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Phytochemicals and *In vitro* antioxidants screening of aqueous unripe fruits extract of *Musa acuminate*

Zayyanu Abdullahi [1,*], Shamsu Nasiru [1], Usman Abubakar [1], Isah Musa Fakai [2] and Jude Nwaogu [2]

[1] *Biochemistry Unit, Department of Science Technology, Waziri Umaru Federal Polytechnic, Birnin Kebbi, Nigeria.*
[2] *Department of Biochemistry, Faculty of Life Science, Kebbi State University of Science and Technology, Aleiro, Kebbi State, Nigeria.*

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Abstract

Musa acuminata remains an essential fruit and its consumption has been increased due to its nutritional content and medicinal properties. This study aims at evaluating the phytochemicals constituents and antioxidants properties of aqueous unripe fruits extract of *Musa acuminata*. The phytochemicals constituents were detected using standard tests methods. The total flavonoids and phenolic contents were determined using folic-ciocalteau method. Free radical scavenging activity and ferric reducing power of the extract was evaluated using 1, 1-diphenyl-2-picryl-hydrazyl (DPPH) and ferric reducing antioxidant power (FRAP) method. The results revealed that the extract contained significant amount of flavonoids (11.37 %), glycosides (9.27 %), alkaloids (7.04 %), tannins (5.88 %), cardiac glycosides (4.61 %), saponins (3.40 %), and steroids (1.07 %). The extract exhibited significant amount of total flavonoids (201.31 mg/g) and total phenolics (452.55 mg/g) content. The extract demonstrated high DPPH free radical scavenging activity of 19.81 %, 32.33 %, 44.81 %, 59.70 %, and 79.54 % at 100 µg/ml, 200 µg/ml, 300 µg/ml, 400 µg/ml, and 500 µg/ml, respectively. The extract showed significant ferric reducing antioxidant power of 221.67 µmol/g, 255.84 µmol/g, 450.96 µmol/g, 543.86 µmol/g, and 681.14 µmol/g at 100 µmol/L, 200 µmol/L, 300 µmol/L, 400 µmol/L, and 500 µmol/L, respectively. The aqueous unripe fruits extract of *Musa acuminate* contains significant amount of phytochemicals, total flavonoids and phenolic compounds and demonstrated high DPPH free radical scavenging activity and ferric reducing antioxidant power.

Keywords: Antioxidants; *Musa acuminate*; Phenolics; Phytochemicals; Total flavonoids

1. Introduction

Plants including fruits have been consuming as foods and for the treatment of many diseases especially in local communities. Almost 80% of people in the world and 95% of people in low and middle income countries relied on plants for remedies [1]. Medicinal properties and pharmacological activities of plants could be attributed to their various phytochemicals [2-4]. Phytochemicals are bioactive compounds that demonstrate antioxidants properties [5] and several pharmacological activities [6]. Phytochemicals are naturally present in different parts of plant including leaves, stem, fruits, root, flower, bark, and peel [7]. Plants phytochemicals exhibited pharmacological properties and have been used in drugs discovery and development [8]. The health-promoting and disease-preventing properties of plant phytochemicals increase the interest of researchers in investigating their functional properties.

Musa acuminate, commonly called Bananais a tropical native plant belonging to *Musaceae* family [9]. *Musa acuminata* is the fourth most important food substance in the world [10]. The demand of banana has increased worldwide with more than 125 million tons production every year [11]. The plant has nutritional importance and demonstrates many medicinal, antioxidants and pharmacological properties [12-14]. The plant has been used in treatment of various

* Corresponding author: Zayyanu Abdullahi

diseases including diabetes, hypertension, cancer, ulcers, diarrhoea, urolithiasis, infections, constipation, piles, and hemorrhoids [12, 15]. Different parts of banana have been used in treatment of menorrhagia, oxidants, dysentery, renal lithiasis, mutagenesis, liver disorder, hypocholesterolemic, hemorrhage, parasitic infections, hair growth promoter, wound, inflammation, pain, wound, blood clotting, and snakebite [6, 16-18]. The leaves been consumed for management of inflammatory disorders and tumor growth [19, 20]. The peel has been used in curing skin irritations, such as bites and warts [21]. The fruit is commonly consumed to manage blood pressure and diabetes [22, 23]. The roots are decocted and consumed during menstruation as a contraceptive measure [24].

In Nigeria, *Musa acuminata* is called Ayaba in Hausa, Unele in Igbo, and Ogede wewe in Yoruba and is abundantly available in almost every parts of the country. *Musa acuminata* have been used in many local communities in Nigeria for the management of several disorders including high sugar level, high blood pressure, tumor growth, gastrointestinal disorders, diarrhoea, urolithiasis, Alzheimer's and bacterial, fungi, parasitic and viral infections [12]. Local herbalists in different areas in all the regions of the country used the opportunities of medicinal properties of *Musa acuminata* to boost their business through selling different parts of the plant. The aim of this study was to evaluate the phytochemicals constituents and antioxidants properties of aqueous unripe fruits extract of *Musa acuminata*.

2. Material and methods

2.1. Collection and Identification of the Plant Sample

The unripe fruits of *Musa acuminata* were obtained from the Prof. Attahiru's farm, at Sokoto Road, Birnin Kebbi, Kebbi State, Nigeria. The fruit sample was authenticated (KSUSTA/PSB/VOUCHER51) at Herbarium Unit, Department of Plant Science and Biotechnology, Kebbi State University of Science and Technology, Aliero, Kebbi, Nigeria.

2.2. Extract Preparation

Preparation of the plant extract was done using the method of Abubakar et al. [3]. The fruits sample were washed and then dried in a ventilated room for fourteen days. The dried samples were grinded to powder using an electric blender. The fruits powder (732 g) was extracted in distilled water (2 L) for 72 hours. The extract was filtered, dried in oven, and then weighed (39 g) with percentage yield (5.3 %).

2.3. Qualitative Phytochemicals Screening

2.3.1. Detection of Alkaloids

Alkaloids in the aqueous unripe fruits extract of *Musa acuminata* were detected using Wagner's test method as described by Trease and Evans [25] and Abubakar et al. [4, 26]. Three miles of extract was treated with three miles of 1% HCl. The contents were heated for twenty minutes, cold, and then treated with one mole of Wagner's reagent. A reddish-brown precipitate indicated the presence of alkaloids.

2.3.2. Detection of Flavonoids

Sodium hydroxide test was employed for the determination of flavonoids in the aqueous unripe fruits extract of *Musa acuminata* using the method of Mosa et al. [27] and Ibrahim et al. [28]. One mile of 10% NaOH solution was added into the test tube containing three miles of the extract. Development of yellow colour showed the presence of flavonoids.

2.3.3. Detection of Tannins

Tannins presence in the aqueous unripe fruits extract of *Musa acuminata* were screened using Ferric chloride test as described by Trease and Evans [25] and Ibrahim et al. [28]. Two miles of 5% Ferric chloride solution was added in drops into the test tube containing two miles of the extract. Dark green color observed showed the presence of tannins.

2.3.4. Detection of Steroids

The qualitative screening of steroids in the aqueous unripe fruits extract of *Musa acuminata* was performed according to the method of Trease and Evans [25] and Ibrahim et al. [28]. The extract (0.5 mL) was transferred into a test tube. Five miles of chloroform and conc. H_2SO_4 were into the test tube. A violet colour which changed to blue-green showed the presence of steroids.

2.3.5. Detection of Saponins

The presence of saponins in the aqueous unripe fruits extract of *Musa acuminata* was detected using Froth test as described by Mosa et al. [27] and Trease and Evans [25]. Three miles of the extract was transfered into the test tube followed by addition of 3 mL of distilled water, vigorously shaken for half minute, and allowed to stand for half hour. The appearance of froth for several minutes showed the presence of saponins.

2.3.6. Detection of Glycosides

Glycosides in the aqueous unripe fruits extract of *Musa acuminata* were screened using Salkowski's test as described by Ibrahim et al. [28] and Abubakar et al. [4, 26]. The extract (5 mL) was treated with 5 mL of 1 % H_2SO_4 solution, boiled for 15 minutes and then allowed to cool. The contents were neutralized with 10% NaOH solution then treated with 5 mL of Fehling's solution A and B. A brick-red precipitate observed showed the presence of glycosides.

2.3.7. Detection of Cardiac Glycosides

The qualitative screening of cardiac glycosides in the aqueous unripe fruits extract of *Musa acuminata* was carried out using Keller-Killani test as described by Trease and Evans [25] and Aliyu et al. [2]. The extract (5 mL) was treated with 2 mL of 3.5% ferric chloride solution and then allowed to stand for sixty seconds. The mixture was treated with 2 mL of conc. H_2SO_4 solution. The formation of reddish-brown ring at the interface and the appearance of violet colour below the brown ring indicated the presence of cardiac glycosides.

2.3.8. Detection of Balsams

Balsams in the aqueous unripe fruits extract of *Musa acuminata* were screened according to the method described by Trease and Evans [25] and Aliyu et al. [2]. The extract (2 mL) was treated with 2 mL of methanol and 2 mL of 90 % ethanol. Two drops of alcoholic ferric chloride solution were added to the mixture. The development of dark green color indicated the presence of balsams.

2.3.9. Detection of Anthraquinones

Anthraquinones in the aqueous unripe fruits extract of *Musa acuminata* were sreened according to the method described by Trease and Evans [25]. The extract (0.2 g) was treated with 10 cm^3 of chloroform, vigorously shaken for 5 minutes and then filtered. The ammonia solution (10 mL) was added into the filtrate and then shaken for 5 minutes. The development of bright pink colour in the upper aqueous portion indicated the presence of anthraquinones.

2.4. Quantitative Determination of Phytochemicals

2.4.1. Determination of Alkaloids

The quantitative determination of alkaloids in the aqueous unripe fruits extract of *Musa acuminata* was performed according to the method described by Trease and Evans [25] and Ibrahim et al. [28]. The extract (5 g) was dissolved in methanol (100 mL) anf then evaporated to dryness. Twenty miles of 0.0025M sulphuric acid was added to the residue, the mixture was thoroughly shaken and then partitioned with ether. Strong ammonia solution was added to the aqueous portion obtained and then extracted many times with excess chloroform. The extract was dried in oven and the final alkaloid residue was weighed. The alkaloids content was obtained using the equation below:

$$\text{Alkaloids Content (\%)} = \frac{\text{Weight of alkaloids residue}}{\text{Weight of extract}} \text{X } 100$$

2.4.2. Determination of Saponins

The saponins content in the aqueous unripe fruits extract of *Musa acuminata* was estimated using the method of El-Olemyl et al. [29] and Ibrahim et al. [28]. The extract (5 g) was treated with 150 mL of 50% ethanol, boiled for 30 minutes and then filtered.The filtrate was treated with 1 g of charcoal, boiled for 30 minutes, filtered, and then cooled at room temperature. The filtrate was treated with 150 mL of acetone and the mixture was filtered. The filter paper was immediately transferred into the desiccator containing anhydrous $CaCl_2$ solution. The saponins residue was dried, weighed and saponins content was calculated using the following equation:

$$\text{Saponins content (\%)} = \frac{\text{Weight of saponins residue}}{\text{Weight of extract}} \text{X } 100$$

2.4.3. Determination of Flavonoids

The quantitative estimation of flavonoids in the aqueous unripe fruits extract of *Musa acuminata* was done according to the method described by Harborne [30] and Ibrahim et al. [28]. The extract (5 mg) was treated with 50 mL of 2M HCl solution, boiled for 25 minutes, cooled and then filtered. The ethylacetate (50 mL) solution was added to the mixture, filtered and then dried in oven. The flavonoids residue was weighed and the flavonoids content was calculated using the equation below:

$$\text{Flavonoids Content (\%)} = \frac{\text{Weight of flavonoids residue}}{\text{Weight of extract}} \text{X } 100$$

2.4.4. Determination of Tannins

The AOAC [31] method was employed for the quantitative determination of tannins in the aqueous unripe fruits extract of *Musa acuminata*. The tannic acid standard solution (10 mg tannic acid in 100 mL distilled water) of conc. 0 – 2.5 mg/mL was used for construction of standard curve. One gram of the dried extract was boiled in 80 ml of water for 30 minutes. The extract was treated with Folin-Denis reagent (2.5 mL) and sodium carbonate solution (1.25 mL). The mixture was incubated at room temperature for 30 minutes. The absorbance was read spectrophotometerically at 760 nm wavelength. The tannin content in the extract was obtained from the tannic acid standard curve.

2.4.5. Determination of Glycosides

Glycosides in the aqueous unripe fruits extract of *Musa acuminata* were quantitatively estimated using the method of El-Olemyl et al. [29] and Sofowora [32]. The extract (10 mL) was treated with 50 mL of chloroform, shaken for one hour and then filtered using Whatman filter paper. The pyridine (10 mL) and 2 mL of 2% sodium nitroprusside were added to the mixture with intense shaking for 10 minutes. The content was finally treated with 3 mL of 20% NaOH and then the absorbance was measured spectrophotometerically at 510 nm wavelength. The glycosides content was calculated using the following equation:

$$\text{Glycosides Content (\%)} = \frac{\text{A x AG x DF}}{\text{Weight of extract}} \text{X } 1000$$

Where;

- A =Absorbance of sample
- AG = Average gradient
- DF = Dilution factor

2.4.6. Determination of Cardiac Glycosides

The quantitative analysis of cardiac glycosides in the aqueous unripe fruits extract of *Musa acuminata* was conducted using the method of Solich et al. [33] and Aliyu et al. [2]. The prepared Baljet's reagent (95 mL of 1% picric acid + 5 mL of 10% NaOH) was added into the conical flask containing 10 mL of the extract. The content was diluted with 20 mL of distilled water and then allowed to stand for 1 hour for colour development. The absorbance was measured at spectrophotometerically at 495 nm. The standard curve was constructed from the prepared solution (12.5 – 100 mg/L). The cardiac glycosides content expressed in percentage was obtained from the standard curve.

2.4.7. Determination of Steroids

The aqueous unripe fruits extract of *Musa acuminata* was quantitatively analyzed for total steroids using the method of Trease and Evans [25] and Ibrahim et al. [28]. The extract (1 mL) was transferred into the conical flask followed by the addition of H_2SO_4 (2 mL) and $FeCl_2$ (2 mL) solution.The mixture was treated with 2 mL of potassium hexacynoferrate (III) solution and then incubated at 70 °C for half hour with constant shaking. The absorbance was measured pectrophotometerically at 780 nm wavelength. The steroids content was calculated using the formula below:

$$\text{Steroids content (\%)} = \text{Absorbance of sample} \times 100$$

A

2.5. Determination of Antioxidant Content

2.5.1. Estimation of Total Phenolics

The aqueous unripe fruits extract of *Musa acuminata* was analyzed for the total phenolic content using folic-ciocalteau method as described by Singleton et al. [34] and Abubakar et al. [35]. The extract (0.5 ml) was treated with 2.5 ml of 1N folin-ciocalteu and then incubated for five minutes at room temperature. The mixture was treated with 2 ml of 7.5 % sodium carbonate, diluted, and then incubated at room temperature for 120 minutes. The absorbance was read spectrophotometrically at 760 nm. The total phenolic content in the extract was obtained from the standard curve (2, 4, 6, 8, 10 µg/ml) constructed using gallic acid as standard and was expressed as mg GAE/g of the extract.

2.5.2. Estimation of Total Flavonoids

Determination of total flavonoids content of the aqueous unripe fruits extract of *Musa acuminata* was performed according to the method of Lamaison and Carret [36] and Abubakar et al. [35]. The calibration curve was constructed using Quercetin (12.5, 25, 50, 100 µg/ml) as standard. The extract (0.5 ml) was treated with 0.1 ml of 10% $AlCl_3$ solution and then incubated at room temperature for half hour. The absorbance was read at 415 nm wavelength and the total flavonoids obtained from the standard curve were expressed as mg QE/g of the extract.

2.6. Assessment of Antioxidant Capacities

2.6.1. DPPH Free Radical Scavenging Activity

Free radical scavenging activity of the aqueous unripe fruits extract of *Musa acuminata* was evaluated using 1,1-diphenyl-2-picryl-hydrazyl (DPPH) method as described by Gyamfi et al. [37] and Abubakar et al. [35]. The extract (2 ml) was treated with 1 ml of 0.3 mM DPPH solution followed by the addition of 100% ethanol. Two mile of 0.3 mM DPPH solution was added to 2 ml of distilled water in the blank tube and 2 ml of the ascorbic acid in the standard tube. The contents were mixed thoroughly, and incubated at room temperature for half hour. The absorbance of the extract and standard against the blank was read spectrophotometrically at 520 nm wavelength. The scavenging activity of the extract was obtained using the following equation:

$$\text{Percentage inhibition} = [(A_0 - A_1) / A_0] \times 100$$

Where:

A_0 is the absorbance of the control and A_1 is the absorbance of the sample/standard.

2.6.2. Ferric Reducing Antioxidant Power

The ferric reducing antioxidant power (FRAP) of the aqueous unripe fruits extract of *Musa acuminata* was analyzed according to the method of Benzie and Strain [38] and Ibrahim et al. [28]. The extract (1 ml) was treated with 2 ml of freshly prepared FRAP reagent (25 ml of 300 mM acetate buffer, 2.5 ml of 10 mM 2,4,6-tripyridyls-triazine, and 2.5 ml of 20 mM ferric chloride) at 100, 200, 300, 400, and 500 µmol/L. The contents were thoroughly mixed, and then incubated at 37 ◦ C for half hour. Ascorbic acid was used as standard and for constructing the standard curve. The absorbance of the extract and standard against the blank was read spectrophotometrically at 595 nm wavelength. The ferric reducing antioxidant power (FRAP) of the extract was obtained from the standard curve and expressed as µmol Fe^{2+} per gram of the extract.

2.7. Statistical analysis

The experiments were performed in triplicate and the results were analyzed using Statistical Package for Social Sciences (SPSS) version 22 software. The results were expressed as mean ± SEM and significant ($p< 0.05$) differences among the values were computed by One-way analysis of variance (ANOVA) at 95 % confidence level.

3. Results

3.1. Qualitative Phytochemicals Screening of the Aqueous Unripe Fruits Extract of *Musa acuminata*

Table 1 shows thephytochemicals present in the aqueous unripe fruits extract of *Musa acuminata*. The extract demonstrated the presence of high amount of alkaloids, flavonoids, glycosides,and tannins. Moderate amounts of

cardiac glycosides, steroids, andsaponins were found on the extract. Low amounts of anthraquinones and balsams were detected in the extract (Table 1).

Table 1 Qualitative Phytochemicals Screening of the Aqueous Unripe Fruits Extract of *Musa acuminata*

Phytochemical	Extract
Alkaloids	+++
Flavonoids	+++
Glycosides	+++
Cardiac glycosides	++
Steroids	++
Tannins	+++
Saponins	++
Anthraquinones	+
Balsams	+

+++ = High amount, ++ = Moderate amount, + = Low amount,

3.2. Quantitative Phytochemicals Composition of the Aqueous Unripe Fruits Extract of *Musa acuminata*

The quantitative phytochemicals composition of the aqueous unripe fruits extract of *Musa acuminata* is shown in Table 2. The extract contained high significant amount of flavonoids (11.37 %), glycosides (9.27 %), alkaloids (7.04 %), and tannins (5.88 %). However, significant amounts of cardiac glycosides (4.61 %), saponins (3.40 %), steroids (1.07 %) were observed in the extract (Table 2).

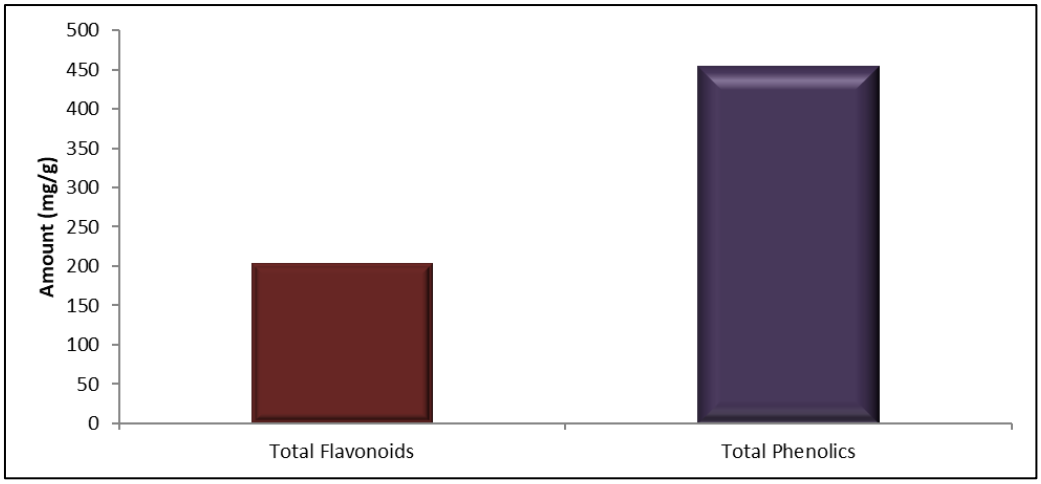
Table 2 Quantitative Phytochemicals Composition of Aqueous Unripe Fruits Extract of *Musa acuminata*

Phytochemical	Composition (%)
Alkaloids	7.04 ± 0.021
Flavonoids	11.37 ± 0.034
Glycosides	9.27 ± 0.031
Cardiac glycosides	4.61 ± 0.043
Steroids	1.07 ± 0.026
Tannins	5.88 ± 0.023
Saponins	3.40 ± 0.022

Results are expressed as mean ± SEM (n = 3)

3.3. Total Flavonoids and Phenolic Content of the Aqueous Unripe Fruits Extract of *Musa acuminata*

Figure 1 shows the total flavonoids and phenolic content of the aqueous unripe fruits extract of *Musa acuminata*. The extract exhibited significant amount of total flavonoids (201.31 mg/g) and total phenolics (452.55 mg/g) content (Figure 1).



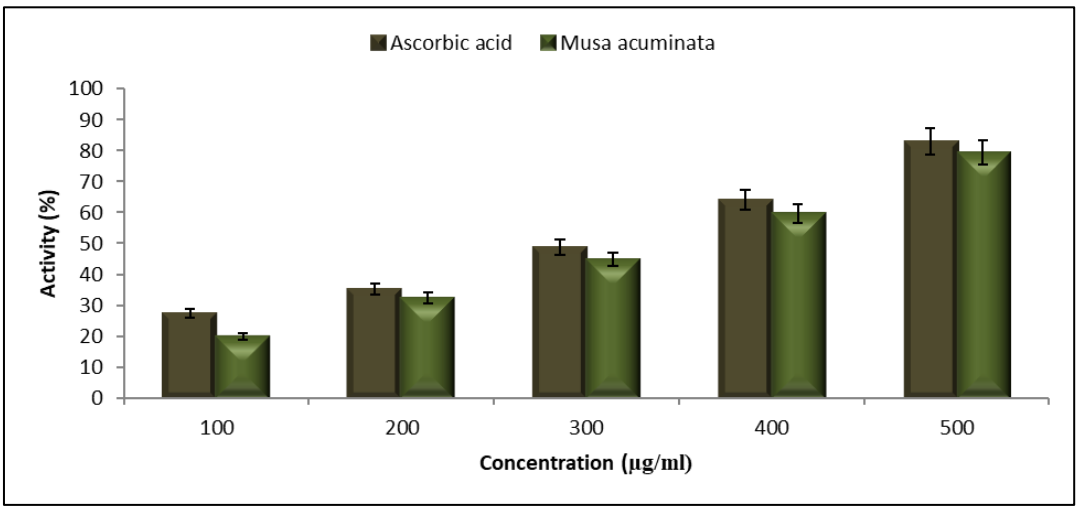
Data are expressed as mean ± SEM (n = 3)

Figure 1 Total Flavonoids and Phenolic Content of the Aqueous Unripe Fruits Extract of *Musa acuminata*

3.4. Antioxidant Capacities of the Aqueous Unripe Fruits Extract of *Musa acuminata*

3.4.1. DPPH Free Radical Scavenging Activity of the Aqueous Unripe Fruits Extract of Musa acuminata

The DPPH free radical scavenging activity of the aqueous unripe fruits extract of *Musa acuminata* is shown in Figure 2. The result showed that the extract and the standard (ascorbic acid) exhibited significant ($p < 0.05$) increase in DPPH free radical scavenging activity in concentration dependent manner (Figure 2). The extract showed high DPPH free radical scavenging activity (19.81%, 32.33%, 44.81%, 59.70%, and 79.54%) almost equivalent to that of the standard, ascorbic acid (27.24%, 35.05%, 48.76%, 64.01%, and 82.99%) at 100µg/ml, 200µg/ml, 300µg/ml, 400µg/ml, and 500µg/ml, respectively (Figure 2).

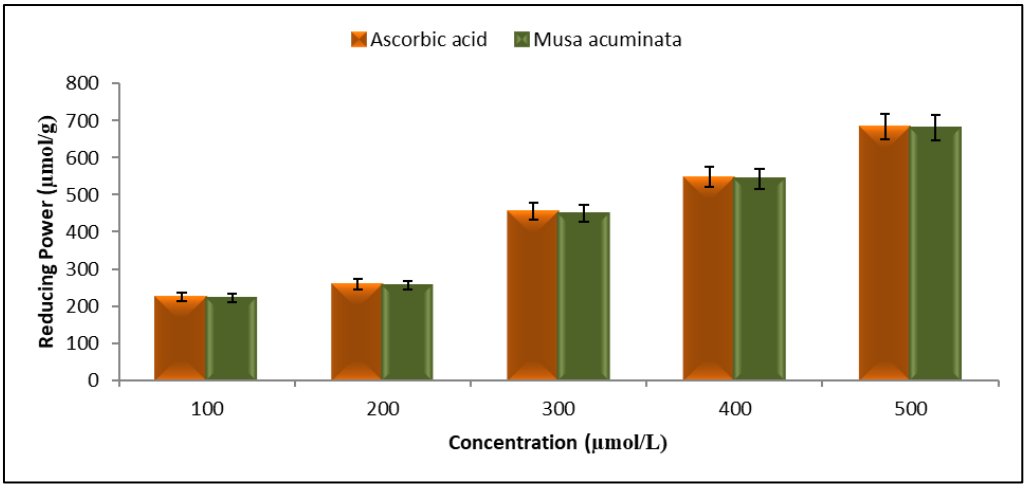


Values are expressed as mean ± SEM (n = 3).

Figure 2 DPPH Free Radical Scavenging Activity of the Aqueous Unripe Fruits Extract of *Musa acuminate*

3.4.2. Ferric Reducing Antioxidant Power (FRAP) of the Aqueous Unripe Fruits Extract of Musa acuminata

Figure 3 shows the ferric reducing antioxidant power of the aqueous unripe fruits extract of *Musa acuminata*. The ferric reducing antioxidant power of extract (221.67µmol/g, 255.84µmol/g, 450.96µmol/g, 543.86µmol/g, and 681.14µmol/g) and standard (ascorbic acid) (224.64µmol/g, 258.72µmol/g, 454.53µmol/g, 547.83µmol/g, and 685.01µmol/g) increased by increased in the concentrations (100µmol/L, 200µmol/L, 300µmol/L, 400µmol/L, and 500µmol/L) of the standard solution (Figure 3). However, the extract demonstrated significant ($p< 0.05$) ferric reducing antioxidant power closely equivalent to that of the ascorbic acid at all the concentration values (Figure 3).



Data are mean ± SEM (n = 3).2

Figure 3 Ferric Reducing Antioxidant Power (FRAP) of the Aqueous Unripe Fruits Extract of *Musa acuminata*

4. Discussion

In this study many phytochemicals including alkaloids, flavonoids, glycosides,tannins, cardiac glycosides, steroids, saponins, anthraquinones and balsams were detected in the aqueous unripe fruits extract of *Musa acuminate*. The results of this study were in agreement with the findings by Mathew and Negi [39] who observed the presence of phytochemicals such as flavonoids, phenols, and alkaloids in methanol, ethanol, and acetone extracts of the leaves of *M. acuminata*. Results of the similar studies showed a number of phytochemicals like saponins, terpenoids, steroids, tannins, phenols, and alkaloids, in the fruit, peel, flower, leaf, pseudostem, and rhizome of *M. acuminata* [40, 41]. Phytochemicals have been documented to demonstrated pharmacological activities [42]. Plant phytochemicals exhibited antioxidant, anti-inflammatory, anti-cancer, anti-viral, anti-diabetic, and anthelmintic [43-45]. Flavonoids exhibited anti-bacterial, antiviral, anti-inflammatory, anti-allergenic and hepatoprotective activities [46]. Alkaloids have anti-oxidants properties and serve important functions in ameliorating neurodegenerative disorders including Alzheimer's disease, Parkinson's disease, Huntington's disease, schizophrenia, epilepsy and stroke [47]. Sterols including stigmasterol, sitosterol, and campesterol isolated from the banana peels exhibited pharmacological properties [48].

This finding showed that the aqueous unripe fruits extract of *Musa acuminata* exhibited significant amount of total flavonoids and phenolics content. This findings agree with the results of studies by Sumathy et al. [49] and Daimari and Swargiary [50] who reported that *M. acuminate* contain high amount of total phenolics and total flavonoids content. Similar studies showed that banana rhizome contains phenolic compounds such as ferulic acid, sinapic acid, salicylic acid, gallic acid, p-hydroxybenzoic, vanillic acid, gentisic acid, and p-coumaric acid [51, 52]. Similar research on different Musa spp. showed a significant difference in total phenolic and total flavonoid contents [53].

Flavonoids are potent antioxidants constituents that serve many functions including preventive oxidative cell damage and demonstrate various pharmacological activities [28]. It has been found that flavonoids isolated from different part of banana significantly reduced the harmful effect of hydroperoxides and conjugated dienes by superoxide dismutase (SOD) and catalase activities [54]. Phenolics are bioactive compounds that demonstrate potential health benefits due to their antioxidant properties [55, 56]. Phenolics have been documented to demonstrate free radicals scavenging activities [28]. Phenolics exhibited antioxidant activities by chelating redox-active metal ions, inactivating lipid free radical chains, and preventing the conversion of hydroperoxide into reactive oxyradicals [57]. The significant amount of total flavonoid and phenolic contents observed in the extract indicated that *M. acuminata* is good sources of natural antioxidants.

The present finding revealed that the aqueous unripe fruits extract of *Musa acuminata* showed potent free radical scavenging and ferric reducing antioxidants activities. This finding is in agreement which the study which showed that methanol extract of unripe fruits of *M. acuminata* demonstrated significant free radical scavenging and ferric reducing antioxidants activities [58]. It has been documented that banana is good source of natural antioxidants [59]. Natural antioxidants demonstrate many biochemical activities including inhibition production of reactive oxygen species (ROS),

scavenging of free radicals, and alteration of intracellular redox potential [60]. Plants antioxidants prevent oxidative cell damage due to their capacities to scavenge free radicals thereby inhibiting the effects of oxidative stress [28].

5. Conclusion

The aqueous unripe fruits extract of *Musa acuminate* contains significant amount of phytochemicals constituents, total flavonoids and total phenolics. The extract exhibited significant DPPH free radical scavenging activity and ferric reducing antioxidant power. Thus, *M. acuminata* is good sources of phytochemicals and natural antioxidants.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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