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Research paper

Phytochemical profiling and antioxidant potential of aqueous and ethereal extracts of elephants' feeds in the savannah ecological zone of Ghana

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Abstract

This study reports on the phytochemical profiles and antioxidant properties of aqueous and ethereal crude extracts of *Cassia sieberiana* root, *Ficus platyphylla* stembark, *Terminalia laxiflora* root, and leaves, *Tamarindus indica* fruits, *Kigelia africana* root and *Mitragyna inermis* stembark as Elephants feed. Standard and approved methods were employed in this study. The phytochemical constituents detected included alkaloids, saponins, anthraquinones, tannins, flavonoids, phenols, terpenoids, and triterpenoids. The IC50s were 115 µg/mL and 7865 µg/mL for aqueous and ethereal extracts of *Mitragyna inermis*. 77.29 µg/mL and 1564 µg/mL for aqueous and ethereal extracts of *Ficus platyphylla*, 5352 µg/mL and 7843 µg/mL for aqueous and ethereal extracts of *Terminalia Laxiflora*, 8.963 µg/mL and 1253 µg/mL for aqueous and ethereal extracts of *Cassia sieberiana*, 10423µg/mL and 12645 µg/mL for aqueous and ethereal extracts of *Kigelia africana*, 1339 µg/mL and 2653µg/mL for aqueous and ethereal extracts of *Tamarindus indica* and 3.819 µg/mL for gallic acid (control). *Cassia sieberiana* root aqueous extract had the highest total phenol content of 62.36 ± 6.18 with a corresponding total antioxidant capacity of 289.0 ± 6.642 and the lowest total phenol content of 1.543±2.76 was detected in ethereal extract of *Terminalia laxiflora* leaves with a corresponding total antioxidant capacity of 241.3±4.04. The aqueous extracts possess stronger DPPH scavenging abilities compared to the ethereal extracts for all samples studied. These findings revealed the health-supporting potentials of these elephant feeds. The finding is also a guide to the managers of our zoos and National parks on the importance of natural feeding in wildlife.

Keywords: *Elephant; Phytochemical Constituents; Savannah Ecological Zone; DPPH; Extract.*

1. Introduction

Elephants are the largest living land animals and are characterized by a long trunk (elongated upper nose), columnar legs, huge head, ivory tusk, and wide flat ears. They are large grayish to brown, and their body hair is spare and course. There exist two species of elephant, the Loxodonta africana (African elephant) and Elephas maximus (Asian elephant) (Jaya et al., 2015). African elephants are widely distributed in Southern Africa and are found in about 37 countries and estimated over 500,000 are either in captive breeding or in free wild range land (For et al., 2008). Elephants are herbivores; they consume a range of plants and plant parts including the roots of plants. Elephants will typically travel farther during the dry season, when resources are depleted, to obtain sufficient food and water (Beth et al., 2013).

Elephants select or reject specific foods from the experience of integration and the feedback that results from the ingestion of those feeds. Thus, the selection of feeds by elephants is guided by many reasons. The choice of certain plants and the combination of the same by elephants have been attributed to the presence of certain defensive chemicals (Gómez & Nichols, 2013). Browsing enables elephants to regulate the intake of phytochemical constituents containing feeds according to the levels of specific phytochemicals at a given time. Another way elephants select forages to maintain their health is the use of odours of plants; these odours are the characteristics of volatile organic compounds which are emitted by plants (Baluska & Ninkovic, 2010. Due to the complex nature of volatile organic compounds arising from plants' odours, these plants can be detected by elephants from a greater distance (Stutz et al., 2015).

Phytochemical constituents have been linked to the total health of elephants since elephants depend on these plants as a source of natural antioxidants and disease prevention (Houdijk et al., 2001). The biological interplay between plants and the variety of competitors, pathogens, insects, and herbivores has led to phytochemical diversity observed recently (Fitzgerald, & Goodwin, 2003). Minerals and water availability during the development stages of plants affect the levels and presence of some important phytochemical constituents such as terpenes (Thórhallsdóttir et al., 1990).

Studies have found that herbivores such as elephants avoided certain plants due to the unpleasant post-ingestive experience stemming from secondary metabolites (Provenza & Balph, 1987: Kyriazakis et al., 1998: Bedoya-Pérez et al., 2014a).

This practise of feeding on a variety of plant species is already a daily practice by free-ranging African elephants since they have the freedom to choose from several available food choices.

The time spent foraging by Loxodonta africana on specific plants may reflect on the specific nutritional and medicinal needs of elephants (Provenza et al., 2007).
Browse contains more plant secondary compounds than grass in the dry season, which reduces intake by herbivores (Jansen et al., 2007; Duncan & Poppi 2008). For example, tannins are pervasive in browse but almost absent in grass (Ellis et al., 1990). Reactive nitrogen species (RNS) also contribute to the pathology of cardiovascular disease in animals as a result of deficiency in animal feed especially in the dry season where nutrient levels of most feeds tend to decrease due to unfavorable environmental conditions (Coss et al., 1992). This might account for the preference of plant-related food by African elephants in the dry season as reported by Aguree et al. (2023).
One important question that remained unanswered is whether these volatile organic compounds as odours in elephant's forages possess any medicinal properties to the health of elephants (Owen-Smith & Chafota, 2012: Madani et al., 2012). This current study assesses the phytochemical constituents and antioxidant properties of identified feeds of elephants and their relation to the health of African elephants in the Savannah Ecological Zone of Ghana.

2. Materials and methods

2.1. Materials

The materials used for this study included Glassware, Whatman No. 1, UV-visible spectrophotometer, Blender, Oven, DPPH, distilled water, sulphuric acid, Dragendorff's reagent, diethyl ether, mechanical shaker, methanol, spectrophotometer, molybdenum (IV), Na_2HPO_4, 4Mm Ammonium molybdate, incubator, gallic acid, Folin-Ciocalteu's reagent, and Na_2CO_3. All reagents used in this study were of chemical grade.

2.2. Study area

The study was conducted in the Larabanga enclave within the Savannah Ecological Zone of Ghana. The study area comprised of the central town of Larabanga, a village in the west Gonja district, and a fringe community to the Mole National Park. It lies on latitude $9^o12^l56.16$ to the north and longitude $-1^o51^l31.18$ to the East. Larabanga is known, among other things for its patterned vernacular architecture and as the entrance to the Mole National Park. Mole National Park is home to the elephants (and other game), so they feed within and around including the fringe community. The current study was carried out between May 2021 and September 2022. A descriptive map of the study area is shown in figure 1 below.

Fig. 1: A Map Showing the Location of the Study Area (From Google Map Data, 2022).

2.3. Laboratory analysis

2.3.1. Processing and extraction of elephant feeds

The selected plants and plants parts eaten by elephants were identified at Larabanga in the Savannah Ecological Zone of Ghana. The samples were transported and air-dried for 16 days under room temperature in the laboratory of Dr. Hilla Limann Technical University, Wa. The dried samples were pulverized and transported to Professor Marion Martiensen's Biotechnology Laboratory, Brandenburg University of Technology-Germany, for laboratory analysis.
Extraction of phytochemical constituents was done using water and Ether. Exactly 100 g of pulverized plant sample was weighed into a cleaned extraction container and 1000 mL of double distilled water was added. The mixture was then placed on a mechanical shaker for 72 hours at 180 rpm to ensure complete extraction. The extracts were filtered into porcelain crucibles and the solvents evaporated under a rotary vamp. The crude extracts were then scooped and stored in a fridge until used. This procedure was repeated on all the samples using Ether (chemical grade).

2.3.2. Phytochemical screening

Qualitative screening of phytochemical constituents was conducted on all crude extracts using protocol by Poojar et al. (2017).
2.4.0 2, 2, Diphenyl-1-Picrylhydrazil (DPPH) Radical Scavenging Assay
The free radical scavenging activity was determined as described by (Govindarajan et al., 2003) with a few modifications. One (1) mL of each of the extracts (1000,500, 250, 125, 62.5, and 31.25 µg/mL in methanol) was added to 3 mL methanol solution of DPPH in a test tube and incubated at 25 °C for 30 min. The absorbance of DPPH was determined at 517 nm in a spectrophotometer (Cecil, CE 7200 spectrophotometer, Cecil instrument limited, Milton Technical Centre, England). Gallic acid (100, 50, 25, 12.5 µg /mL) was used as the standard free radical scavenger. Methanol was added to 3 mL of DPPH solution and incubated at 25 °C for 30 min to serve as the negative control (blank). All experiments were carried out in triplicates and each result was quantified as a percentage of the blank. The concentration required to scavenge 50% of DPPH was estimated (IC_{50}) by plotting the log of concentration against the percentage inhibition. The percentage DPPH scavenging ability was calculated using the equation below:

$$\%\text{DPPH radical scavenging activity} = \frac{(\text{Abs (control)} - \text{Abs (Sample)})}{\text{Abs (control)}} \text{ X } 100 \ldots\ldots\ldots\ldots \quad \text{Eqn (1)}$$

Where Abs (control) = absorbance of negative control; Abs= absorbance of the test sample or positive control.

2.4.1. Total antioxidant capacity assay by phosphomolybdate method

The total antioxidant capacity (TAC) assay is a spectroscopic method which is based on the reduction of Molybdenum (VI) to Molybdenum (V) complex by the sample analyte and the formation of a green reaction mixture. One (1) mL of the extract at different concentration (2000, 1000, 500, 250, 125, 62.5 and 31.25 µg/mL) were each added to a test tube containing 3 mL of the reagent solution (0.6 M H_2SO_4, 28 mM Na_2HPO_4 and 4 mM Ammonium molybdate) and incubated at 95 °C for 90 min. After cooling at room temperature, the absorbance was measured at 695 nm against a blank. Gallic acid at concentrations (100, 50, 25, 125, 6.25 and 31.125 µg/mL) was used to construct a calibration curve of concentration against absorbance. The total antioxidant capacity was expressed as milligram of Gallic Acid Equivalent (GAE) per gram of the crude extracts (Prieto et al., 1999).

2.4.2. Estimation of total phenolic content (TPC)

The total phenolic content for each of the extracts was determined using Folin-Ciocalteu's reagent method. In brief, 1 mL each of (2000, 1000, 500, 250, 125, 62.5, 31.25 µg/mL) solutions of the extracts was mixed with 5 mL of Folin-Ciocalteu's phenol reagent. After 15 min of incubating the mixtures at room temperature, 2.5 mL of a 2% Na_2CO_3 solution was added to the mixture and mixed thoroughly. The mixtures were further incubated in the dark for 15 min at room temperature after which the absorbance was read at 760 nm using a UV spectrophotometer. Prepared concentrations of Gallic acid (3.125, 6.25, 12.5, 25, 50, 100 µg/mL) were taken through the same procedure. The total phenolic content was determined from extrapolation of calibration curve which was made by using Gallic acid (3.125 - 100 µg/mL). The total phenolic content was expressed as milligrams of Gallic acid equivalents (GAE) per gram of dried extracts (Lu & Foo, 2011).

3. Results and discussion

Table 1: Phytochemical Screening of Aqueous and Ethereal Extracts of Plants Consumed by Elephants Within the Savannah Ecological Zone of Ghana

Phytochemical Constituents	Aqueous Extract							Ethereal Extract						
	CSR	KAL	TIF	MIS	TLR	TLL	FPS	CSR	KAL	TIF	MIS	TLR	TLL	FPS
Alkaloids	-	-	+	-	+	+	-	-	-	-	-	-	-	-
Saponins	+	+	+	-	+	+	+	+	+	+	+	+	-	-
Tannins	+	+	+	+	+	+	+	-	-	-	-	-	-	-
Anthraquinones	-	+	-	-	-	-	-	-	-	-	-	-	-	-
Glycosides	+	-	+	-	+	-	+	+	-	+	-	+	+	-
Terpenoids	+	-	+	+	-	+	+	+	+	+	+	+	+	+
Triterpenoids	+	-	+	+	-	+	+	+	+	+	+	+	+	+
Flavonoids	+	+	+	-	+	+	-	-	-	-	-	-	-	-

Key: CSR –Cassia sieberiena root, KAL-Kigelia africana leaves, TIF-Tamarindus indica fruits, MIS-Mitragyna inermis stembark, TLR-Terminalia laxiflora root, TLL-Terminalia laxiflora leaves, FPS-Ficus platyphylla stembark.

Table 2: DPPH Scavenging Activities of Extracts of Plants Consumed by Elephants Within the Savannah Ecological Zone of Ghana

Elephant Feeds	(Aqueous Extract) Ic_{50}/µg/mL	(Ethereal Extract) Ic_{50}/µg/mL
CSR	8.963	1253
KAL	10423	12645
TIF	1339	2653
MIS	115	7865
TLR	5352	7843
TLL	38.33	1563
FPS	77.29	1564

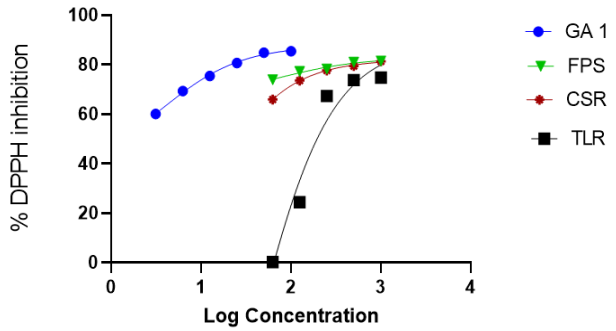

Fig. 1: A) Percentage Inhibition of DPPH by Aqueous Extracts of Elephants' Feeds.

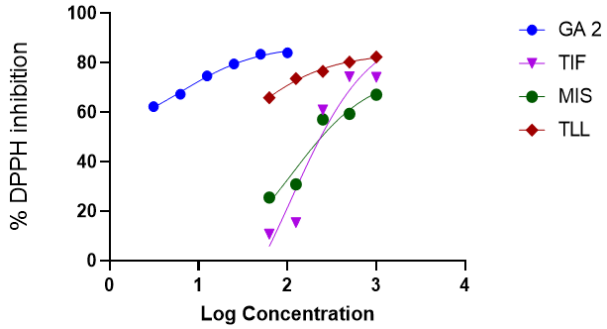

Fig. 1: B) Percentage Inhibition of DPPH by Ethereal Extracts of Elephants' Feeds.

Table 3: Total Phenol Content of Extracts of Selected Elephants Feeds

Selected Elephants' Feeds Sample code	Aqueous Extract (Mean ± Standard Deviation)	Ethereal Extract (Mean ± Standard Deviation)
CSR	62.36 ± 6.18	2.994±0.88
KAL	3.721 ± 1.35	0.564±0.113
TIF	5.827 ± 0.00	1.057±0.06
MIS	6.619±0.26	2.453±0.79
TLR	114.3 ±0.38	9.785±0.67
TLL	3.178 ± 1.22	1.543±2.76
FPS	121 ± 0.67	34.786±0.23

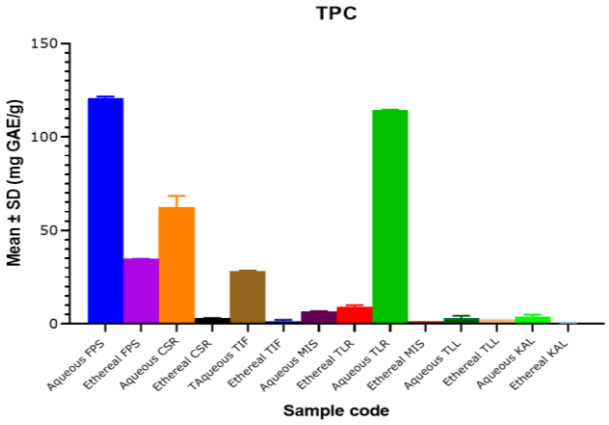

Fig. 2: Comparison of Total Phenol Content of Selected Elephants Feeds.

Table 4: Total Antioxidant Capacity of Extracts of Selected Elephants' Feeds

Selected Elephants' Feeds Sample code	Aqueous Extract ((Mean ± Standard Deviation)	Ethereal Extract (Mean ± Standard Deviation)
CSR	289.0 ± 6.642	11.885±1.22
KAL	7.871 ± 0.00	3.752±1.743
TIF	14.13±0.00	4.673±2.88
MIS	65.71 ± 15.17	5.32±2.124
TLR	21.29 ± 0.00,	5.884±1.783
TLL	241.3 ±4.04	9.614±1.045
FPS	79.67 ± 0.95,	7.893±2.432

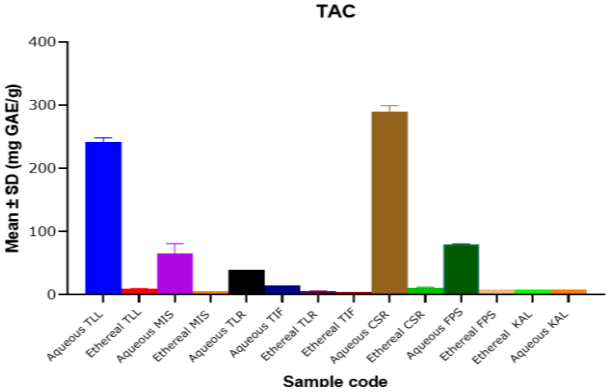

Fig. 3: Comparison of Total Antioxidant Capacity of Extracts of Selected Elephants Feeds.

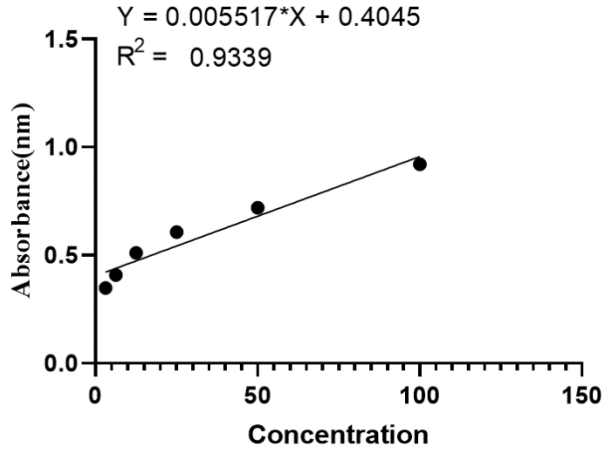

Fig. 4.1: A) Calibration Curve of Gallic Acid for TAC for Ethereal Extract.

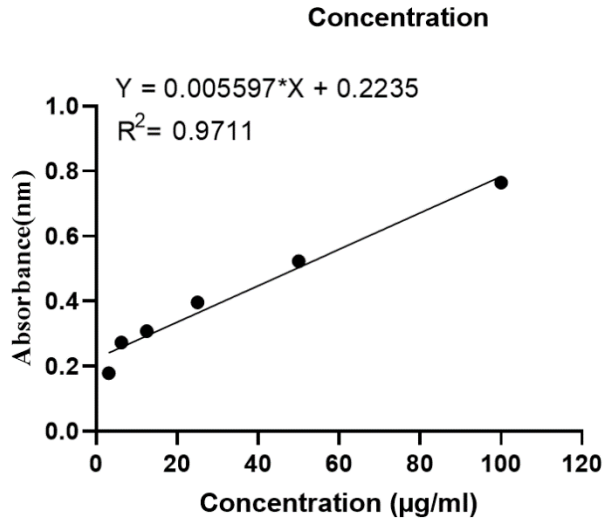

Fig. 4.1: B) Calibration Curve of Gallic Acid for TAC for Aqueous Extract.

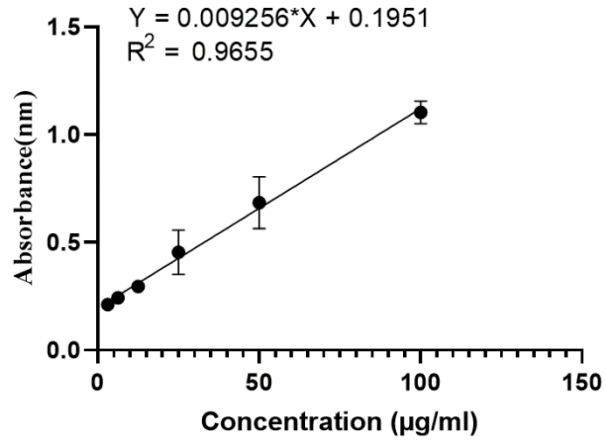

Fig. 4.2: A) Calibration Curve of Gallic Acid for Total Phenol Content for Ethereal Extract.

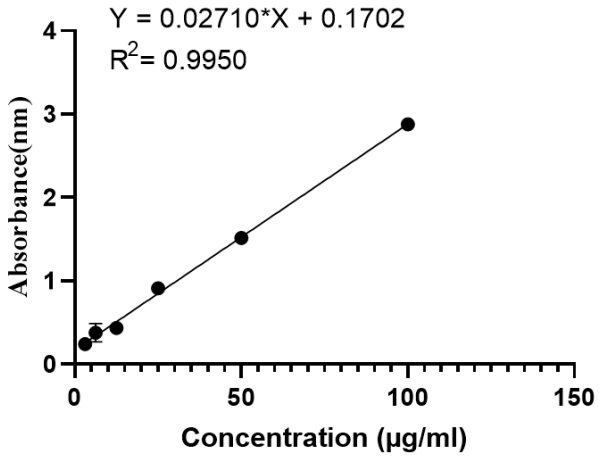

Fig. 4.2: B) Calibration Curve of Gallic Acid for Total Phenol Content for Aqueous Extract.

3.1. Discussion

The phytochemical screening on the aqueous and ethereal extracts of *Cassia sieberiena* root, *Kigelia africana* leaves, *Tamarindus indica* fruits, *Mitragyna inermis* stembark, *Ficus platyphylla* stembark and *Terminalia laxiflora* root and leaves revealed the presence of alkaloids, glycosides, flavonoids, tannins, anthraquinones, terpenoids and triterpenoids among the various extracts as shown in table 1. The differences in the phytochemical constituents as shown in table 1 among the aqueous and ethereal extracts may be attributed to the different geographical locations of the plants, time of harvest, stage of maturity of the plants and processing procedures (Bhardwaj et al., 2015).

The current finding is in conformity with the research findings of Mehanni et al. (2017) who reported the presence of alkaloids, tannins, anthraquinones and saponins in the root extract of Cassia sieberiena. Further studies on comparative chemical constituents by Awomukwu et al. (2015) also reported the presence of triterpenoids, terpenoids, glycosides, tannins, flavonoids, saponins, and phenols in *Cassia sieberiena* root. The current finding (Table 1) is consistent to the findings of Lai. (2004) who reported the presence of glycosides, tannins, flavonoids, saponins, alkaloids in aqueous and ethereal extracts of the root and leaves of *Terminalia laxiflora*. Research findings reported by Toma et al. (2009) also revealed the presence of tannins, alkaloids, saponins, steroids, flavonoids, cardiac glycosides, cyanogenic glycosides and reducing sugars in *Tamarindus indica* fruits which is not much different from the current findings reported in table 1.

In the determination of the free radical scavenging activities of the crude extracts of selected elephants' feeds 1, 1-Diphenyl-2-PicrylHydrazyl (DPPH) (stable radical) was used. The lowest IC_{50} was found to be 8.963 µg/mL and the highest at 12645 µg/mL against aqueous extract of *Cassia sieberiena* root and ethereal extract *Kigelia Africa* leaves respectively. The DPPH scavenging activities of the extracts were compared to Gallic acid, which showed IC_{50} of 3.819 µg/mL. From the samples analysed it can be deduced that as the concentration of the extracts increases, there was a corresponding increase in the free radical scavenging abilities of the extracts (Figure 1).

It is general knowledge that plant food rich in polyphenolic compounds are protective against a variety of diseases in wildlife (Ross et al., 2000: Ness et al., 1997).

Polyphenolic compounds, tannins possess enough hydroxyls and carboxyls groups that form complexes with free radicals in the process of mopping out free radicals from biological tissues (Ashok et al, 2012). Tannins are often abundant in tree bark, where they serve as a barrier to microbial invasion and protection against radiations (Ashok et al, 2012). As a result of its numerous health benefits, tannins have been incorporated into the food industry as natural antioxidant and a preservative (Khanbabaee et al., 2001). Research findings reported by Hargreaves et al. (2002) on wildlife revealed that antioxidants levels are influenced by the choice of food wildlife feed on. The antioxidant ability of polyphenolic containing elephants' feed is due to their ability to, activate antioxidant enzymes, reduce alpha-tocopherol radicals, and terminate oxidases (Jez et al., 2000). This is believed to be the linkage between plants and herbivores interactions (Feeny, 1976: Swain, 1979). The presence of phenolic compounds has influenced plants selections by elephants and other animal species partly due to the odours emanating from plants (Jachmann, 1989).

The antioxidant abilities of phenolic compounds in plants is mainly due to its redox property in absorbing and neutralizing free radicals, quenching singlet and triplet oxygen, and having a metal chelation potential (Iqbal et al, 2015). The ability of phenolic compounds to donate a hydrogen is believed to be the reason for their impact on free radical scavenging. The presence of phenolic compounds in herbivores feeds have the potential of preventing lipid peroxidation in wildlife (Jez et al., 2000). Phytochemical constituents such as flavonoids serve a variety of purposes in plants and are found inside or on the surface of different plant organs. These plant phenolics function in plants as photoreceptors, visual attractants, feeding repellents, antioxidants, antimicrobials, and light filters (Bell, 2012). The biological and pharmacological traits of flavonoids are typically explained by their effectiveness in scavenging free radicals, metal-like appearance, and highly selective protein binding. Flavonoids mostly differ in heteroatomic ring saturation. These phytochemicals are mostly present in lower plants as well as higher plant parts such as bark, roots, stems, and flowers. Phenolic compounds give flowers, fruits, and leaves their eye-catching hues making it possible for locating by elephants (Kondoh et al., 2003).

The aqueous extracts (Figure 1a) demonstrated higher DPPH scavenging abilities compared to the ethereal extracts (Figure 1b), this might be due to the presence of flavonoids, tannins and phenols detected in the aqueous extracts compared to the ethereal extracts (Table 2). The presence of polyphenolic compounds such as phenols, flavonoids, tannins in the aqueous extracts but absent in the ethereal extracts might be largely contributing to the higher free radical scavenging activities as observed in the aqueous extract (Table 2) compared to the ethereal extract (table 2). Research finding reported by Jez et al. (2000) established that antioxidant activities of polyphenolic compounds is due to their ability to, activate antioxidant enzymes, reduce alpha-tocopherol radicals, and terminate oxidases. This is believed to be the linkage between plants and herbivores interactions (Feeny, 1976: Swain, 1979). Free radical scavenging activities can be attributed to the Total phenolic contents as observed in the current study. Cassia sieberiena root aqueous extract had the highest total phenol content of 62.36 ± 6.18 with a corresponding total antioxidant capacity of 289.0 ± 6.642 and the lowest total phenol content of 1.543±2.76 was detected in ethereal extract of Terminalia laxiflora leaves with a corresponding total antioxidant capacity of 241.3±4.04 as presented in figures 2 & 3. There is a correlation between antioxidant activity and total phenol content according to the research findings reported by Zemmouri et al.(2019). Jain et al. (2011) in his research findings reported a phenolic content of 30.95 g GAE/mg in aqueous extract of the root of

Terminalia laxiflora. A considerable Total Phenolic Content level that is far greater than previously reported has been achieved from an aqueous root extract of Terminalia laxiflora in this investigation (Table 3).
The correlation between the total antioxidant capacity and the total phenol content of the aqueous and ethereal extracts was determined by establishing the correlation coefficient (R^2) of the scatter plots as shown in figures 4.1a, 4.1b, 4.2a, 4.2b. From the R^2 values, it can be inferred that 93.39 % of the total antioxidant activities exhibited by the ethereal extract is due to its total phenol content and 97.11 % of the total antioxidants' activities exhibited by the aqueous extract is due to its total phenol content. The total phenol content of an extracts is not always directly proportional to its total antioxidants capacity as established in this current study (figures 2 and 3). This is because different compounds possess various degrees of antioxidant activities. The current study corresponds with the findings of Pourmorad et al. (2006) who reported that total phenol content of an extract is a crude measure of the total phenolic compounds present in the extract and not specific total polyphenols, but many interfering compounds that also react with Folin-Ciocalteu reagent giving elevated apparent phenolic concentrations (Pourmorad et al., 2006).
Research comparing the antioxidant concentrations of blood serum of Zoo-housed and free foraging African elephants in the 1990's showed high serum antioxidants of 0.8ug/mL necessary for optimum biological function compared to the serum antioxidants of captive elephants of 0.4ug/mL (Dierenfeld & Taber, 1992). The variations in the serum antioxidants levels between the free ranging and zoo-housed elephants were attributed to the different choices of feeds available to Free ranging elephants compared to Zoo-housed elephants. This led to the modifications of feeds of Zoo-housed or captive elephants with antioxidants enriching plants in most Zoos and parks. Research conducted by Dierenfeld & Traber. (1992) also established that as elephants grow in age more antioxidants containing feeds is needed for optimum health. Research conducted on Northern Elephant seals showed that there is a strong relationship between free radical generation and breeding (Dierenfeld & Traber, 1992).
Elephants' feeds containing limited polyphenolic constituents contribute to cellular ageing, mutagenesis, carcinogenesis and coronary heart diseases in elephants and other wildlife due to destabilization of membrane, DNA damage and through oxidation of low lipoprotein (Hirano et al., 2001). In addition, prolong deprivation of antioxidant containing foods to wildlife and elephants, increases myocardial hydrogen peroxide production and decreases liver and muscle glutathione content and antioxidant enzyme activities (grattagliono et al., 2000). Research findings established the addition of antioxidants to animal feeds has the potential of reducing ischemic stroke by half (Martineau et al., 2006). The consumption of these plants could enrich the health of elephants since these plants possess varying phytochemical constituents and may be responsible for the self-medication of elephants in our various zoos and National Parks.
As free radical is inevitable in biological systems, the consumption of these plants species by elephants will go a long way to support metabolic balance and overall health since elephants' trek far distance in search of food and water and as a result may generate excessive free radicals.
The continuous consumption of these feeds will go a long way to protecting the health of these elephants in Savannah Ecological Zone of Ghana against oxidative stress and against parasites invasion.

3.2. Conclusion

The results obtained from this current study established that the crude aqueous and ethereal extracts of Cassia sieberiena root, Ficus platyphylla stembark, Mitragyna inermis stembark, Terminalia laxiflora root and leaves, Tamarindus indica fruits and Kigelia africana leaves revealed the presence of alkaloids, tannins, saponins, anthraquinones, flavonoids, phenols, terpenoids and triterpenoids.
The findings also revealed that the aqueous and ethereal extracts of the selected elephant's feed demonstrated scavenging abilities against the stable free radical (DPPH). The aqueous extracts showed higher antioxidant activities compared to the ethereal extracts with Cassia sieberiena root showing the highest inhibition against DPPH with an IC_{50} of 8.963 µg/mL compared to 3.819 µg/mL of garlic acid as standard antioxidant agent. Aqueous extract of Cassia sieberiena root had the highest total phenol content of 62.36 ± 6.18 with a corresponding total antioxidant capacity of 289.0 ± 6.642 and the lowest total phenol content of 1.543±2.76 was detected in ethereal extract of Terminalia laxiflora leaves with a corresponding total antioxidant capacity of 241.3±4.04. The aqueous extracts possess higher DPPH scavenging abilities compared to the ethereal extracts for all samples studied. The presence important phytochemical might be contributory factors to the known practice of self-medications in wild elephants.

3.3 Acknowledgements
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Author's contributions

The original concept was initiated by Professor Samson Abah Abagale and Professor Isaac Sackey. The laboratory investigations were conducted by Mr. Sylvenus Aguree and drafted by same. The manuscript editing was done by Samson Abah Abagale and Isaac Sackey.

Declaration statement

The authors declare no conflict of interest before, during and after the study.

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