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Antioxidant potentialities and Antiradical Activities of *Oxalis corniculata* Linn from Tanzania.

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ABSTRACT

Introduction: This study provides essential antioxidant potentialities of the plant *Oxalis corniculata* Linn (creeping wood sorrell) indigenous from Tanzania and the associated precursors of biochemical compounds responsible for its folkloric pharmacological rationales.

Methodology and Results: Extracts were made from the whole plant using methanol and ethanol solvents. DPPH assay was used to evaluate its antioxidant potentials while phytochemical screening for precursors of biochemical compounds responsible for its pharmacological rationales was qualitatively determined. Total antioxidant necessary to decrease the initial DPPH radical concentration by 50% (EC_{50}) value, were obtained from the linear regression plots of Sigma Plot R (2001).

Results showed significant activities in all antioxidant assays compared to the reference antioxidant ascorbic acid in a dose dependent manner. In DPPH scavenging assay the EC_{50} value of the crude extract was found to be 0.04 mg/ml while that of the reference standard ascorbic acid was 0.59 mg/ml. Likewise the highest iron chelating ability of 97.31% was obtained at a higher crude extract concentration of 0.4 mM while the lowest ability of 23.25% was obtained at the lowest crude extract concentration of 0.001mM. It also portrayed high antiradical activities of up to EAU515 = 1.868 number of antiradical unit and several precursors of biochemical compounds including Flavonoids, Terpenoids, Coumarins, Glycosides, as well as Steroids and Phytosteroids.

Conclusion and application of results: The results indicated that *Oxalis corniculata* could be an important dietary source of antioxidants with high scavenging abilities as well as rich in biomolecules that are precursors of most biologically active chemicals of medical importance. These findings may thus, justify their wide usage in traditional medicine and envisage a purposeful thoroughly study for possible developments into nutraceutical and drugs.

Key words: antioxidants, antiradical, folk medicine, *Oxalis corniculata*, DPPH

INTRODUCTION

Human beings like other aerobic organisms, are highly protected against oxidative damage by natural occurring antioxidant in our body such as glutathione created within cells. Unfortunately, they are naturally insufficient which render our bodies into many oxidative stresses, which lead to brain dysfunction, pathology of cancer, atherosclerosis, malaria and rheumatoid arthritis (Mizuno, 1999; Tibuhwa, 2012). Free oxygen reactive species are capable of damaging all components of body including proteins, lipids, DNA and sugars. Anti-oxidant refers to a substance that has extra electrons that it can give off

to clean up free radicals. Free radicals are reactive oxygen species (ROS) in cells, which include hydrogen peroxide (H_2O_2), the superoxide anion and the hydroxyl radical (OH^-), which is endogenously constantly produced in the human body. All aerobic organisms depends on oxidation reactions for energy production used in different biological processes however, they are insufficient to totally prevent the damage (Mizuno, 1999). Antioxidants are thus important in living organisms because they may delay or stop formation of free radical by giving hydrogen atoms or scavenging them (Navarro-Ocaña, 2008). It is well known that every organism has natural endogenous defence mechanisms to eliminate free radicals, habitually excess production of ROS overwhelms the system; thence taking foods rich in antioxidants help the endogenous defence system to reduce oxidative damage (Temple 2000, Fang 2002, Liu 2003). Scarcity and relatively high cost of orthodox medicine has resulted into many populations in different parts of the world to popularly use traditional medicine. For example, Srikanth *et al*. (2012) in their work report that Indian medicine uses over 2000 herbs. Besides, it is well reported that some of the very important life saving drugs used in the armamentarium of modern medicine are from herbs (Goyal *et al*., 2017). A review study done by Srikanth *et al*. (2012) on phytochemistry and pharmacology of *Oxalis corniculata* Linn also establishes that this plant is highly exploited and screened for biological compounds with therapeutics potential. *Oxalis corniculata* Linn. (Family: Oxalidaceae) is one of the most well known plant for its traditional uses and its wide spectrum of biological activities. In Tanzania, it is very versatile, either consumed as a raw vegetable or used as a medicinal plant to treat different human ailments. A recent work by Tibuhwa (2016) revealed its traditional uses in twenty-five ethnic groups including five new uses (Table 1), while provided the scientific proof of its antimicrobial activity and safety to cell through cytotoxicity test. The present work furthers scientific support on its traditional uses by establishing essential antioxidant potentialities of *Oxalis corniculata* indigenous from Tanzania. The work also establishes important precursors of biochemical compounds that might be associated with its pharmacological rationales.

Table 1: Indigenous knowledge on *Oxalis corniculata* and its utilization from different 25 ethnic groups in Tanzania.

S/No	Ethnic group	Local name	Traditional uses	Local preparation and administration
1	Sambaa	Kidadaishi	Food, appetizer, Medicinal	Eaten raw or added to stew to make it taste, juice taken by sick people to improve their health, appetite and stop stomach upset including diarrhoea /vomiting/anti nausea and wound healing
2	Chaga-Machame	Manyonyo	Vegetable, Medicinal	Eaten raw especially by children, Treat children first milk tooth irritation and aching, remove 'sticky plant latex, nausea and brings appetite, stop stomach aching and anti rusts.
3	Kurya	Mnyonyo	Vegetable	Eaten raw, tonic for various gastrointestinal ailments in infants and diarrhoea
4	Nyambo	Bunyunyambuzi	Vegetable and medicinal	Eaten raw, few know it as tonic for various gastrointestinal ailments (e.g., abdominal pain, diarrhoea and stomach ache) and wound healing
5	Kerewe	Bukanoro	Food	Eaten raw or boiled and taken as a juice The juice used to infants in treating stomach aching and severe diarrhoea, treat flue, tonsillitis and cough and brings appetite
6	Jita	NK		Eaten as raw vegetable, treat stomach upset, diarrhoea, tonsillitis, flue and cough
7	Masaai	NK	None	Do not eat vegetables like cows!

8	Nyakyusa	Mwakatilolo	Food and Medicinal	Eaten as raw vegetable, treat flue, tonsillitis, its juice used as medicine stop stomach upset, diarrhoea, increase appetite, remove ' sticky banana latex,
9	Haya	Kanywambuzi	Food	Eaten raw, stop stomach upset, diarrhoea, anti nausea in pregnant mothers and give them appetite, remove ' sticky banana latex and healing wounds
10	Lugulu	Kikwadangu	Vegetable	Eaten raw and treat stomach aching and diarrhoea in infants
11	Hangaza	Umunyuwanyamanza	Food, medicinal	Eaten as raw vegetable, its juice used as medicine to treat, wound, stomach upset, flue in infants and spice to make the stew tasty
12	Ha	NK	Food and medical	Eaten raw and treat stomach upsets
13	Zinza	NK	Food and medicinal	Eaten raw, treat wound, stop stomach upset and nausea especially for pregnant mothers and give them appetite
14	Hehe	linyanyinyanyi	Food Good appetizer	Eaten raw, mixed with salads to make it sour for increasing appetite Stop nausea, stomach upset, diarrhoea and heart burn
15	Simbiti	NK	Food and medicinal	Eaten raw, treat wound, flue, tonsillitis and cough
16	Gweno	Uchecheri	Medicinal Food	Eaten raw, treat tonsillitis and flue when chewed, stomach upsets, diarrhoea and nausea,
17	Chaga-Rombo	Vedivedi	Food, medicinal	Eaten as raw vegetable, its juice used as medicine to treat stomach upset in infants Cleaning rusts
18	Sukuma	Buseli	Food, medicinal	Eaten raw, treat stomach upsets and diarrhoea especially in infants
19	Pare	Ushesheri	Food, medicinal	Eaten raw, treat wounds, tonsillitis, flue when chewed and stomach upsets
20	Zaramo	NK	Food, medicinal	Eaten raw, treat stomach aching and diarrhoea
21	Hehe	NK	Food, medicinal	Eaten raw, treat stomach upsets diarrhoea especially in children
22	Bena	NK	Food, medicinal	Eaten raw and treat stomach upsets
23	Machame	Misii	Food, medicinal	Eaten raw and treat stomach upset, nausea and brings appetite
24	Chaga-oldmoshi	Kisinga mana-heho	Food, medicinal	Eaten raw, treat tooth ache and stomach upset in infants
25	Wakibosho	Ndela	Food, Medicinal	Eaten raw and used in treatment of wound, cough, flue and tonsillitis

* NK= Not known. Source: Tibuhwa (2016) published in the Journal of Applied Biological Sciences.

MATERIALS AND METHODS

Collection of plant samples: *Oxalis corniculata* whole plant (Figure 1) was collected from Dar es Salaam and Tanga regions at 6°48' 21' ' South, 39°17' East and 4° 52' 0' ' South, 38° 37' 60' ' East respectively in three consecutive years 2014-2016. Plants were identified by a plant taxonomist from Botany Department of the University of Dar es Salaam and the collections are deposited at the DSM herbarium with voucher number ffm 3562.

Figure1: *Oxallis corniculata* growing on the garden in Dar es Salaam, Tanzania. (Photo taken by Tibuhwa DD 2014)

Quantitative and Qualitative determination of antioxidant activity: All the chemicals used in this work were analytical grade and purchased from Sigma Aldrich Co. (St Louis, MO, USA). The antioxidant ability was analyzed using DPPH radical and antioxidant properties were analysed by determining the polyphenols (Total phenolic compounds, vitamin C, and carotenoids (ß -carotene, lycopene) using the methanolic extracts.

Plant extracts preparation and yield: Fresh whole plants of *Oxalis corniculata* and fresh frozen samples were used in extraction. Using the analytical balance 125 g of the whole was weighed at room temperature (25-27°C). The plants were powdered in a motor using pestles and soaked in 250 ml of methanol or ethanol and extraction proceeded as explained in Tibuhwa *et al*. (2012) adopted from Jaita *et al*. (2010). It involved constant stirring of the material for 48 hrs, then filtered using Whatman filter paper. The filtrates were evaporated to dryness at 40ºC in a rotary evaporator (Labrota 4001, Heidolph® Essex Scientific Laboratory Supplies LTD) under reduced pressure. The obtained concentrated extracts were stored in the dark at 4ºC until further analysis. The yields of evaporated dried extracts were obtained by gravimetric method. The percentage yield extracts were calculated based on dry weight as:

$$\text{Yield } (\%) = \frac{(\text{W1 x } 100)}{\text{W2}}$$

Where W1= weight of extract after methanol evaporation;
W2= Weight of the extracted plant

Total phenolic contents determination: The total phenolic content was determined using the Folin-Ciocalteu colorimetric method as detailed in Tibuhwa (2012) adopted in Singleton *et al* (1999). Each 0.1 gm of extracts was diluted with 5 ml of methanol. 200 µl of the plant extract was transferred into a test tube then mixed thoroughly with 1 ml of Folin-Ciocalteau reagent. After 3 min, 0.8 ml of 7.5% (w/v) Sodium carbonate was added to the mixture. The mixture was agitated for further 30 minutes in the dark and centrifuged at 3300 g for 5 minutes. The absorbance of plant extracts and prepared blanks were measured at 515 nm using spectrophotometer (Uv-vis model 6305 Jenway UK). The total phenolic content in the plant extract was expressed as milligrams of gallic acid equivalent per 100 g weight of plant using the linear equation obtained from standard gallic acid calibration curve.

ß-carotene and Lycopene antioxidant activity assays: The assay was carried out according to the method of Hussein *et al* (2015) as adopted in Nagata and Yamashita (1992). The plant extract (100 mg) was shaken with 10 ml of Acetone-hexane mixture (92:3) for 1 minute and filtered through Whatman number 4 filter paper. The absorbance of the filtrate was measured at 453, 505 and 663 nm. The ß-carotene and Lycopene content were calculated as:
Lycopene mg/100 mg = 0.0458 A663 + 0.372 A505 − 0.0806 A453

ß-carotene mg/100 mg = 0.216 A663−0.304A 505 + 0.452A 453

Determination of Vitamin C: The vitamin C content was determined titrametrically using 2.6 Dichloropheno Indophenol methods following the method detailed in

Tibuhwa (2014). One hundred grams of grounded sample were mixed with 25 ml of 5% metaphosphoric acid solution and shaken for 30 min. The mixture was then filtered through Whatman no 42 filter paper using suction pump. Ten ml was pipetted from the extract in 250 ml conical flask and titrated against 0.025% of 2.6 Dichlorophenol Indophenol reagents. The amount of vitamin C in each extract was calculated from the equation:

$$\text{mg of ascorbic acid per 100 g} = \frac{\text{Ax Ix V1 x 100}}{\text{V2 x W}}$$

Where A = quantity of ascorbic acid (mg) reacting with 1 ml 0f 2.6 Indophenol

I = volume of indophenol (in ml) required for the completion for the titration with extract

V1 = Total volume of the extract; V2 = Volume of aliquot

W = Weight of the plant sample extracted

DPPH free radical scavenging activity assays: The qualitative assays were performed according to the method of Jaita *et al*. (2010). A series of extracts to methanol (1:10- 1:107) were prepared. 1ml of the extract was mixed with 1ml of 0.4 mmol-1 methanolic solutions containing 1:1- diphenyl-2picryhydrazyl (DPPH) radical that are very stable. Each free radical scavenging activity assay was done three times from the same extract in order to determine their reproducibility and standard deviation for the three readings were statistically determined. The mixture was left in the dark for 30 min. and the absorbance measured at 515 nm. The percentage of DPPH radical scavenging activity of each extract was determined at these five concentrations, within the range of dose response and was calculated as:

$$\text{DPP radical scavenging activity} = A_0 - \frac{(A_1 - A_s)}{A_0} * 100$$

Where A_0=Absorbance of the control solution containing only DPPH

A_1=absorbance in the presence of plant extract in DPPH solution and

A_s = the absorbance of the sample extract solution without DPPH

The EC_{50} value (total antioxidant necessary to decrease the initial DPPH radical concentration by 50%) was determined from plotted graph of scavenging activity against the concentration of extracts.

Determination of antiradical activity: DPPH (di phenyl-2picryhydrazil) radical in its radical forms has a characteristic absorbance at 515 nm that disappear after its reduction by an antiradical compound. The reduction of DPPH thus was monitored by measuring the decrease in its absorbance at 515 nm during the reaction as detailed in Tibuhwa (2012) adopted in Sroka *et al*. (2005). Absorbance was measured at 515 nm at time 0, and after 1 min. The antiradical activity of each extract was calculated as:

$$AU515 = (A0-A1) - (A0C-A1C)$$

Where AU515 = antiradical activity of the extract;

A0= the absorbance of the sample at the beginning of the reaction;

A1= the absorbance of the sample after one minute of the reaction;

A0C= the absorbance of the control sample at the beginning of the reaction;

A1C= the absorbance of the control sample after one minute of the reaction.

Qualitative method of phytochemical screening: The plants extracts from *Oxalis corniculata* was analyzed for some precursors of antimicrobial compounds which includes alkaloids, flavonoids, coumarines acids, quinones, Terpenoid, steroids, phytosterols, glycosides and phlobatannins (Raghavendra *et al*., 2005). The tests were based on the visual observation of colour change or formation of a precipitate after the addition of specific reagents as detailed in Evans (2001), Sangeetha *et al*. (2014), Minj *et al*. (2017, Zohra *et al* (2012) summarized below:

Detection of Alkaloids: The presence of alkaloids in *Oxalis corniculata* was tested as detailed in Evans (2001) whereby 50 mg of solvent free extract was stirred with 3 ml of dilute hydrochloric acid and then filtered thoroughly. The filtrate was tested with Wagner's test (Wagner 1993). In this, 1.3 grams of Potassium iodide were dissolved in 5 ml of water, topped with distilled water to 100 ml. A prepared Wagner's reagent was added by the side of the test tube containing 1 ml of the filtrate. Formation of reddish-brown precipitates indicated positive results.

Detection of flavonoids and coumarins acids: Treating an aqueous solution of plant extract in a test tube (1 ml) with Ammonium hydroxide solution tested the presence of flavonoids, which was confirmed by the yellow fluorescence. On the other hand the presence of coumarins was confirmed by the presence of yellow colour resulted from treating 1 ml of plant extract with 10% of Sodium hydroxide.

Detection of Quinone and Terpenoid: The presence of these two compounds were confirmed by the formation of red colour after treating 1 ml of plant extracts with concentrated sulphuric for the presence of Quinones, while the presence of terpenoids was tested by treating

0.5 ml of equal volume of Chloroform 2 ml and concentrated sulphuric acid.

Detection of steroids and phytosteroids: To 0.5 ml of the plant extract, equal volume of chloroform was added and subjected with few drops of concentrated sulphuric acid. Appearance of brown ring indicated the presence of steroids while appearance of bluish brown ring indicated the presence of phytosteroids.

Detection of Glycosides and Phlobatannins: Glycoside was tested using Legal's test whereby 3 ml of Chloroform and 10% of Ammonia solutions were added to 2 ml of *Oxalis corniculata* extract. Formation of pink colour indicated the presence of glycosides. On the other hand, the appearance of pink colour precipitates after adding few drops of 10% Ammonia solution into 0.5 ml of plant extract indicated positive results for phlobatannins.

Testing for Carbohydrate: To test the presence of Carbohydrates, equal volume of Benedict's reagent and plant extract (0.5 ml) was mixed and heated on a boiling water bath for 2 minutes whereby a red precipitates indicated positive results.

Data analysis: Data were analysed as in Tibuhwa (2014) with slight modifications, where by the scavenging activities of crude extracts on DPPH radicals were carried out in triplicate and the results expressed as means ± standard errors. The total antioxidant necessary to decrease the initial DPPH radical concentration by 50% referred to as EC_{50} value, were obtained from the linear regression plots of Sigma Plot R (2001) or calculated by substituting 50% for "y" into the curve equation of scavenging activity against extracts concentrations.

RESULTS AND DISCUSSION

The results of this study found *Oxalis corniculata* from Tanzania (Figure 1) portraying high antioxidant potential compared to synthetic standard drug ascorbic acid. The plant showed high vitamin C and lycopene, phenolic compounds, ß-carotene, and low flavonoids (Table 3). It further showed that the IC_{50} value of the extracts expressed the antioxidant abilities whereby low IC_{50} value corresponded to a high antioxidant capacity. These results suggest that, the consumption of this *Oxalis corniculata* can be exceptionally beneficial to human health, since they presumably offer antioxidant protection against oxidative damage. It is well known that exogenous antioxidants especially of biological origin are very essential in boosting endogenous antioxidants defences of the body, which helps in combating the undesired effect of excess reactive oxygen species (ROS). Excess ROS are well known as among the root cause of several body ailments Kasote *et al*. (2015) bearing in mind that synthetic drugs are alleged to be more damaging and less safe to the human body than natural herbal remedies (Srikanth *et al*. 2012). This study envisages further studies on isolation and identification of biologically active substances with therapeutic potentials.

Phytochemical screening: Phytochemical screening using both ethanol and methanol solvents in this study revealed that the studied *Oxalis corniculata* possess most of the bioactive compounds usually associated with precursors of antimicrobial compounds and other useful pharmacological roles. This finding thus supports the observation by Raghavendra *et al* (2005) that biomolecules of plant origin appear to be one of the alternatives to the control of this antibiotic resistance. Nevertheless, some of the screened phytochemicals were completely absent from the plant material and only 60% of the analysed precursors of biochemical compounds were present (Table 1). For example, Alkaloid, Phlobatannins, Quinone was not found in both extracts. It was however interesting to note that Methanol extracts yielded more phytochemical than ethanol including Steroids, phytosteroids and glycosides, which were completely lacking in the ethanolic extracts (Table 1). The discrepancies in obtained results of the phytochemical extraction efficiency might be attributed by various factors including chemical nature of phytochemicals, the nature of the solvent used (polarity, pH, temperature) as well as the presence of interfering substances as it has been established in Stalikas (2007) and Do *et al*. (2014). Some of the examined phytochemicals, which portrayed positive results including phenol, Tannin, alkaloids, flavonoids, amino acids and Carbohydrates, are well known for their medicinal activity and physiological activity (Vijayalakshmi 2012). The observed Terpenes may be promising substances in cancer therapy as it was reported in Graßmann (2005), especially the monoterpenes limonene and perillyl alcohol. The phytochemical screening results also established the presence of steroid in *Oxalis corniculata* (Table 2). Steroids are well known in medicine playing important roles in patients with loss of function of testicles, breast cancer, low red blood cell count, delayed puberty and debilitated states resulting from surgery or sickness as detailed in Drug Enforcement Administration (DEA, 2016). Steroids are also well administered by Veterinarians to domesticated animals such as cats, cattle, dogs, and horses for legitimate purposes such as to promote feed efficiency, and to improve weight gain, vigour, hair coat, anaemia and

counteract tissue breakdown during illness and trauma. Illegally the same compound is believed and used to seek Athletic dominance and better appearance (DEA, 2016). It is very interesting to note that the finding in Table1 indicates a related indigenous knowledge where by the juice of the studied plant is taken by sick people to improve their health and appetite. There is a need thus for further investigations into the ability of this plant in fighting diseases and publicize its utilization for general health benefits. Free radical posses one or more unpaired electrons in its outer orbital, which make them very unstable thus quite reactive with other molecules due to the oxidative phosphorylation (Halliwell, 1994). Their roles in association with many disease conditions have been well-established (Halliwell, 1994, Halliwell and Gutteridge 1995). Our body generates reactive oxygen species capable of damaging crucial bio-molecules, which lead to disease conditions including Cerebrovascular Disease, Cancer, Arteriosclerosis, Atherosclerosis, Heart Disease, Cataracts, Sunburn, Ulcers, Osteoporosis Rheumatoid Arthritis, Diabetes Mellitus, Emphysema, Stroke [Sharma and Clark, 1998, Halliwell, 1994, Halliwell and Gutteridge 1995). The high antioxidant potential responsible for neutralizing these free radicals portrayed by this plant in this study (Figure 2 and Table 3), support its folkloric uses especially in improving health of long ill people.

***Oxalis corniculata* antioxidant potentials:** Results of the analyzed antioxidant activity of *Oxalis corniculata* revealed it to possess enormous antioxidant potentials, which might be associated with its folkloric uses. The plant showed high vitamin C and lycopene, phenolic compounds, ß-carotene, and low flavonoids (Table 3). These results suggest that, the consumption of this plant can be beneficial for health, since they presumably offer antioxidant protection against oxidative damage. For example, the studied plant (*Oxalis corniculata*) was found to possess a substantial amount of Carotenoid up to 4.316 mg/100g (Table 3). Carotenoids are well known antioxidant acting in three main ways of quenching of singlet oxygen, hydrogen transfer or electron transfer. In human carotenoids play an important role for health by providing vitamin A, which is very important for vision while other carotenoids influence the human immune function and gap-junctional communication as reported in Graßmann (2005).

Table 2: Phytochemical screening of various extracts of the *Oxalis corniculata* showing the presence of most important phyto-constituents

S/N	Phytochemical constituents	Methanol	Ethanol
1	Alkaloids	-	-
2	Flavonoids	+	+
3	Terpenoids	+	+
4	Coumarins	+	+
5	Carbohydrates	+	+
6	Phlobatannins	-	-
7	Quinone	-	-
8	Steroids & phytosteroids	+	-
9	Glycosides	+	-

Key: *(+) means present and (–) means absent*

The plant is well applied and widely used in folk medicine by different ethnic groups in the country and elsewhere in the world (Raghavendra 2005, Srikanth *et al* 2012, Tibuhwa 2016). It is well known that different ethnic groups do not utilize some useful products of indigenous organism simply because they do not know the organism or they lack knowledge on the usage of the organism. This tendency is very prominent in mushroom edibility whereby migration of one ethnic group into a new area expose them to unfamiliar mushroom species, thus do not eat them not because they are inedible but their edibility is not known to them (Tibuhwa 2013). A recent study by Tibuhwa (2016) noted the local use of this plant in different ethnic groups as food; food supplement and medicinal applications (see Table 1). This study thus recommends a purposeful popularization of the beneficial utilization of this plant to other ethnic groups especially on the revealed high antioxidant potentials. Furthermore, the study recommends that in order to improve its shelf life for wider distribution they should be processed into nutraceutics or processed for pharmaceutical applications. Although the antioxidant properties of medicinal plants depend on the plant, its variety, environmental conditions, climatic and seasonal

variations, geographical regions of growth, degree of ripeness and growing practices (Škrovánková 2012). it was interesting to note that the *Oxalis corniculata* collected from two different regions exhibiting different weather conditions Kinondoni-Dar es Salaam with warm weather experiencing temperature ranges up to 34°C and Lushoto- Tanga experiencing cold weather up to 16°C portrayed the same activity.

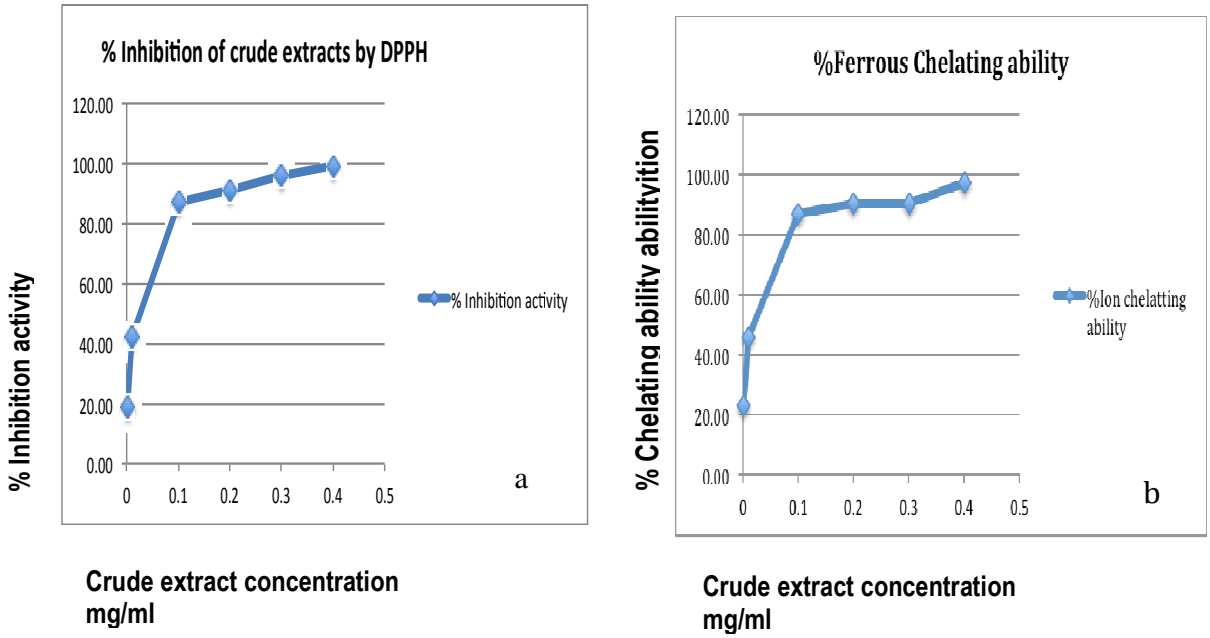

Figure 2: (a) Percentage (%) of scavenging abilities of Methanolic crude extract by DPPH (b) % Ferrous chelating ability.

Besides, the studied plant exhibited substantial flavonoid content ranging from 55.22-59.53 quercetin Equivalent mg/RE/gdw. Flavonoids are of essential uses for human body and have been reported to exert wide range of vital biological activities. For example, Cushine and Lamb (2005) and Murray (1998) report it to have anti-inflammatory, antibacterial, antiviral, antiallergic; Cook and Samman (1996); Cushine *et al*. (2005), Williams (2004) report it to portray cytotoxic antitumour while it has been also found to be useful in treatment of neurodegenerative diseases and vasodilatory action (Cushine 2006; Murray 1998; Cook 1996, Williams 2004). These results thus support its folkloric uses and the need to widely popularize it.

Table 3: Antioxidant potentials in *Oxalis corniculata* using methanolic extracts

Potential antioxidants	Sample C1	Sample C2	Sample C3	Average
Total Phenols (Gallic Equivalence GAE/gdw)	129.21	135.17	132.22	132.2
Total flavoniod quercetin Equivalent mg/RE/gdw	59.53	55.22	59.17	57.97
ß-Carotene mg/100g	4.316	4.21	4.09	4.21
Lycopene mg/100g	5.62	5.31	4.81	5.25
EAU 515 (Number of antiradical units)	1.795	1.868	1.866	1.83
Vitamin C	587.2	588.1	581.3	578.87
% yield	15.15	12.09	13.14	13.46

Antiradical activity: Ability of compound to break radical chains by donation of a hydrogen atom is often used as an indicator of its electron donating ability. This is a reducing power associated with anti oxidative properties, which arbitrate it to be used in testing antioxidative and reducing action of a given compound. In this study, the numbers of antiradical activity units per 1 mg of extract (EAU_{515}) were calculated for the three triplicate samples presented in Tables 4 all showed high antiradical activity up to (EAU_{515} 1.868). It is well known that antiradicals are

whole food antioxidant that helps the body to neutralize excess free radicals where they provide them with extra free electrons (Sroka and Cisowski, 2003). The high-portrayed antiradical activity by the studied plant implies that *Oxalis corniculata* can be used in dietary applications with a potential to reduce oxidative stress. The presented result shows that *Oxalis corniculata* possess high antiradical activity, which support them to be potential source of antiradicals of high profile. It is well known that the antiradical or antioxidant activities of plant extracts are connected with the qualitative and quantitative content of polyphenols whereby a majority of plant polyphenolics have antiradical and antioxidant features but the intensity of their activity strongly depends on the chemical structure (Sroka and Cisowski, 2003). The studied plant was found to possess high phenolic compounds up to 135.17 Gallic acid equivalence GAE/gdw that probably corresponded well with the high-observed antiradical value EAU_{515} 1.868 (Table 3).

Table 4 *Oxalis corniculata* Iron chelating and Radical scavenging ability

	Iron Chelating ability			
Concentration	S1	S2	S3	**Average**
0.001	23.17	23.16	23.25	23.19
0.01	49.27	42.17	46.17	45.87
0.1	86.21	87.11	87.21	86.84
0.2	90.01	90.81	90.02	90.28
0.3	90.55	90.55	90.63	90.58
0.4	97.33	97.28	97.31	97.31

	Radical scavenging ability DPPH			
Concentration	S1	S2	S3	**Average**
0.001	19.18	19.07	19.22	19.16
0.01	42.16	42.18	42.16	42.17
0.1	87.16	86.95	87.11	87.07
0.2	91.22	90.83	90.86	90.97
0.3	96.34	95.72	96.33	96.13
0.4	99.27	99.23	99.63	99.38

***Oxalis corniculata* Iron Chelating ability:** This study used the 1,1-diphenyl-2-picrylhydrazyl (DPPH) radical scavenging activity, antioxidant assays to establish the chelating ability in the studied plant. The results shows that iron chelators are therefore concentration dependent (Table 4). The highest ability of 97.31% was obtained at a concentration of 0.4 mM while the lowest ability of 23.25% was obtained at the lowest concentration of 0.001mM. It is well known that Iron chelators function as antioxidants by scavenging ROS and reduce the amount of available iron thereby decreasing the quantity of free radicals generated during oxidative reaction (Jonathan 2015). Since excess ROS in the body easily cause oxidative damage to various biomolecules such as proteins, lipids and DNA leading to various disease conditions (Jonathan *et al*., 2015), the obtained results reveal that the studied plants extracts portrays good chelating ability which plays a big roles in reducing oxidative damages. This is an indication that the studied plant is a very useful source of phytochemicals with powerful antioxidant abilities thus supporting its diversified folkloric uses.

CONCLUSION

In this study *Oxalis corniculata* extracts portrayed high antioxidant activities and possess a vast number of precursors of antimicrobial compounds, which support its folkloric use as a cure for some human ailments. The high antioxidant results portrayed by this plant shows that it can be the source of natural antioxidants representing a potentially side effect-free which is the best alternative to synthetic antioxidants in the food processing industry as

well as possible uses in preventive medicine. It also reveals it to possess a great potential to act as a source of useful drugs because of the presence of various primary and secondary metabolites.

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