminated soils.

The grass also produces secondary metabolites, including phenolic compounds such as gallic acid and quercetin-3-O-glucuronide. Total phenolic content is estimated at 350-463 mg gallic acid equivalents/g based on analogous African grasses. Hydrolyzable tannins (1.3-2.4%) impart astringency and protein-binding effects. Terpenoids dominate the essential oil profile, featuring antimicrobial constituents like germacrene D, spathulenol, and caryophyllene oxide. While alkaloids such as conessine are known in related species, their presence in Guinea grass requires further quantification. Similarly, saponins with potential antiparasitic activity remain chemically undefined despite traditional ethnoveterinary use.

Agronomic practices significantly alter phytochemistry. Frequent cutting preserves forage quality but reduces yield, whereas longer 9–12-week intervals increase biomass at the expense of higher fiber, as noted by Barbosa *et al*. (2011). Nitrogen application elevates crude protein up to 18% without changing stem structure. Shade adaptation leads to broader leaves and higher chlorophyll in genotypes like 'IG 01-93', accompanied by reduced fiber. Seasonal changes cause a 3.5-fold increase in leaf elongation from winter to summer. Nigerian innovations include silage formulations by Mpieri *et al*. (2024) blending Guinea grass with cassava peels (50:50 ratio), improving digestibility and reducing methane emissions.

Nigerian research addresses critical local challenges. Mbahi *et al*. (2023) enhanced Red Sokoto goat diets by supplementing Guinea grass with *Prosopis africana* pods (450g/day), boosting crude protein intake (6.93 g/day) and weight gain (0.07 kg/day). Fakayode and Onianwa (2002) established strong correlations ($r > 0.85$) between soil and grass tissue heavy metal levels near Lagos, defining livestock safety thresholds.

2.7 The Critical Issue of Heavy Metal Contamination in Forages

In urban and peri-urban agricultural landscapes, the issue of heavy metal pollution transitions from a theoretical risk to a practical and severe threat to animal and human health. The sources are diverse: lead from historical automotive fuel and deteriorating paints, chromium from tanning and electroplating industries, and cadmium from phosphate fertilizers and battery recycling (Nnaji *et al*., 2022).

The danger lies in the process of bioaccumulation. Forage grasses like Guinea grass, grown on contaminated soils, absorb these toxic elements. When consumed by livestock, the metals are not readily excreted and instead accumulate in soft tissues and organs over time. This chronic exposure can lead to subclinical toxicity in animals, manifesting as reduced growth, immunosuppression, and reproductive failures, often without clear, overt signs of poisoning (Ezeonyejiaku *et al*., 2020). The ultimate consequence is the transfer of these toxic elements into the human food chain via meat, milk, and offal, posing significant public health risks. Studies in Nigerian cities, including Benin City, have documented concerning levels of Pb and Cd in vegetables and soils, underscoring the urgency of monitoring forage crops in these environments (Okedeyi *et al*., 2019).

2.8 Forage management

Guinea grass demonstrates notable adaptability across various forage applications, including pasture, silage, and hay production. For pasture systems, it supports sustainable long-term use under regulated grazing regimes, though management must prevent defoliation below 35 cm and avoid utilization during excessively wet conditions to maintain stand health (FAO, 2009). Rest intervals permitting regrowth to approximately 2.5 leaves per tiller significantly enhance animal productivity outcomes (Candido *et al*., 2005). In cut-and-carry operations for silage or hay, optimal quality emerges when harvesting occurs at 60–90 cm; however, cutting at heights up to 1.5 m still yields acceptable quality without excessive coarseness (Hongthong Phimmasan, 2005). Peak silage quality is achieved when harvesting coincides with pre-anthesis or anthesis growth stages (Sarwatt *et al*., 1989). The ensiling process preserves favorable texture characteristics, and blending grass from varied age cohorts does not detrimentally affect overall silage integrity (Babayemi *et al*., 2009).

CHAPTER THREE

MATERIALS AND METHODS

3.1. Experimental Samples

The research took place in Benin City, Edo State, Nigeria, situated in the South-South geopolitical region. Located at 6.3380° N latitude and 5.6258° E longitude, the city experiences a humid tropical climate with distinct wet and dry seasons. Annual rainfall averages between 1,500 mm and 2,000 mm, with mean temperatures ranging from 26°C to 30°C. Three sites within Benin City, chosen for their differing environmental conditions and land uses, were sampled. They were assigned the codes A, B and C respectively as shown in Table 3.1

Table 3.1. Sample Codes and Locations

Location	Code	LGA
Ekehuan	**A**	Ovia north east.
Ekosodin	**B**	Oredo
Uniben	C	Egor

3.1.1 Experimental materials used

Fresh leaves of Guinea grass, scissors, volumetric flask, weighing balance, plastic bowls, Measuring cylinder, Hot plate and Engine grinder.

3.2 Sample Collection

Fresh leaves of Guinea grass were collected from each location using the following procedure; Five random sub-sampling points were identified within a 100-meter radius at each site, approximately 500 grams of mature fresh leaves (post-vegetative growth, pre-flowering) were harvested from each sub-point, leaves from the five sub-points per location were combined to create a single composite sample, composite samples were labeled, placed in clean perforated polythene bags, and transported to the laboratory.

3.3 Sample Preparation

The leaves were thoroughly washed under running tap water to remove adhering dust, soil particles, and other physical contaminants. They were then chopped into smaller pieces for easy drying using scissors. The chopped samples were spread thinly on trays and sun-dried for 4-5 days until a constant weight was achieved. The completely dried leaves were milled into a fine powder using milling machine, the powdered samples were stored in labeled, airtight plastic containers at room temperature until analysis.

3.4 Mineral Analysis

Mineral content (macro and micro) in the powdered Guinea grass leaf samples was determined using standard AOAC (2019) methods.

3.4.1 Sample Digestion

About 2 g of powdered sample was weighed into a digestion flask, a mixture of 10 ml concentrated nitric acid (HNO_3) and 5 ml perchloric acid ($HClO_4$) was added, the mixture was heated on a hot plate until a clear digest solution formed, after cooling, the digest was filtered and diluted to 50 ml with deionized water in a volumetric flask.

3.4.2 Mineral Determination

Calcium (Ca) and Magnesium (Mg): Measured by Atomic Absorption Spectrophotometry (AAS), Potassium (K) and Sodium (Na) were Measured by Flame Photometry, Phosphorus (P) was Determined using the vanadomolybdate colorimetric method, read at 420 nm via spectrophotometer, Iron (Fe), Zinc (Zn), Copper (Cu), Manganese (Mn) were measured by Atomic Absorption Spectrophotometry (AAS).

All analyses were performed in triplicate.

3.5 Data Analysis

Mineral concentrations were reported as mg/100 g dry matter. Statistical analysis involved:

Analysis of Variance (ANOVA) using SPSS (Version 25.0) to identify significant differences in mineral levels between locations. Duncan's Multiple Range Test (DMRT) for post-hoc mean separation (significance level $p < 0.05$). Results are presented as mean values ± standard deviation (SD).

3.6 Quality Assurance

The following quality control measures were implemented:

All glassware and equipment were meticulously cleaned and rinsed with deionized water, analytical grade reagents were used, blank samples and standard reference solutions were analyzed concurrently with the test samples, instruments (AAS, Flame Photometer, Spectrophotometer) were calibrated according to manufacturer specifications before each use.

Plate 1: Guinea grass leaf meal

Plate 2: Fresh Guinea grass

CHAPTER FOUR

RESULTS

4.1. Reports the findings of a mineral analysis conducted on samples of *Megathyrsus maximus* (guinea grass) collected from three different locations (EKE, EKO, UNI) in Benin City, Nigeria. The study quantified the concentrations of essential minerals (e.g., Ca, Mg, K, P) and trace elements (e.g., Fe, Zn, Cr, Mn, Pb). A one-way analysis of variance (ANOVA) was employed to assess variations, with Duncan's Multiple Range Test (DMRT) used post-hoc to distinguish between the means of groups where significant differences were detected ($p < 0.05$).

Table 4.1. Mineral Composition (mg/kg) Of Guinea grass collected from three different locations in Edo state, Nigeria

Mineral	EKE	EKO	UNI	±SEM
Ca	887.2^{b}	741.2^{a}	888.2^{b}	0.11
Mg	110.3^{b}	102.4^{a}	115.2^{c}	0.25
Na	56.4^{b}	50.6^{a}	66.5^{c}	0.04
Fe	22.4^{b}	19.5^{a}	28.1^{c}	0.02
Zn	10.3^{a}	10.1^{a}	11.7^{b}	0.02
K	111.0^{b}	85.3^{a}	331.3^{c}	3.24
P	345.0^{c}	210.1^{b}	185.2^{a}	2.85
Cr	0.1^{a}	0.4^{b}	0.5^{b}	0.01
Mn	28.8^{a}	45.2^{b}	51.8^{c}	0.39
Pb	0.1^{a}	0.3^{b}	0.3^{b}	0.01

Mean with the same superscripts are significantly different at 5% level of significance.

SEM: Standard errors of mean, Eke: Ekenwan, EKO: Ekosodin, UNI: Uniben

4.2. MACRO MINERALS

Calcium (Ca)

The calcium content in guinea grass varied significantly ($p < 0.001$) across the three locations. The mean values were 887.14 mg/kg (EKE), 741.18 mg/kg (EKO), and 898.22 mg/kg (UNI). Duncan's test indicated that the calcium content at UNI was significantly higher than at EKO, while EKE was intermediate and not significantly different from either.

Magnesium (Mg)

Magnesium content also showed significant variation ($p < 0.001$). The mean values were 110.27 mg/kg (EKE), 102.43 mg/kg (EKO), and 115.23 mg/kg (UNI). According to DMRT, all three locations differed significantly from each other, with UNI having the highest Mg content and EKO the lowest.

Sodium (Na)

A significant difference ($p < 0.001$) was observed in sodium content. The mean values were 56.40 mg/kg (EKE), 50.57 mg/kg (EKO), and 66.53 mg/kg (UNI). Duncan's test revealed that UNI had significantly higher sodium than EKE and EKO, while EKE was significantly higher than EKO.

Potassium (K)

Potassium content varied highly significantly ($p < 0.001$) among the locations. The mean values were 111.0 mg/kg (EKE), 85.3 mg/kg (EKO), and 331.3 mg/kg (UNI). DMRT showed that all means were significantly different, with UNI having the highest K content.

Phosphorus (P)

Phosphorus levels also differed significantly ($p < 0.001$). The mean values were 345.0 mg/kg (EKE), 218.0 mg/kg (EKO), and 185.2 mg/kg (UNI). Duncan's test indicated that EKE had significantly higher phosphorus than EKO and UNI, and EKO was significantly higher than UNI.

4.2.2 TRACE MINERALS

Iron (Fe)

Iron content showed significant variation ($p < 0.001$). The mean values were 22.43 mg/kg (EKE), 18.50 mg/kg (EKO), and 28.10 mg/kg (UNI). DMRT results showed that all three locations differed significantly, with UNI having the highest Fe content and EKO the lowest.

Zinc (Zn)

Zinc content varied significantly ($p < 0.001$). The mean values were 10.13 mg/kg (EKE), 10.30 mg/kg (EKO), and 11.70 mg/kg (UNI). Duncan's test indicated that UNI had significantly higher Zn than both EKE and EKO, which were not significantly different from each other.

Manganese (Mn)

Manganese content differed significantly ($p < 0.001$). The mean values were 28.77 mg/kg (EKE), 45.23 mg/kg (EKO), and 51.77 mg/kg (UNI). DMRT showed that all three locations had significantly different Mn levels, with UNI having the highest and EKE the lowest.

Chromium (Cr)

Chromium content showed significant variation ($p < 0.001$). The mean values were 0.1400 mg/kg (EKE), 0.1500 mg/kg (EKO), and 0.4507 mg/kg (UNI). Duncan's test revealed that UNI had significantly higher Cr than both EKE and EKO, which were not significantly different from each other.

Lead (Pb)

Lead content also varied significantly ($p < 0.001$). The mean values were 0.0833 mg/kg (EKE), 0.2500 mg/kg (EKO), and 0.3000 mg/kg (UNI). DMRT indicated that all three locations differed significantly, with UNI having the highest Pb content and EKE the lowest.

CHAPTER FIVE

DISCUSSION

5.1. The Critical Role of Location in Mineral Content

The presence of statistically significant differences ($p < 0.001$) across all ten minerals strongly indicates that local soil conditions and human factors are the main influences on the grass's chemical composition. This observation supports existing studies on tropical soils, particularly Nigerian research by Odewande and Abimbola (2021), which emphasizes the considerable variability in soil nutrients and pollutants, especially in city environments. In this context, the Guinea grass serves as a biological monitor, with its tissue analysis providing a direct snapshot of the elements available in the soil where it grows. Thus, the strong contrasts seen between the UNI, EKE, and EKO sites are a logical outcome of the unique soil conditions and human impacts at each location.

5.2. Analysis of Essential Macronutrient Differences

The substantial difference in Potassium (K) levels, where the UNI site (331.3 mg/kg) significantly exceeded other areas, is likely due to specific local farming practices. The behavior of potassium in the soils of Southern Nigeria is not simple. Research from

South-West Nigeria by Adekiya *et al*. (2020) shows that the availability of this nutrient is heavily influenced by management, changing based on the types of fertilizers used and how quickly organic matter in the soil decomposes. The high K at UNI points to a background of organic waste application or use of potassium-based fertilizers, increasing the amount of the element available for plant absorption.

In a similar case, the unusually high Phosphorus (P) level at the EKE site (345.0 mg/kg) stands as a clear sign of human input. This finding is in strong agreement with the work of Chukwuma *et al*. (2021) in Southern Nigeria, who connected high soil phosphorus levels directly to farming intensity and waste disposal. Because phosphorus does not move easily in soil, it builds up in areas where it is applied, resulting in the high concentrations measured in the grass at EKE. This pattern clearly identifies this site as one with significant agricultural use, probably involving both organic and chemical phosphate fertilizers.

5.3 The Serious Risk of Heavy Metal Pollution

A particularly alarming result from this study is the increased level of toxic Lead (Pb) and Chromium (Cr) at the UNI site. This offers clear proof of environmental pollution, a common and severe problem reported in many urban studies across Nigeria. The origins of these harmful metals are well-known. Studies in Benin City and similar urban areas, such as those by Okedeyi *et al*. (2019), repeatedly point to human activities as the main sources, including exhaust from vehicles (from past use of leaded fuel and tire dust), industrial waste, and the common incineration of electronic and plastic rubbish.

The uptake of these dangerous metals from soil into forage crops shifts the issue from an environmental problem to a direct danger for animals and people. The tendency of these elements to build up in living tissue, as seen in the grass at UNI, presents serious health risks to livestock, including possible nerve damage, kidney problems, and reduced growth. More critically, this creates a direct route for these poisons to enter the human food supply. This serious concern is directly reflected in the work of Nnaji *et al*. (2022) on forage grasses in Southeastern Nigeria, who cautioned that contaminated feed is a major channel for transferring heavy metals into animal products, thereby creating a hidden health threat for people who consume meat and milk.

5.4. The Animal Nutrition Dilemma: Balancing Benefit and Harm

The difficulty of reconciling the benefits of forage with its potential dangers. The mineral composition of forage is a critical determinant of livestock health and productivity. This is particularly true within Nigeria's small-scale farming systems, where the high cost of commercial mineral supplements often places them out of reach. The research brings to light a severe and multifaceted issue. Forage from the UNI location was found to have elevated concentrations of essential trace minerals such as Iron (Fe), Zinc (Zn), and Manganese (Mn). This suggests that, from a strictly nutritional perspective, this forage could be highly effective for preventing common deficiency disorders. This finding is significant, as it aligns with the work of Akinsoyinu (2019), who identified mineral shortages as a primary constraint on cattle production in Nigeria.

However, this potential dietary advantage is entirely negated by a concurrent and serious threat: the risk of heavy metal toxicity. The level of Lead (Pb) detected at the UNI site (0.3000 mg/kg), while not acutely lethal, indicates a clear danger of chronic, low-level exposure. Investigations into animals from other polluted regions of Nigeria, such as those conducted by Ezeonyejiaku *et al*. (2020), have demonstrated how these metals progressively accumulate in bodily tissues. This bioaccumulation leads to a gradual deterioration of health and results in animal products that are unsafe for human consumption. Consequently, utilizing forage from the UNI site constitutes an unsafe agricultural practice, as any short-term nutritional benefit is vastly outweighed by the potential for long-term toxicological damage.

In direct opposition to this, the consistently low mineral levels found at the EKO site present a different challenge: fundamental nutritional inadequacy. Livestock that consume forage from this area would undoubtedly require a carefully formulated mineral supplementation program to maintain proper health, support reproduction, and ensure normal growth. This is a widely recognized necessity in Nigerian animal management, a point corroborated by Adeyinka *et al*. (2018). This situation creates a significant predicament for local farmers, who are effectively forced to choose between forage that is potentially poisonous and forage that is inherently deficient. This starkly illustrates the profound impact that localized soil conditions and environmental pollution have on the sustainability of livestock farming operations.

CHAPTER SIX

SUMMARY, CONCLUSION AND RECOMMENDATIONS

6.1. SUMMARY

This investigation was undertaken to evaluate and contrast the mineral content of Guinea grass (*Megathyrsus maximus*) obtained from three separate sites EKE, EKO, and UNI in Benin City, Edo State. The research was driven by the importance of forage quality for animal health in Nigeria's small-scale farming operations and the escalating issue of environmental pollution in urban zones, which can negatively affect the safety of natural fodder.

Methodologically, the study consisted of gathering Guinea grass leaf samples from the three designated locations. These samples were processed and subjected to laboratory analysis to quantify the levels of ten key minerals: Calcium (Ca), Magnesium (Mg), Sodium (Na), Iron (Fe), Zinc (Zn), Potassium (K), Phosphorus (P), Chromium (Cr), Manganese (Mn), and Lead (Pb). Statistical evaluations were then performed to ascertain the significance of any differences observed between the sites.

The findings demonstrated statistically significant ($p < 0.001$) differences in the grass's mineral makeup across the three locations, firmly establishing site-specific factors as a primary influence. Among the notable results, the UNI site displayed substantially elevated concentrations of Potassium (331.3 mg/kg) along with crucial micro-minerals such as Iron, Zinc, and Manganese. Paradoxically, this location also registered concerningly high levels of toxic heavy metals, namely Lead (0.3 mg/kg) and Chromium (0.5 mg/kg). Meanwhile, the EKE site was distinguished by its uniquely high Phosphorus content (345.0 mg/kg), and the EKO site generally showed lower readings for a majority of the essential nutrients.

Analysis of these results connects the variations directly to human-induced factors at each site. The increased heavy metal presence at UNI is consistent with urban contamination from sources like traffic and waste, while the abundant Phosphorus at EKE suggests agricultural fertilization practices. This presents a significant challenge for livestock management: while the UNI location offers superior nutritional value, it simultaneously carries a substantial toxicological risk due to metal contamination. On the other hand, feed from the EKO site, though safer, lacks sufficient mineral content and would likely need to be supplemented in animal diets.

6.2. CONCLUSION

The findings lead to the overarching conclusion that the quality of Guinea grass in Benin City is a direct reflection of its local environment, heavily influenced by pollution. This creates a significant challenge for sustainable livestock farming. The same location that provides the most nutritious grass also presents the greatest threat to animal health due to toxic metal contamination. Consequently, using forage from such polluted areas jeopardizes livestock well-being and introduces a serious risk to food safety, as these toxins can accumulate in animals and enter the human food supply through meat and milk.

6.3. RECOMMENDATIONS

To address these issues, the following actions are recommended:

1. For Farmers: Source forage from areas with low pollution levels and provide mineral supplements to animals grazing on nutritionally poor sites. Testing grass for heavy metals is advised where possible.

2. For Authorities: Develop educational programs to alert farmers of the dangers of contaminated forage and enforce stricter environmental controls to reduce pollution from industry and waste.

3.For Future Studies: Broaden the research to map contamination across more of the city and investigate the direct transfer of heavy metals from grass into livestock and their products.

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