OPEN ACCESS

Scholars International Journal of Biochemistry
Abbreviated Key Title: Sch Int J Biochem
ISSN 2616-8650 (Print) | ISSN 2617-3476 (Online)
Scholars Middle East Publishers, Dubai, United Arab Emirates
Journal homepage: https://saudijournals.com

Original Research Article

Phytochemical, Nutritional Composition and Antioxidant Activity of Sugarcane (*Saccharum officinarum. L*) and Sugarcane Biomass

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DOI: https://doi.org/10.36348/sijb.2026.v09i02.003 | **Received:** 17.06.2026 | **Accepted:** 11.08.2026 | **Published:** 22.08.2026

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Abstract

Sugarcane (Saccharum officinarum) is a highly efficient agro-industry plant with known ability to accumulate biomass and produce sucrose sugar, making it an essential cash crop globally. This also results in the environmental pollution due to the accumulation of sugarcane biomass, the plant residues. left behind after extraction of sugar. This study was conducted to determine the phytochemicals contents, proximate, mineral, and antioxidant activities of sugarcane and its biomass, with a focus on their sustainable utilization through agricultural, therapeutic and industrial application. The samples were collected from Sharada market, Kano State, Nigeria, and analyzed for phytochemical using quantitative and qualitative method and antioxidant activities using the (DPPH, FRAP) method, proximate using standard Association of Analytical Chemistry (AOAC) methods and mineral using the Atomic Absorption Spectroscopy (AAS).The results revealed that sugarcane biomass had higher fiber and carbohydrate content (26.01±0.02% and 79.34±6.96%, respectively) compared to raw sugarcane (19.19±0.02% and 62.75±0.96%). However, sugarcane had a higher moisture (2.41±0.34%), fat (1.52±0.64%), and protein content (0.42±0.01%) than the biomass. In terms of mineral composition, sugarcane exhibited higher iron (5.59±0.17 mg/l), manganese (0.20±0.002 mg/l), and calcium concentration (14.10±0.03mg/l), while the biomass contained more potassium (207.5±0.24 mg/l). The result revealed that sugarcane had higher total phenolic content (279.92±3.66), compared to sugarcane biomass (255.65±9.48), also contains higher total flavonoids content (95.90±2.04) compared to sugarcane biomass (88.79±1.33). However, sugarcane had a higher antioxidant activity in term of the DPPH assay with an IC_{50} value of (774.28±5.60) higher than the biomass which has (1234.64±8.03). In terms of Ferric reducing antioxidant power (FRAP) Sugarcane exhibited higher antioxidant activity at higher concentration while the biomass shows higher antioxidant activity at low concentration. Sugarcane and sugarcane biomass has strong antioxidant activity, this indicate that the sugarcane and sugarcane biomass are effective in giving antioxidant protection at various levels, inhibition of radical formation (by reducing iron complexes). These findings suggest that sugarcane and sugarcane biomass are richer in phytochemicals which makes it suitable for the treatment of several ailments. Also, that sugarcane is nutritionally richer in proteins and essential trace minerals, whereas the biomass is an excellent source of dietary fiber and macro minerals, making it suitable for bio-fuel production, animal feed, and soil enrichment. The utilization of sugarcane biomass as a renewable resource could alleviate environmental pollution caused by waste disposal while promoting sustainable agriculture and energy solutions. Therefore, utilizing the full potential of sugarcane

Keywords: Sugarcane, Sugarcane biomass, phytochemicals, minerals, proximate and antioxidant.

INTRODUCTION

Sugarcane (*Saccharum officinarum L.)* is a major agricultural crop and one the most significant agro-industry commodities, with annual global production of approximately 1.87 billion (FAOSTAT, 2022; Oleszek, 2023*)*. It is an important economic crop cultivated in several countries, including Nigeria. Predominately grown in the northern states of Kano, Kaduna, Niger, Jigawa, Sokoto, Katsina, Taraba Adamawa and Kwara where the climatic conditions are favourable (Alhassan, 2021). Nigeria is endowed with abundant natural resources, including sugarcane, which is considered a valuable agricultural resource with tremendous potential for industrial and economic development (Adeleke, 2023). Sugarcane is primarily cultivated for sucrose production. The increasing global demand for sugarcane has led to a substantial rise of by-products and agricultural waste, posing tremendous environmental challenges. The increase in consumption and processing of sugarcane produces large quantities of biomass residues, particularly bagasse, which can contribute to extreme environmental pollution (Akram *et al.,*2023). Sugarcane bagasse, the fibrous residue remaining after processing is one of the most abundant and promising agricultural bio-resource (Koraspati *et al.,*2022; Akram, 2023). It is estimated that around 280 Kg of bagasse is generated for every tonne of sugarcane processed (Oleszek, 2023). Although, biomass residues present serious disposal challenges, it also offers considerable potential for value added applications. In numerous areas such as bio-energy, bio-feeds, bio-composites, bio-fuels and other sustainable industrial products. Biomass residues has attracted considerable attention within the scientific community because of its renewability, cost effectiveness, widespread availability, and sustainability (Brodeur *et al*., 2011; Isikgor *et* al., 2015). Recent studies have demonstrated that agro-industrial residues from different crops, including sugarcane, are considered renewable source of value-added products with diverse applications in animal husbandry, food, agriculture, pharmaceutical, and industrial sectors (Mustafa, 2020; Oleszek, 2023). The potential applications of several agro-industrial residues and their bio-active compounds across various industries have been extensively documented (Oleszek, 2023). Consequently, there is increasing interest in utilizing these by-products as sources of valuable phytochemicals with potential antioxidant, anti-inflammatory, anti-cancer, antimicrobial, and cardiovascular protective activities (Kasapidou *et al.,*2018). Natural products have gained significant attention because of their antioxidant and free radical scavenging activities. These plant substances contain a wide range of secondary metabolites with bio-active compounds that may protect bio-molecules from oxidative damage and thus reduce inflammatory responses associated with the onset of various diseases (Sanarat *et al*., 2021). Consequently, the exploration of agricultural biomass as a source bio-active compounds has become an important area of study. This study aims to evaluate the the phytochemical, compositional and antioxidant content of sugarcane and sugarcane biomass to determine their potential as sustainable bio resource. Assessing their nutritional and mineral profile will provide an assessment of their value and sustainability for use in the pharmaceutical, food, agricultural and various other sectors. Furthermore, efficient utilization of sugarcane biomass and other agricultural by products offers a cost effective and environmentally friendly approach to waste management. While promoting the utilization of value-added products with potential health benefits and reducing environmental pollution Gbadeyan, *et al*., 2024). Thus, examining their potential use as bio-products for further studies in various medical applications. Also, renewable use of the bio-waste would provide a means for cost effective and sustainable utilization of the different bio-products for potential health benefits thus prevent environmental pollution.

MATERIALS AND METHOD

Chemicals and reagents

Chemicals and reagents used for the research were Distilled water, Methanol, EDTA (Ethylene), 1,1diphenyl-2-picrylhydrazine (DPPH), folin-ciocalteu reagent, sodium carbonate, Methanol, 1M Potassium Acetate, 10% Aluminium Chloride, Ammonia, Ferric Chloride reagent, Acetone, Diphenyl sulphoxide, Ice, Petroleum ether, Concentrated Sulphuric acid (H_2SO_4), 20% Sodium hydroxide (NaOH), Copper Sulphate ($CuSO_4$), Boric acid (H_3BO_3), Concentrated Hydrochloric acid (HCl), Concentrated Nitric acid (HNO_4), Naphthol, Fehling solution A&B, Mayer's reagent, Wagner's Reagent.

Materials

High-speed grinder, Crucible, Vacuum oven (Towson and Mercer Limited) Weighing balance (Mettle PC 440), Whatman Filter paper, Retort stand, Extraction Thimble, Soxhlet extractor, Conical flask, Measuring cylinder, Hot Plate, Volumetric flask, Beaker, Funnel, Muffle Furnace(Callen Kamps 1300 016), Test tubes, Digestion flask, Kjeldahl digestion and Distillation flask, Rack, Desiccators, Fume cupboard, Pipette, Calibrated plastic bottle, Atomic Absorption Spectrophotometer (Buck scientific 205 model), Knife cutter and plant samples (sugarcane and sugarcane biomass).

Sample Collection and Authentication

Sugarcane (*Saccharum officinarum L.)* plant samples were purchased from the local Sharada Market, Gwale Local Government area of Kano State, Nigeria. The samples were identified at the Faculty of Science, Department of Biological Sciences, Northwest University, Kano and were given the authentication number YUMSUKHAN 24/013.

Sample Preparation

The purchased samples were cleaned and washed properly to remove impurities. The outer woody layer of each sugarcane stem was peeled off and used as the biomass sample (Figure;1b), while the inner sugary pulp was cut into small sugarcane cubes (Figure:1a) using a kitchen knife. The samples were washed thoroughly with water and allowed to dry under room temperature. The samples were subsequently grinded to a fine consistency using a high-speed grinder (Figure1c and Figure 1 d). The samples were labeled accordingly and then stored in an airtight container for further analysis as shown in Figures 1a-1d.

Figure 1a: Pictorial representation of sugarcane

Figure 1b: Pictorial representation of sugarcane- biomass

Figure 1c: Pictorial representation of sugarcane powder

Figure 1d: Pictorial representation of sugarcane biomass powder

Solvent Extraction:

The solvent methanol was used for extraction; the plant powder was added to the beaker containing the solvent and kept at room temperature for 30 minutes. The mixture was shaken every 24 hours for (7) seven days. The extract was filtered using Whitman filter paper and dried at room temperature in a watch glass slide.

Methodology:

Quantitative and Qualitative Phytochemical analysis was carried out on the powered extract for the detection of alkaloids and tannins (Trease and Evans, 1989; Oluduro, 2012), tannins, saponin (Sofowora, 1982). Cardiac glycoside (Keller-Killani Test), Determination of total flavonoids content was done using the Aluminium Chloride Colorimetric method was used with some modifications to determine flavonoid content. **(**Aiyegroro *et al*., 2010). Determination of Total Phenolics Content. The total phenolic content of the samples was measured using a modified colorimetric Folin-Ciocalteu method (Singleton *et al*., 1999; Rabiu *et al*., 2019). Quantification of Antioxidant Activity was done using DPPH Radical Scavenging Activity (Aryal *et al*., 2019). The Ferric reducing antioxidant power (FRAP) was determined using the method described by (Alam *et al.,* 2019). Proximate analysis was carried out to determine the nutritional composition of the samples; Sugarcane and Sugarcane Biomass (SCB) and the parameters include: Total Moisture Content, Ash Content, Protein, Fat, Crude Fiber, and Total Carbohydrate. The analysis of the samples were carried out using methods as described by the Association of Analytical Chemistry (AOAC 2016). Mineral Analysis was carried out after ashing of the sample, triple acid digestion was carried out by the method described by (Sahrawat *et al.*, 2000). The minerals were analyzed using Atomic Absorption Spectrophotometry (AAS), all determinations were carried out in triplicate and reported as mean mineral content.

Statistical Analysis

This was done using SPSS: The results were expressed as mean standard deviation. Student's test's was used to determine significant difference between the parameters accessed.

RESULTS AND DISCUSSIONS

The present study evaluated the nutritional composition, phytochemical constituents, mineral profile, and antioxidant activity of sugarcane and sugarcane biomass.

Phytochemical Contents

The results of the Phytochemical Content in the Methanolic Extracts for Sugarcane and Sugarcane biomass is shown in table 1.0

Table 1.0: Results for the Qualitative Phytochemical Screening of Methanolic Extracts of Sugarcane and Sugarcane Biomass

Phytochemicals	**Sugarcane**	**Sugarcane biomass**
Flavonoids	+	+
Alkaloids	-	-
Phenols	+	+
Cardiac Glycosides	-	+
Saponins	-	-
Tannins	-	-

(+) = Present, (-) =Absence

Table 2.0: Results for the Quantitative Phytochemicals Analysis of Sugarcane and Sugarcane Biomass

Sample	**Total Phenolics (mg/g)**	**Total Flavonoids (mg/g)**	**Cardiac Glycoside(mg/g)**
Sugar Cane	279.92 ± 3.66^a	95.90 ± 2.04^a	ND
Sugar Cane Biomass	255.65 ± 9.49^b	88.79 ± 1.33^b	57.51 ± 5.36^a

Values are presented as mean ± standard deviations of triplicate readings n=3. Values within the same column bearing different superscripts letters are statistically (p<0.05). while values with the same superscript letters are not significantly different ($p > 0.05$). ND = Not detected.

Phytochemical screening of sugarcane and sugarcane biomass of methanolic extract as shown in table 4.2 shows that sugarcane has total phenolic content of (279.92±9.49mg/g) this is higher than that of sugarcane biomass at (255.65±3.66mg/g) and total flavonoids content (95.90±2.04mg/g) higher than sugarcane biomass (88.79±1.33mg/g) with only sugarcane biomass having a total cardiac glycoside content of (57.51±5.36mg/g). This is in line with findings from Duarte-Almeida *et al.,* (2006), who reported high phenolic content in sugarcane extracts. Furthermore, Walaiporn *et al* (2021), reported that sugarcane biomass contained lower phenolic compounds compared to the plant itself, which corroborates our results showing that sugarcane biomass has less bio-active potential.

Result for Ferric Reducing Power (Frap) of Sugarcane and Sugarcane Biomass

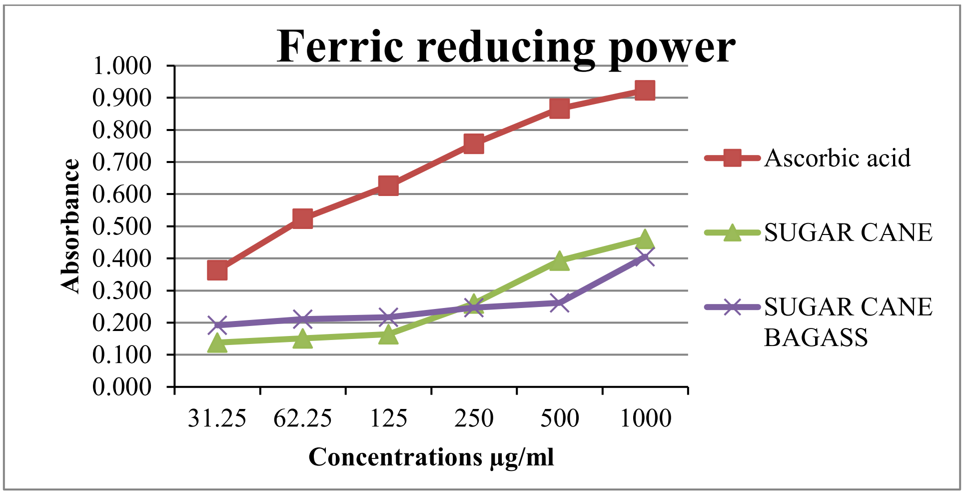

Figure 1.0. Ferric reducing antioxidant power of sugarcane and sugarcane biomass

In terms of Ferric reducing antioxidant power (FRAP) sugarcane exhibited higher antioxidant activity at Conc.1000.µg/ml with about 43% activity higher than the biomass which has about 39% at the same concentration, at Conc. 500.µg/ml sugarcane exhibit antioxidant power of about 40% higher than the biomass which exhibit about 28 % activity, at Conc.250µg/ml sugarcane exhibit antioxidant activity of about 25% similar to the sugarcane biomass, also at Conc.125.µg/ml sugarcane exhibit antioxidant activity of about 15% lower than the sugarcane biomass which has about 21%, at Conc.62.25µg/ml sugarcane exhibit antioxidant activity of 15% lower than the sugarcane biomass which has about 21%, at Conc.µg/ml 32.25% sugarcane exhibit lower antioxidant potential of 12% lower than the sugarcane biomass which has about 20%. At lower concentrations, sugarcane biomass demonstrated higher antioxidant activity than sugarcane, suggesting that some antioxidant compounds may remain strongly associated with the biomass matrix.

Result for DPPH Scavenging Activity of Sugarcane and Sugarcane Biomass

Table 3.0: Results for DPPH Radical Scavenging Activity of the Sugar Cane and Sugarcane Biomass

Sample	IC_{50} (µg/ml)
Sugar Cane Biomass	1243.64 ± 8.03^{a}
Sugar Cane	774.28 ± 5.60^{b}
Ascorbic acid Standard	8.39 ± 0.39^{c}
Values are presented as mean ± standard deviations of triplicate readings (n=3). Values within the same column bearing different superscripts letters are statistically (p<0.05) difference	

The DPPH radical scavenging assay was used to evaluate the antioxidant capacity of sugarcane and sugarcane bagasse extracts. The DPPH antioxidant activity was expressed as IC_{50} values, which represent the concentration of extract required to inhibit 50% of DPPH free radicals. A Lower IC_{50} value indicates stronger antioxidant activity, because 50% radical inhibition is achieved with a smaller amount of extract. The results showed significant differences ($p < 0.05$) in the DPPH scavenging activity among sugarcane, sugarcane biomass, and the ascorbic acid standard. The ascorbic acid standard exhibited the strongest antioxidant activity with the lowest IC_{50} value (8.39 ± 0.39 µg/ml), confirming its high radical scavenging efficiency. Among the plant samples, sugarcane demonstrated significantly higher antioxidant activity than sugarcane biomass, with an IC_{50} value of 774.28 ± 5.60 µg/ml, while sugarcane biomass recorded a higher IC_{50} value of 1243.64 ± 8.03 µg/ml. The higher IC_{50}

value of sugarcane biomass indicates weaker DPPH radical scavenging activity compared with sugarcane.

The stronger antioxidant activity observed in sugarcane may be associated with its higher concentration of bio-active compounds, particularly phenolic compounds and flavonoids. In the quantitative phytochemical analysis, sugarcane showed higher total phenolic content (279.92 mg/g) and total flavonoid content (95.90 mg/g) compared with sugarcane biomass (255.65 mg/g phenolics and 88.79 mg/g flavonoids). Phenolic compounds are effective hydrogen donors and electron donors, enabling them to neutralize free radicals such as DPPH.

Although sugarcane biomass showed lower antioxidant activity, its considerable radical scavenging ability suggests that it retains valuable phytochemicals within the fibrous matrix. The antioxidant properties of sugarcane by-products have been attributed to the presence of bound phenolic compounds associated with cellulose, hemicellulose, and lignin fractions. These observations are similar with previous studies that show sugarcane contains phenolic acids and flavonoids responsible for antioxidant activity. Duarte-Almeida *et al.* (2006) reported significant antioxidant activity of sugarcane-derived products due to their phenolic constituents. Similarly, findings reported by Payet *et al.* (2006) and also Walaiporn *et al* (2021), demonstrated that sugarcane products possess antioxidant potential associated with phenolic compounds. The higher antioxidant activity of sugarcane is consistent with its higher phenolic and flavonoid contents. Phenolic compounds are known to reduce oxidative stress by donating hydrogen atoms or electrons to unstable free radicals. However, the antioxidant potential demonstrated by sugarcane biomass confirms that this by-product retains important bio-active compounds and thus should not be considered merely waste.

Results for the Proximate Composition of Sugarcane and Sugarcane Biomass

Table 4 present the proximate composition and some selected mineral composition of sugarcane and sugarcane biomass.

The analysis includes parameters such as (moisture, ash, fiber, fat, protein, and carbohydrate content). These results help to understand the compositional differences between raw sugarcane and sugarcane biomass, which is essential for industrial and agricultural applications.

Table 4.0: Proximate Compositions (%) of Sugar-cane and Sugarcane Biomass

Parameter	Sugacane Biomass	Sugarcane
Moisture	1.14 ± 0.04^{a}	2.41 ± 0.34^{b}
Ash	5.09 ± 0.01^{b}	6.89 ± 0.04^{a}
Fiber	26.01 ± 0.02^{a}	19.19 ± 0.02^{b}
Fat	0.23 ± 0.04^{b}	1.52 ± 0.64^{a}
Protein	0.03 ± 0.01^{b}	0.42 ± 0.01^{a}
Carbohydrate	79.34 ± 6.96^{a}	62.75 ± 0.96^{b}

All values are expressed as mean ± standard deviation of triplicate determinations (n = 3). Means within the same row with different superscript letters (^{a}, ^{b}) differ significantly at $p < 0.05$ according to one-way analysis of variance (ANOVA). Means sharing the same superscript letter are not significantly different.

Discussion on Proximate Analysis

Moisture Content:

The moisture content of sugarcane biomass was recorded as 1.14±0.04%, whereas sugarcane exhibited a significantly higher moisture content of 2.41±0.34%. The difference between the two is statistically significant ($p<0.05$), indicating that sugarcane retains more water compared to its biomass. Moisture content is crucial in determining the shelf life and processing efficiency of agricultural products, with lower moisture contents often leading to decreased degradation and susceptibility to microbial activity. Previous research on fresh sugarcane reports a moisture content, which is significantly higher than in processed sugarcane biomass, indicating the substantial reduction in moisture during processing (White *et al.*, 2011). this is also similar to previous studies conducted by Pandey *et al.*, 2000. Thus low moisture content is indicative of extended shelf life and its suitability as a bio-fuel sources.

Ash Content

Ash content represents the total mineral composition of a sample. The ash content in sugarcane biomass (5.09±0.01%) was lower than that of sugarcane (6.89±0.04%). The significant difference ($p<0.05$) suggests that sugarcane contains a higher concentration of mineral residues after combustion. A higher ash content typically implies a greater presence of appreciable minerals, which may contribute to nutritional benefits in sugarcane-derived products. The findings are similar to previous researches conducted by Rezende *et al.* (2011); they reported that sugar cane products are found to contain high concentration of essential minerals.

Fat Content

The fat content in sugarcane biomass was found to be 0.23±0.04%, significantly lower than in sugarcane (1.52 ± 0.64%). This indicates that sugarcane contains more lipophilic compounds, which may contribute to its energy content and flavor profile. While fat content in sugarcane is generally low, it can influence certain metabolic and nutritional properties in its processed products (Ima, *et al.,*2016). The low-fat content is consistent with the nature of sugarcane as a carbohydrate rich crop, the low lipid content is advantageous due to its reduced risk of oxidative rancidity during storage and enhanced suitability of biomass for fermentation.

Crude Fibre Content

Sugarcane biomass exhibited a significantly higher fiber content (26.01±0.02%) compared to sugarcane (19.19±0.02%). The significant difference ($p<0.05$) suggests that sugarcane biomass contains more structural carbohydrates, which are crucial for biofuel production and dietary fiber applications. Fiber plays a vital role as a dietary fiber enrichment source and is a valuable livestock animal feed and industrial applications. The higher fiber in biomass makes it suitable for bio-fuel production, bio-degradable, composites and paper manufacturing (Hassan *et al.,* 2005). This result is expected because sugarcane biomass consists primarily of fibrous materials such as cellulose, hemicellulose, and lignin. The results are consistent with findings reported by Sun and Tomkinson (2002), who described sugarcane biomass as a ligno-cellulosic material rich in structural carbohydrates suitable for industrial applications.

Protein Content

Sugarcane biomass was found to contain negligible amount of protein at 0.03 ± 0.01% protein, whereas sugarcane had a significantly higher protein content of 0.42 ± 0.01% ($p<0.05$). This suggests that sugarcane contains slightly more protein than biomass, though the overall protein content is very low. This research findings is consistent with previous studies where sugarcane biomass was found to contains lower protein than sugarcane, this can be due to the predominance of structural fibre (Canilha 2012). The lack of protein in suggests it might contain small amounts of enzymes, amino acids, or other nitrogen-containing compounds. Biomass low protein level, indicates its unsuitability as a primary protein source for food production. However, sugarcane slightly higher protein makes it marginally more nutritious in human and animal diets. The low protein in biomass means it can be used in non-food industries like paper production or biofuel without protein degradation concerns (Sarmento, *et al.*, 2001).

Carbohydrate Contents

Carbohydrates are the predominant component in both sugarcane biomass and sugarcane. Sugarcane biomass contained a significantly higher carbohydrate percentage (79.34 ± 6.96%) compared to sugarcane (62.75 ± 0.96%) ($p<0.05$). This is an indication that both sugarcane and sugarcane biomass have high carbohydrate content, with sugarcane biomass having slightly more carbohydrates content than sugarcane. Carbohydrates mainly include sugars (sucrose, glucose, fructose) and structural polysaccharides (cellulose, hemicellulose).

Sugarcane's carbohydrates are primarily in the form of sucrose, making it a valuable crop for sugar production. High carbohydrate content makes sugarcane an excellent raw material source of sugar and ethanol. High carbohydrate content makes sugarcane an excellent raw material for sugar and ethanol production. Sugarcane biomass, with its structural carbohydrates which include cellulose, hemicellulose and possibly lignin. These structural carbohydrates have several useful applications such as cellulose are useful for bio-fuel production, and hemicellulose can be converted into ethanol. Lignin into fuels and well-defined chemicals with a wide range of applications; pharmacological applications. The presence of carbohydrates in both suggests they can be used for fermentation, biogas generation, and industrial starch production (Danielle, *et al*., 2014).

Results for Some Selected Mineral Composition of Sugarcane and Sugarcane Biomass

Table 5.0: The results for mineral composition in (mg/l) of sugarcane and sugarcane biomass

Minerals (mg/L)	Sugarcane	Sugarcane biomass
Ca	14.10 ± 0.03^{a}	10.18 ± 0.03^{b}
Fe	5.59 ± 0.17^{a}	3.82 ± 0.03^{b}
K	203.70 ± 0.84^{b}	207.50 ± 0.24^{a}
Mg	1.264 ± 0.020^{b}	1.310 ± 0.012^{a}
Mn	0.204 ± 0.002^{a}	0.127 ± 0.010^{b}
Na	56.67 ± 0.15^{a}	56.12 ± 0.30^{a}
All values represent mean ± standard deviation of triplicate determinations readings. Values with different superscript within a column indicate a significant difference between the groups ($p<0.05$)		

Discussion on Mineral Analysis

The mineral composition analysis revealed that both sugarcane and sugarcane biomass contained appreciable amounts of essential minerals, including calcium (Ca), iron (Fe), potassium (K), magnesium (Mg), manganese (Mn), and sodium (Na). Statistical analysis showed significant differences ($p < 0.05$) in the concentrations of Ca, Fe, K, Mg, and Mn between the two samples, whereas sodium content did not differ significantly ($p > 0.05$). These findings indicate that processing sugarcane into biomass influences the distribution and retention of certain minerals.

Calcium (Ca)

The calcium concentration in sugarcane and sugarcane biomass was determined to be 10.18 ± 0.028 and 14.10±0.026, respectively, with sugarcane biomass having the higher value. A significant difference ($p<0.05$) was observed between sugarcane and sugarcane biomass. Comparing the two, it is evident that sugarcane biomass contains more calcium than sugarcane. Calcium is a crucial macro-nutrient for humans, accounting for about 2 % of body weight in an adult (Petrovich *et al.,* 2007). It plays a pivotal role in bone and tooth formation, is essential for blood clotting, and is required for muscle contraction and maintaining a steady heartbeat (Petrovich *et al.*, 2007). and nerve transmission, it is an essential component of plant cell wall stability (Bettani *et al.*, 2024). This is an indication that sugarcane biomass can have possible pharmacological applications.

Iron (Fe)

The iron concentration in sugarcane and sugarcane biomass was found to be 5.586±0.172 and 3.815±0.0314, respectively. A significant difference ($p<0.05$) was noted, with sugarcane containing a higher concentration of iron than sugarcane biomass. This suggests that some iron may be lost or less accumulated in the biomass stage. Since iron is essential for hemoglobin formation and oxygen transport in the body, sugarcane appears to be a richer source of iron compared to the sugarcane biomass. This variation may be due to differences in processing or mineral redistribution within the plant during biomass formation (Singh *et al*., 2011). Sugarcane can serve as a rich source of dietary iron used in preventing iron deficiency anemia.

Potassium (K)

The potassium concentration in sugarcane and sugarcane biomass was found to be 203.7±0.84 and 207.5±0.24, respectively. The results show that sugarcane biomass contains slightly more potassium than sugarcane, though the difference is not much this is an indication higher potassium retention in sugarcane biomass. Potassium is vital for plant metabolism, enzyme activation, muscle contraction, nerve impulse transmission, electrolyte balance and osmo-regulation (Evelyn *et al.,* 2021; Souza, *et al.,*2019). The higher potassium content in sugarcane biomass suggests that potassium is well-retained in the biomass phase, this is an indication that sugarcane biomass is a slightly better source of potassium than raw sugarcane.

Magnesium (Mg)

The magnesium concentration in sugarcane and sugarcane biomass was 1.264 ± 0.0149 and 1.306±0.012, respectively. A slight increase in magnesium concentration was observed in sugarcane biomass compared to sugarcane. Magnesium plays a critical role as a co-factor in enzyme function, energy production, carbohydrate, metabolism, protein synthesis, DNA synthesis, and muscle contraction (Ibrahim *et al*., 2022; Bettani et al., 2024). The results indicate that magnesium is retained or slightly enriched in the biomass stage, making sugarcane biomass a valuable source of this essential mineral. The higher magnesium concentration in sugarcane biomass is an indication of its potential value for agricultural and biotechnological applications (Bettani *et al.*, 2024).

Manganese (Mn)

Manganese concentration in sugarcane and sugarcane biomass was determined to be 0.204±0.002 and 0.127±0.0073, respectively. Manganese is essential for enzyme activation and bone formation and development (Allen *et al*., 2006), enzyme antioxidant activity, carbohydrate metabolism an essential component of plant physiology and human nutrition. The decrease in manganese content in sugarcane biomass suggests possible mineral redistribution during biomass processing. The results indicate that sugarcane has a higher manganese content compared to sugarcane biomass (Bettani *et al.*,2024).

Sodium (Na)

The sodium concentration in sugarcane and sugarcane biomass was found to be 56.67±0.152 and 56.12±0.298, respectively. The results suggest that there is no significant difference in sodium concentration between sugarcane and sugarcane biomass. Sodium is vital for maintaining fluid balance, nerve function, and muscle contraction. (Petrovich *et al.*, 2007). Therefore, both sugarcane and sugarcane biomass can serve as comparable sources of sodium.

The results indicate both sugarcane and sugarcane biomass to be valuable sources of essential minerals. Although sugarcane biomass was shown to relatively retain higher concentration of magnesium and potassium. Sugarcane exhibited slightly higher concentration of calcium, iron, manganese.

Although sugarcane biomass showed reduced levels of some nutrients and phytochemicals compared with sugarcane, it retained considerable amounts of minerals, fibre, carbohydrates, phenolics, and antioxidant compounds. The presence of cardiac glycosides and antioxidant activity further indicates its potential for value-added applications.

Thus, indicating their potential uses in various industries as bio-value added products with numerous applications in husbandry (animal feed), agriculture (bio-fertilizer) and bio-process engineering (bio-refinery). the presence of nutritionally viable minerals and is an indication of the importance, viability and potential uses as an agro-industry plant with potential pharmacological uses as a sustainable bio product.

CONCLUSION

The study concluded that that sugarcane and sugarcane biomass possess significant nutritional, mineral, phytochemical, and antioxidant properties. Sugarcane is not only a valuable food crop but also has possible industrial potential through its biomass. Sugarcane is an excellent source of carbohydrates and minerals which are beneficial to human nutrition, while sugarcane biomass can be utilized as a valuable agricultural by-product rather than waste. Its high fibre content, mineral composition, and presence of bio-active compounds make it a promising material for food, agricultural, pharmaceutical and industrial applications, contributing to sustainable utilization of sugarcane processing residues. Sugarcane byproducts should be efficiently utilized to promote cost effective, economic and environmentally sustainable bio-product.

REFERENCES

- Abbas, K., Rashid, M.I., and Ahmed, Z. (2018). antioxidant potential of sugarcane leaf extract using DPPH assay. *Journal of Agricultural Sciences 45(10,65-72.*
- Adeleke, A. A., Petrus, N., Ayuba, S., M. Yahya, A., P. Ikubanni, P., S. Okafor, I. Adebayo I.O. and Ademidun, A.A (2023). Nigerian Biomass for Bio-energy Applications: A Review on the Potential and Challenges. *Journal of Renewable Materials, 11,* 4123-4141. https://doi.org/10.32604/jrm.2023.043915
- Akram, R., Farooq, U., Usman., M., Ahmad, S., Batool, A., Firdous,N., Saleem, H., Tufail, T., Saeed, F., Huma, Bader U.l and Ansar Rasul Suleria, H.(2023). Ain. "of Sugar Industry Waste Products." *Importance of Plant Based Byproducts: Nutritional and Functional Properties*: 289. https://doi.org/10.1007/978-3-032-03503-5_11
- Alhassan, M. (2021).Sugarcane:Fascinating Guide to Start Your SugarcaneFarm.*http://agriculturenigeria.com/sugarcane*
- Allen, M. J. and Sharma, S., (2019). Magnesium update 2019 Apr-4 ln Statpearls Treasure Island. [FL): *Stat pearl publishing*.
- AOAC. (2016). Association of official analytical chemists, official methods of analysis. 18. Washington, DC: *AOAC International*; 2016. [Google Scholar]
- Aryal, S., Baniya, M. K., Danekhu, K., Kunwar, P., Gurung, R., and Koirala, N. (2019). Total phenolic content, flavonoid content and antioxidant potential of wild vegetables from Western Nepal. *Plants*, *8*(4), 96.
- Aiyegroro O.A, and Okoh, A.I. Preliminary phytochemical screening and in vitro antioxidant activities of aqueous extract of *Helichrysum longifolium* DC. *BMC Compl And Alt Med* 2010; 10: 21.
- Bettani S.R, Borges, M.T., Soares, M.R, Liska, G. R and Rodrigues C.E.D.C. (2024). Relationship between the mineral content of sugarcane and its genuine derivative, non-centrifugal raw cane sugar. *Food Res Int*. 2024 Sep; 192:114783. doi: 10.1016/j.foodres.2024.114783. Epub 2024 Jul 15. PMID: 39147532.
- Canilha, L., Chandel, A. K., Dos Santos Milessi, T. S., Antunes, F. A. F., Luiz da Costa Freitas, W., Das Graças Almeida Felipe, M., and Da Silva, S. S. (2012). Bio-conversion of sugarcane biomass into ethanol: An overview about composition, pre-treatment methods, detoxification of hydrolysates, enzymatic saccharification, and ethanol fermentation. *Journal of Bio-medicine and Biotechnology, 2012, 989572.*
- Danielle., S.Cr Browski, Ana palva, putarelo Arin, Zandona Funo, Kung peneira ramie (2011). Sugarcane biomass for bio-refineries: A comparative composition of carbohydrate and non-carbohydrate compound o bagasse and straw 114:95-101.
- Duarte-Almeida, J. M., Novoa, A.V., Linares, A.F., Lajolo, F. M., and Genovese, M.I, (2006). Antioxidant activity of phenolic compounds from sugarcane(sa) Juice. *Plant Foods for Human Nutrition, 61(4), 187-192*
- Evelyne, N., Gikundi, Daniel, N., Sila, Irene, N., Orina, and Ariel, K. B., (2021). Nutritional and Physico-chemical properties of selected Irish potato varieties grown in Kenya. *African Journal of Food Science*. Vol. 15(1) pp. 10-19.
- FAO (2022). - Food and Agriculture Organization of the United Nations, Crops and Livestock Products, FAOSTAT, 2022. https://www.fao.org/faostat/en/.
- Feng, S., Luo, Z., Zhang, Y., Zhong, Z., and Lu, B. (2014). Phytochemical contents and antioxidant capacities of different parts of two sugarcane (Saccharum officinarum L.) cultivars. *Food Chemistry,* 151 , 452–458.
- Gbadeyan, O. J., Alabi, O.D., Dube, L., and Tshapha, L. (2024). *Valorization of Biomass Waste Materials, a Bio-refinery Concept* (2024): 85.
- Gupta, A., and Verma, J.P., (2015). Sustainable bio-ethanol production from agro-residues: a review. *Renew. Sust. Energy Rev*. 41, 550–567.
- Hassan, L. G., Umar, K. J., Abdullahi, S., and Mohammed, A.S., (2005b). Proximate composition and physico-chemical properties of seed and oil of *Cassia siamea*. Bull. *Sci. Assoc. Niger.* 26: 373-380.
- Ibrahim, A. M., Tasi'u, A. M., Abdulmumin, Y., Sadiya, A. B., Maimuna, M. D., Hassan, L. G., Umar, K. J., Abdullahi, S., and Mohammed, A.S., (2005b). Proximate composition and Physicochemical properties of seed and oil of Cassia siamea. Bull. *Sci. Assoc. Niger.* 26: 373-380.
- Isikgor, F.H., and Becer, C. R., 2015. Lignocellulosic biomass: a sustainable platform for

the production of bio-based chemicals and polymers. *Polym. Chem.* 6, 4497–4559.

- Koraspati Kasapidou, E., Sossidou, E. and Mitlianga, P. (2018) Fruit and vegetable co-products as functional feed ingredients in farm animal nutrition for improved product quality. *Agriculture,* 5, 1020–1034
- Ima, I.O., Ibanga, D.E and Okon, (2016). Minerals and anti-nutrients in two varieties of African pears (*Dacryodes edulis*). *Journal of food technology* 7(4:)106-110
- Mustafa, G., Arshad, M., Bano, I. and Abbass, M.*(2023).* Biotechnological applications of sugarcane bagasse and sugar beet molasses. *Biomass Conv. Bioref.* **13**, 1489–1501 (2023). https://doi.org/10.1007/s13399-020-01141-x
- Menon, V., and Rao, M., (2012). Trends in bio-conversion of lignocellulose: biofuels, platform chemicals and biorefinery concept. Prog. *Energy Combust. Sci.* 38, 522–550.
- Oluduro,O.A., Idowu, T.O., Aderiye, B. I., Famuriwa,O., and Omoboye, O.O. (2012). Evaluation of antibacterial potential of crude extract of *Moringa oleifera* seed on orthopedic wound isolates. *Research Journal of medicinal plant* 6(5),383-394.
- Oleszek, M., Kowalska, I., Bertuzzi, T., and Oleszek, W. (2023). Phytochemicals derived from agricultural residues and their valuable properties and applications. *Molecules*, *28*(1), 342.
- Pandey, A., Soccol, C. R., Nigam, P., and Soccol, V. T. (2000). Biotechnological potential of agro-industrial residues. I: Sugarcane bagasse. *Bioresource Technology,* 74(1), 69–80.
- Petrovich, M.B., Filho, V. R and Neto J.A. (2007). Direct determination of Calcium in milk by atomic absorption spectrometry using flow-injection analysis *J. Ecle. Quí.* 32(3):2-5.
- Rabiu, Z., Mahmud, K.N., Hasham, R., and Zakaria, A. Z.(2019). Characterization and Antioxidant Properties of Ethyl-acetate Fractions from Pyroligneous acid obtained by Slow Pyrolysis of Palm Kernel Shell. *Malaysian Journal of Fundamental and Applied Science.* 15(5): 644-650
- Rungjang, W., Liengprayoon, S., Sunthornvarabhas, J., and Sriroth, K. (2022). Screening of the phenolic compound and antioxidant activity from sugar process. *Trends in Sciences*, *19*(2), 2057-2057.
- Rezende, C. A., De Lima, M. A., Maziero, P., De Azevedo, E. R., Garcia, W., and Polikarpov, I. (2011). Chemical and morphological characterization of sugarcane bagasse submitted to a delignification process for enhanced enzymatic digestibility. *Biotechnology for Biofuels,* 4, 54.
- Sahrawat A., (2000). Evaluation of mineral elements in potatoes*. Journal of triple acid digestion in elemental analysis.* Vol 2: 29-30.
- Sahu, O. (2018). Assessment of sugarcane industry: suitability for production, consumption, and utilization, Ann *Agrar Sci.* 16 , 389–395.
- Sarmento P., Garieia. B, and Pires, A.J., (2001). Soybean grain as urease source of the sugarcane bagasse amoniation with urea. *Science agriculture* 58(2):223-227.
- Singh, R., Kumar, M., and Patel, A. (201). Sugarcane bagasse. A promising biomass for bio-ethanol production. *Bioresource Technology,*256,112-120.
- Singh, A., Srivastava, R. N., Gupta, A. K., and Sharma, M. L. (2011). Effect of sulphur and iron nutrition on the yield and juice quality of sugarcane (*Scharaum officinarum* L.).
- Singh, R., Kumar, D., and Patel, S., (2019). Iron distribution and its role in hemoglobin formation and oxygen transport in plants. *Plant Mineral Studies,* 15(4), 289-301.*Pharmacogn. Rev.* 9 (2015), doi:10.4103/0973-7847.156340.
- Sofowora A.(1993). Recent trends in research into African medicinal plants. *J Ethnopharmacol.* 1993; 38:209–214. doi: 10.1016/0378-8741(93)90017-Y. [DOI] [PubMed] [Google Scholar]
- Souza, S. O., Silvério, S. L., Costa, B. C.T. Brum, S. H., Santos, Carlos Alexandre B. Garcia, Geovanny, R. O. and Araujo, (2019). Determination of nutrients in sugarcane juice using slurry sampling and detection by ICP OES, *Food Chemistry*, Volume 273, 2019, Pages 57-63, ISSN 0308-8146, https://doi.org/10.1016/j.foodchem.2018.03.060.
- Trease, G. E, and Evans, W. C (1989). *Pharmacognosy*. Bailliere Tindall, London, United Kingdom.
- White J. E., Catallo, W. J and Legender, B. L., (2011). Biomass Pyrolysis. A comparative critical review with relevant agricultural residue *Journal of anal application pyrolysis* 9:1-33.