

Proximate Composition, Qualitative Phytochemical Screening and *In-Vitro* Antioxidant Potential of *Triumfetta rhomboidea* Leaves Extracts

Emmanuel Akintimehin^{1,*}, Iyere Onoagbe² and Osahon Abu²

¹Biochemistry Unit, Department of Chemical Sciences, School of Sciences, Olusegun Agagu University of Science and Technology, Ondo State, Nigeria

²Department of Biochemistry, Faculty of Life Sciences, University of Benin, Edo State, Nigeria

(*Corresponding author's e-mail: emmanuelakintimehin@yahoo.com)

Received: 5 March 2022, Revised: 1 July 2022, Accepted: 8 July 2022, Published: 11 November 2022

Abstract

Continuous exploration of medicinal plants for bioactive constituents is essential since the availability and activities of these compounds speaks volume of their possible medicinal benefits. This study evaluated the proximate composition, phytochemical constituents and antioxidant potential of *Triumfetta rhomboidea* leaf extract. Extraction of aqueous (AETR) and ethanol (EETR) extract were performed by maceration. Proximate composition of pulverized leaf sample was performed following Association of Official Analytical Chemists (AOAC) standards. Antioxidant capacity of extracts were evaluated by determining the total phenolics content (TPC), total flavonoid content (TFC), total antioxidant capacity (TAC), ferric reducing antioxidant power (FRAP) scavenging ability, reducing power (RP) and lipid peroxidation inhibition. Results of proximate analysis revealed 11.01 % moisture content, 3.38 % ash content, 15.15 % crude fiber, 7.34 % crude fat, 61.09 % carbohydrate content, 17.18 % protein content and 379.14 kJ energy value. The total phenol content in aqueous and ethanol extracts were 20.36 ± 0.27 and 12.66 ± 0.28 mg GAE/g, respectively. Total flavonoid was 18.18 ± 1.02 mg QE/g for aqueous and 22.27 ± 0.26 mg QE/g for ethanol extracts with antioxidant capacity of 16.34 ± 4.92 mg AAE/100 g and 48.16 ± 8.50 mg AAE/100 g, respectively. AETR demonstrated highest Fe (II) reducing ability with IC_{50} of 0.33 ± 0.04 and 0.36 ± 0.04 mg/mL for FRAP and RP activities. This study has demonstrated that *T. rhomboidea* leave possess biologically active constituents and could presumably perform free radical scavenging activities in reactive oxygen species related diseases.

Keywords: Antioxidant, Crude fibre, Phenols, Proximate, Reactive oxygen species, Reducing power, *Triumfetta rhomboidea*

Introduction

Plants with therapeutic functions are often used as alternative medicines for the prevention, management and treatment of ailments such as diabetes mellitus, hypertension and anemia owing to their effectiveness, safety and easy access. The effectiveness and health benefits of medicinal plants in tradomedical practices have urged scientists to explore their chemical compositions and roles in the treatment of diseases [1].

Chemical agents from plant origin are usually organic and exert similar physiological actions relative to synthetic drugs. Owing to this feature, they are often employed as important source of pharmaceutical ingredients and lead compounds in food industries [2]. Common bioactive compounds with curative or disease preventive attributes include phenolic compounds, alkaloids, steroids, flavonoids, tannins, saponins and glycosides [3]. These non-nutritive compounds have been implicated in the mitigation of oxidative stress in neurodegenerative disorders, diabetes mellitus, cardiovascular diseases, allergic response and inflammations [4].

Triumfetta rhomboidea L. jacq, an herbaceous perennial plant belongs to family of *Tiliaceae*. The pantropical plant is commonly called bur weed or chinese burr in English and locally known as Udo (Igbo), Ilasa omode or Ewe akeri among the Yorubas in Nigeria [5]. Conventionally, the species of *Triumfetta* are used for the treatment of various ailments such as diarrhoea, tumours, gonorrhoea and diabetes mellitus. The leaves are used for diverse purposes in various Africa countries [6]. Recent report on petroleum ether and methanolic extract of *T. rhomboidea* have revealed the presence of glycosides, phytosterol, flavonoid and triterpenoids [7].

Indigenous people of Côte d'Ivoire and Burkina Faso use the leaf as infusions for children to prevent diarrhea, dysentery and fever [5]. Snakebites, pneumonia are conventionally treated with the leaves in Rwanda. The plant decoction is commonly consumed by pregnant women in Uganda and South Africa to ease and hasten childbirth. Local practitioners of veterinary medicine in Nigeria frequently feed horses with the leaves to cure internal digestive disorders and get rid of worms [5]. Continuous investigation of bioactive compounds in medicinal plants cannot be undermined since availability of these compounds speak volume of its antioxidant properties and to large extent the health benefits of medicinal plants. This study therefore investigated the proximate composition, phytochemical constituents and *in-vitro* antioxidant properties of *Triumfetta rhomboidea* leaf extracts.

Materials and methods

Plant material and extracts preparation

Triumfetta rhomboidea leaves were freshly harvested from a local farm in Okitipupa, Ondo State, identified and authenticated at the Herbarium unit, Plant Biology and Biotechnology Department, University of Benin with voucher number *UBH_T – 403*. Leaves were air dried and pulverized into powder using an electric blender. Portion (1000 g) of powdered sample were weighed in different containers, soaked with distilled water and absolute ethanol respectively for 72 h with intermittent stirring. After filtering the mixtures, the aqueous filtrate was freeze-dried using a freeze dryer to obtain concentrated aqueous extract of *T. rhomboidea* (AETR), while the ethanol filtrate was concentrated into a slurry paste using rotary evaporator under reduced pressure and further freeze-dried to obtain the ethanol extract of *T. rhomboidea* (EETR).

Proximate analysis

Proximate composition of dried sample of *T. rhomboidea* leaf was determined using the AOAC method [8] and each analysis was carried out in triplicates. The moisture content was performed in dry oven at 110 °C while ash was analyzed following calcination of dried sample in muffle furnace at 550 °C for 3 h. Crude fiber was measured by initial digestion of 5 g of dried sample under reflux in equal concentration of acid and base followed by sequential washing with hot water, acetone and hydroethanol. Petroleum ether was used for the extraction of crude fat using soxhlet extractor at 60 °C for 6 h following drying in hot air-oven at 120 °C. Total protein in leaf sample was estimated using Kjeldahl method. Carbohydrate content was estimated by difference method using the equation below:

$$\begin{aligned} \text{Carbohydrate (\%)} \\ &= 100 - [\text{Moisture (\%)} + \text{Ash (\%)} + \text{Crude protein (\%)} \\ &\quad + \text{Crude fat (\%)} \end{aligned}$$

Total energy value was calculated by Atwater factors:

$$\begin{aligned} \text{Energy value (KJ)} \\ &= (\% \text{ Crude protein} \times 4) + (\% \text{ Carbohydrate} \times 4) + (\% \text{ Crude fat} \times 9) \end{aligned}$$

Preliminary phytochemical screening

Preliminary phytochemical analysis to detect the presence of phytochemical constituents in aqueous and ethanol extracts of *Triumfetta rhomboidea* leaf was determined following standard procedures [9-11].

Antioxidant assays

Determination of total phenolic content

Exactly 1 mL of folin-ciocalteu phenol reagent (1:15) was added to 1 mL of extracts (conc. 1 mg/mL) in a test tube and allowed to stand for 5 min. Thereafter, 5 mL of 7 % Na₂CO₃ solution was added to the mixture followed by 6.5 mL of distilled water and mixed thoroughly. The mixture was allowed to incubate in the dark for 90 min at 25 °C followed by an absorbance was reading at 750 nm against reagent blank [12]. The phenolic concentration was extrapolated from a gallic acid calibration curve and the total phenolic content (as expressed in mg gallic acid equivalent (GAE)/g of extract) was calculated below.

$$C = (c \times V)/m$$

where, C = total content of phenolic compounds (mg GAE/g of extract); c = the concentration of garlic acid established from the calibration curve (mg/mL); V = the volume of extract (mL), m = the weight of crude plant extract (g).

Determination of total flavonoids content

Briefly, 1 mL of plant extract (1 mg/mL), 3.4 mL of 30 % methanol, 0.15 mL of 0.5 M NaNO₂ and 0.15 mL of 0.3 M AlCl₃·6H₂O were mixed vigorously in a 20 mL test tube. After 5 min, 1 mL of 1 M NaOH was added, mixed thoroughly and the absorbance was measured against the reagent blank at 506 nm. The total flavonoid content was determined from Quercetin standard calibration curve. The total flavonoids were expressed as mg of Quercetin equivalent (QE) per g of the extracts [13].

Total antioxidant capacity

The total antioxidant capacity was measured by phosphomolybdate method [14]. In test tubes containing 1.0 mL of extracts (conc. 1 mg/mL) were added 1 mL of working reagent (0.6 M sulphuric acid, 28 mM sodium phosphate and 4 mM ammonium molybdate) and mixed thoroughly. The test tubes were capped and incubated at 95 °C in a water bath for 90 min followed by cooling and absorbance reading of mixtures against reagent blank at 765 nm. The reagent blank contained 1 mL of working reagent and incubated under the same conditions. The antioxidant capacity was expressed as mg of ascorbic acid equivalent per gram of extracts.

Ferric reducing antioxidant power (FRAP)

Exactly 1.5 mL of freshly prepared FRAP working reagent {25 mL acetate buffer (300 mM; pH 3.6), 2.5 mL of 2,4,6-tripyridylstriazine (10 mM TPTZ prepared in 40 mM HCl), and 2.5 mL of 20 mM ferric chloride (FeCl₃·6H₂O)} was mixed with 1 mL of extracts at various concentrations (0.2 - 1.0 mg/mL) in test tubes. The mixtures were incubated at 37 °C for 30 min and absorbance at 593 nm was measured. Similar concentrations of FeSO₄ were used to prepare the calibration curve and values were expressed as μmol FeSO₄ equivalents per gram of sample. The reference control (ascorbic acid) was also performed following similar experimental condition [15].

Reducing power

A total of 1.0 mL of different concentrations of extracts (conc. 0.25 - 1.0 mg/mL) was mixed with 1 mL of phosphate buffer (0.2 M, pH 6.6) and 1 mL of potassium ferricyanide (10 mg/mL). The mixture was incubated at 50 °C for 20 min followed by the addition of 1 mL of 10 % trichloroacetic acid to terminate the reaction. The mixture was centrifuged at 3000 rpm for 10 min to collect the supernatant. Exactly 1 mL from the supernatant was mixed with 1 mL of distilled water and 0.2 mL of freshly prepared ferric chloride (0.1 %). Reaction mixture was allowed to stand for 10 min and the absorbance was measured at 700 nm. Ascorbic acid was used as the standard and a plot of absorbance against various concentration was used to express the reducing potential of the extracts [16].

Lipid peroxidation determination

Lipid peroxidation was determined using the method of Ohkawa [17]. Briefly, 0.1 mL of extracts was mixed with 0.5 mL of 10 % fresh egg yolk homogenate in a test tube and made up to total volume of 1 mL with distilled water. To induce lipid peroxidation, 0.05 mL of 0.07 M FeSO₄ was added and incubated for 30 min in the dark. After incubation, 1.5 mL of 20 % acetic acid (adjusted to pH 3.5 with NaOH), 1.5 mL of TBA-SDS (0.8 % TBA in 1.1 % sodium dodecyl sulphate) and 0.05 mL 20 % TCA were added. The test tubes were capped to vortex the resulting mixture and heated at 95 °C for 60 min in a water bath. The absorbance of pink color form was measured at 532 nm.

Inhibition of lipid peroxidation (%) was calculated with the formula:

$$\% \text{ Inhibition} = (C-E)/C \times 100 \%$$

C is the absorbance value of the fully oxidized control, E is the absorbance of the extract.

Statistical analysis

Data are expressed as mean \pm standard error of mean. Statistical significance was evaluated by one-way analysis of variance using Statistical Package for Social Sciences (SPSS) version 17 SPSS and individual comparisons were obtained by least significant difference (LSD) test.

Results and discussion

Results of the proximate analysis and qualitative phytochemical screening of *Triumfetta rhomboidea* leaf are shown in **Tables 1** and **2** respectively. The proximate composition of the pulverized plant sample revealed moisture content value of 11.01 ± 0.13 %, ash content (3.38 ± 0.22 %), crude fibre (15.15 ± 0.28 %), crude fat (7.34 ± 0.34 %), carbohydrate (61.09 ± 0.41 %), 17.18 ± 0.29 % total protein content and 379.14 ± 5.86 KJ of energy value.

Proximate assessments of food and biological materials are essential in food processing for evaluating the quality and nutritional composition of food samples. Pulverized sample of *T. rhomboidea* leaves contained appreciable percentage of proximate composition in the decreasing order of carbohydrate > crude protein > crude fibre > moisture > crude fat > ash. Carbohydrate content of *T. rhomboidea* leaf is high compared to values obtained from the leaves of *Chenopodium ambrosioides*, *Oscium gratissimum* [18] and *Combretum racemosum* [3]. However, the value was low compared to 73.77 % carbohydrate content from *Ficus capensis* leaves [19]. Carbohydrate is an essential class of food that is stored in the body, serves as precursor for biological synthesis of many compounds and provides energy for living systems [20]. The crude protein content reported in this study is similar to 17.05 % obtained from *Aneilema aequinoctiale* leaves [21] and 17.94 % from *Persea Americana* leaves [22]. The crude protein content is slightly lower compared to crude protein of *Parquetina nigrescens* (25.06 %), *Oscium gratissimum* (29.01 %), *Chenopodium ambrosioides* (30.00 %) leaves [18]. The role of protein in diverse body functions (such as hormone synthesis, immune function and body development etc) cannot be underrated since deficiencies is one of the major factors that contribute to nutritional pathology [19].

Crude fiber in *T. rhomboidea* is high compared to 1.34 % obtained from *Aneilema aequinoctiale* [21] and 4.77 % from *Ficus capensis* [19]. *T. rhomboidea* leaves could be considered as an excellent source of dietary fiber for the absorption of trace elements in gastrointestinal tracts and improving bowel movement in order to prevent digestive disturbances arising from indigestion [23]. The moisture content (11.01 %) obtained from dry leaves of *T. rhomboidea* is similar to moisture contents of 11.04 % and 11.9 % obtained from *Crescentia cujete* leaves [24] and *Acalypha hispida* leaves [25] respectively. However, it is lower when compared to *Persea Americana* (21.74 %) and *Annona muricata* (16.58 %) by Princewill-Ogbonna *et al.* [22]. The moisture content of *T. rhomboidea* leaves could depicts good storage strength, low susceptibility to microbial infection and possible reduction of enzyme activities that might hydrolyze bioactive constituent in the pulverized sample [21]. The total ash content of *T. rhomboidea* leaves is low compared to values reported for the leaves of some selected medicinal plants [18] and 6.65 % ash content reported for *Ficus capensis* leaves [19]. The low ash content obtained from this study could indicate subtle amount of mineral matter in the plant since ash content of food material is a measure of mineral contents.

Table 1 Proximate composition of *T. rhomboidea* leave sample.

Parameters	% Composition
Moisture	11.01 ± 0.13
Ash	3.38 ± 0.22
Crude fibre	15.15 ± 0.28
Crude fats	7.34 ± 0.34
Protein crude	17.18 ± 0.29
Carbohydrate	61.09 ± 0.41
Energy value (KJ)	379.14 ± 5.86

Values are presented as mean \pm SEM of 3 independent determinations.

Qualitative phytochemical screening of AETR and EETR showed the presence of saponins, tannin, phenols and flavonoid. Triterpenoids and steroid were only detected in aqueous extract while alkaloid was not detected in both extracts.

The qualitative phytochemical screening of aqueous and ethanol extracts of *T. rhomboidea* leaf showed that both extracts are rich in medicinally active phytochemical constituents (**Table 2**). The availability of these phytochemicals in extracts of *T. rhomboidea* leaf may be accounted for the medicinal potential of the plant. Secondary metabolites in various plant and their parts (leaf, stem and root bark) could differ in terms of availability, structure, mechanism of actions and biological properties. These phytochemicals have been scrutinized and showed to be responsible alone or in synergy for different biological activities such as antioxidant, antimicrobial, anti-diuretic and anti-inflammatory activities [26].

The total phenol content (mg GAE/g), total flavonoid content (mg QE/g) and total antioxidant capacity (mg AAE/g) of aqueous and ethanol extracts of *T. rhomboidea* leaf are shown in **Table 3**.

Table 2 Qualitative phytochemical screening of extracts of *T. rhomboidea* leaf.

Phytochemicals	AETR	EETR
Flavonoid	+	+
Phenol	++	+
Alkaloid	--	--
Steroid	+	--
Saponin	++	+
Tannin	+	+
Triterpenoids	+	--

Extract(s) having double plus (++) sign is an indication that phytochemical constituent(s) is highly present, those with single plus (+) sign shows that phytochemical constituent is moderately present while minus sign (-) shows that phytochemical constituent(s) is absent. Flavonoids, phenols, saponins, steroid, triterpenoids and tannins are present while alkaloids is absent in both aqueous and ethanol extract of *T. rhomboidea* leaf.

The total phenol content, flavonoid content and antioxidant capacity obtained for aqueous and ethanol extracts were 20.36 ± 0.27 and 12.66 ± 0.28 mg GAE/g, 18.18 ± 1.02 and 22.27 ± 0.26 mg QE/g, 16.34 ± 4.92 and 48.16 ± 8.50 mg AAE/100 g, respectively. Total flavonoid and total antioxidant capacity of ethanol extract showed significant ($p < 0.05$) increase compared to aqueous counterpart while the aqueous extracts showed significant ($p < 0.05$) increase in total phenol content compared to ethanol extract. The high trend of phenolic content obtained in aqueous extract compared to ethanol extract corroborated with previous study. Ashafa *et al.* [27] obtained total phenolic content of 83.4 ± 0.03 and 60.4 ± 0.01 mg GAE/g, respectively from aqueous and ethanol extract of *Felicia muricata* leaf. Total phenolic content obtained from extracts (AETR and EETR) were higher than phenolic contents of the aqueous (0.03 ± 0.02) mg/g GAE and ethanol (0.12 ± 0.01) mg/g GAE extracts of *Simarouba glauca* leaf [28], *Zataria multiflora* (3.01 ± 0.07) mg GAE/g and *Otostegia persica* (5.21 ± 0.118) mg GAE/g [29].

The high phenolic content obtained in the aqueous extract could be an indication that aqueous solution (water) is more suitable for the extraction of phenolic compounds in *Triumfetta rhomboidea* leaf. Water is a universal solvent that is commonly used for the extraction plant materials with antimicrobial activity. Corroborating with previous studies, high amounts of phenolics obtained in this study could be responsible for the antimicrobial and free radical scavenging activity [6]. The high flavonoid content obtained from ethanol extract compared to aqueous extract of *T. rhomboidea* leaf is agreement with previous study. Total flavonoids contents obtained from the ethanol and aqueous extracts of *Felicia muricata* leaf were 30.4 ± 0.03 and 25.4 ± 0.01 mg QE/g, respectively [27]. The concentration of flavonoid was also high in ethanol extract (625.33 ± 31.25) compared to aqueous extract (449.33 ± 20.96) of *Murraya koenigii* leaf [30]. Flavonoid contents from *Crataegus meyeri* Pojark leaf aqueous and ethanol extracts were 2.15 ± 0.01 and 3.56 ± 0.01 mg QE/g, respectively [31]. In this study, both aqueous and

ethanol extracts of *Triumfetta rhomboidea* leaf possessed higher flavonoid relative to extracts of *Simarouba glauca* leaf [28], *Crataegus meyeri* Pojark leaf [31], leaf of *Clerodendrum volubile* [32]. The high flavonoid contents observed in ethanol extract compared to aqueous extract in this study could be due to the polarity of ethanol and presumably easy penetration into cellular membrane of plants [33]. Medicinal plants that are rich in flavonoids have been reported to be useful as anti-inflammatory, anti-microbial, hepatoprotective agents and also prevent platelets aggregation [20].

Table 3 Phenol, flavonoid and total antioxidant capacity of the extracts of *T. rhomboidea*.

Extracts	Total Phenol (mg GAE/g)	Total Flavonoid (mg QE/g)	TAC (mg AAE/100g)
AETR	20.36 ± 0.27 ^a	18.18 ± 1.02 ^c	16.34 ± 4.92 ^a
EETR	12.66 ± 0.28 ^b	22.27 ± 0.26 ^a	48.16 ± 8.50 ^b

Values are presented as Mean ± SEM (n = 3). Values with the different letters (a,b,c) in superscript along the same column are significantly different ($p < 0.05$). AETR - aqueous extracts of *T. rhomboidea*, EETR - ethanol extracts of *T. rhomboidea*, GAE - Gallic Acid Equivalent, AAE - Ascorbic Acid Equivalent, QE - Quercetin Equivalent

The ferric reducing antioxidant power (FRAP) and reducing ability (RP) of *T. rhomboidea* leaf extract are presented in **Figures 1** and **2**, respectively. From these findings, aqueous extract (AETR) demonstrated high FRAP and RP abilities compared to ethanol extract (EETR). Possible reason for the increase FRAP and RP activities could be as a result of high phenolic contents obtained in the aqueous extract of *T. rhomboidea* leaf. In the presence of oxidative assaults, high phenolics in plant have been reported to cause the release and free flow of electrons for the neutralization free radicals, thereby making such plant a good candidate with FRAP and reducing power ability [34,35]. High FRAP and RP obtained for AETR in this study corroborates with the findings of Erhunse *et al.* [1] who reported high FRAP activity in aqueous extract of *Anthocleista djalonensis* compared to ethanol extract. Similarly, aqueous extract of *Alstonia boonei* was also reported to demonstrate high FRAP activity and reducing ability compared to their ethanol counterpart [36].

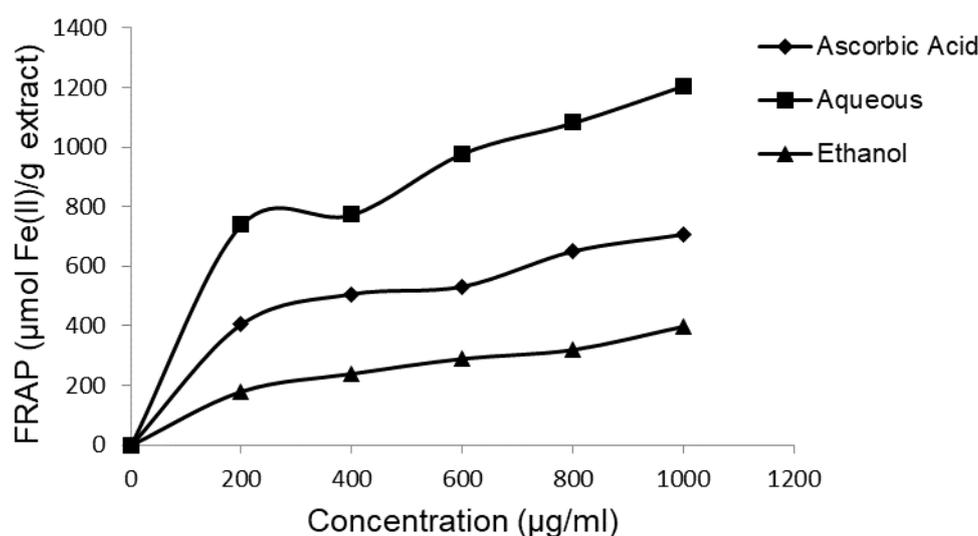


Figure 1 FRAP of *T. rhomboidea* leaf extracts and standard (ascorbic acid).

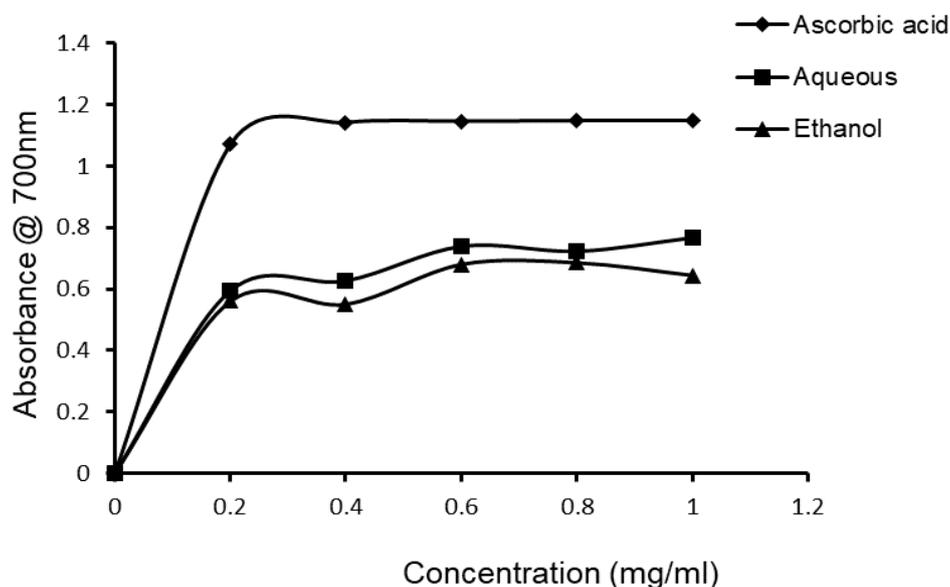


Figure 2 Reducing power of the extracts of *T. rhomboidea* leaves and ascorbic acid.

Values represent the mean of absorbance of reducing power of standard antioxidant (ascorbic acid), aqueous and ethanol extracts of *T. rhomboidea* leaf. Analyses were performed in triplicates. Vertical axis represents values of absorbance reading at 700 nm while horizontal axis represents varying concentration (between 0.2 - 1.0 mg/mL) of standard and extracts.

The extracts demonstrated ferric reducing ability in concentration dependent manner with the aqueous extract showing highest FRAP ($\mu\text{mol/g}$ extract) activity with IC_{50} value of $0.33 \pm 0.04 \mu\text{g/mL}$ (Table 4). Similar to FRAP activity, the AETR also demonstrated a concentration dependent reducing power with IC_{50} value of $0.36 \pm 0.04 \text{ mg/mL}$ compared to ethanol extract with IC_{50} value of $0.48 \pm 0.02 \text{ mg/ml}$ (Table 4).

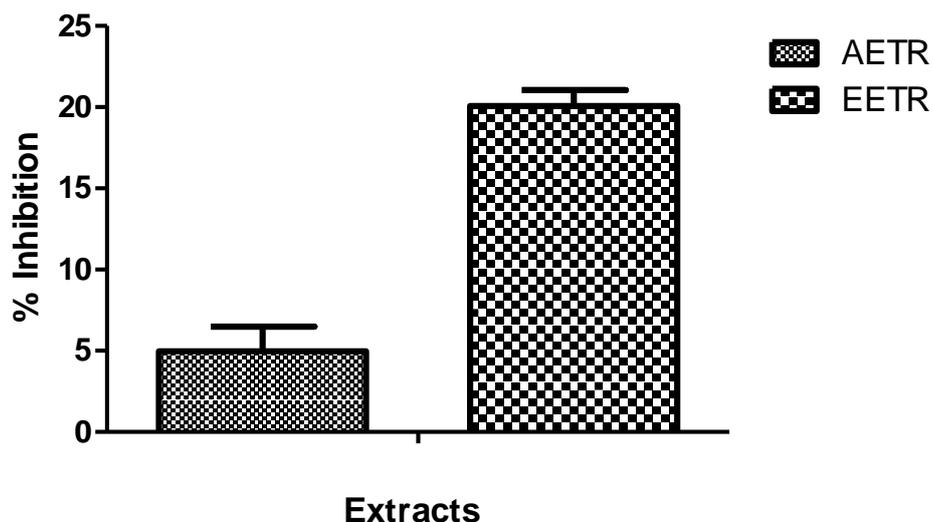


Figure 3 Percentage inhibition of lipid peroxidation by aqueous and ethanol extracts of *T. rhomboidea* leaf.

The above graph represents mean \pm SEM (standard error of mean) of % inhibition of lipid peroxidation of *T. rhomboidea* leaf ethanol and aqueous extracts. Experiment was performed in triplicate. Where AETR: Aqueous extract of *T. rhomboidea* leaf; EETR: Ethanol extract of *T. rhomboidea* leaf

The percentage inhibition of lipid peroxidation by aqueous and ethanol extracts of *T. rhomboidea* leaf is presented in **Figure 3**. The ethanol extract showed higher percentage inhibition of lipid peroxidation compared to aqueous extract.

Peroxidation of lipids usually occurs due to accumulative effect of reactive species, causing loss of membrane integrity including its permeability and fluidity, alterations of ion transport and inhibition of metabolic processes [37]. The inhibition observed in this study could be attributed to presence of phytoconstituent and other antioxidant compounds in the plant extracts. The extracts of *T. rhomboidea* leaf could possibly be a good antioxidative agent that can protect the physiological architecture of membrane bilayers from effect of free-radicals.

Table 4 Summary of IC₅₀ value of FRAP and RP of *T. rhomboidea* leaf extracts.

Samples	FRAP ($\mu\text{g/mL}$)	RP (mg/mL)
AETR	0.33 \pm 0.04 ^a	0.36 \pm 0.04 ^a
EETR	1.12 \pm 0.05 ^b	0.48 \pm 0.02 ^b
Ascorbic acid	0.62 \pm 0.05 ^c	0.06 \pm 0.03 ^c

Values are expressed as mean \pm SEM (n = 3). Values with the different letters (a, b or c) in superscript along the same column are significantly different ($p < 0.05$).

Conclusions

Investigation of bioactive constituents in plants and their therapeutic importance has contributed immensely to scientific validations and general acceptance of medicinal plants in metabolic detoxification system and diseases management. Findings from this study has revealed that *Triumfetta rhomboidea* leaf have good nutritional composition, rich in active phytochemical constituents and possessed antioxidant properties. Further, this study has also demonstrated that the aqueous extracts of *Triumfetta rhomboidea* leaf possessed good radical scavenging ability compared to ethanol extracts presumably due to its high phenolic content.

Acknowledgements

We acknowledge the assistance rendered by Mr. Ojo Samuel of Biological Sciences Department, Olusegun Agagu University of Science and Technology, Okitipupa, Ondo State during plant sample collection.

References

- [1] N Erhunse, O Kelly, NEJ Orhue and ES Omoregie. Comparative study on phytochemical constituents, antioxidant activity and acute toxicity of extracts of *Alstonia boonei* de Wild and *Anthocleista djalonensis*. *J. Pharm. Biores.* 2016; **13**, 14-24.
- [2] LL Lifongo, CV Simoben, F Ntie-Kang, SB Babiaka and PN Judson. A bioactivity versus ethnobotanical survey of medicinal plants from Nigeria, West Africa. *Nat. Prod. Bioprospect.* 2014; **4**, 1-19.
- [3] ES Akintimehin, KO Karigidi, EO Anthony and FO Adetuyi. Proximate composition, minerals, vitamins, phytochemical constituents and anti-nutrient profile of *Beilschmiedia mannii* seeds and *Combretum racemosum* leaves for soup preparation. *J. Food Sci. Tech.* 2022; **59**, 1847-54.
- [4] V Soni, AK Jha, J Dwived and P Soni. Qualitative and quantitative determination of phytoconstituents in some antifertility herbs. *Indian J. Pharm. Sci.* 2018; **80**, 79-84.
- [5] CH Bosch. *Triumfetta rhomboidea* Jacq. In: M Brink and EG Achigan-Dako (Eds.). Plant Resources of Tropical Africa/Ressources végétales de l'Afrique tropicale, Wageningen, Netherlands, 2011.

- [6] N Duganath, DR Krishna, RG Deepak, B Sudheera, M Mallikarjun and P Beesetty. Evaluation of anti-diabetic activity of *Triumfetta rhomboidea* in alloxan induced Wistar rats. *Res. J. Pharm. Bio. Chem. Sci.* 2011; **2**, 721-6.
- [7] MP Ullewar, AR Bukkawar and AB Bagade. Preliminary screening of diuretic activity of *Triumfetta rhomboidea* Jacq leaves extracts in rats. *Res. J. Pharm. Bio. Chem. Sci.* 2010; **1**, 469-73.
- [8] Association of Official Analytical Chemists. *Official methods of analysis*. 17th ed. Association of Official Analytical Chemists, Virginia, 2000.
- [9] JB Harborne. *Phytochemical methods*. Chapman and Hall, London, 1973, p. 49-188.
- [10] A Sofowora. Recent trends in research into African medicinal plants. *J. Ethnopharmacol.* 1993; **38**, 209-14.
- [11] GE Trease and WC Evans. *Pharmacognosy*. Bailliere Tindall, London, 1989.
- [12] DO Kim, OK Chun, YJ Kim, HY Moon and CY Lee. Quantification of polyphenolics and their antioxidant capacity in fresh plums. *J. Agr. Food Chem.* 2003; **516**, 6509-15.
- [13] YS Park, ST Jung, SG Kang, BK Heo, P Arancibia-Avila, F Toledo, J Drzewiecki, J Namiesnik and S Gorinstein. Antioxidants and proteins in ethylene-treated kiwifruits. *Food Chem.* 2008; **107**, 640-8.
- [14] P Prieto, M Pineda and M Aguilar. Spectrophotometric quantitation of antioxidant capacity through the formation of a phosphomolybdenum complex: Specific application to the determination of vitamin E. *Anal. Biochem.* 1999; **269**, 337-41.
- [15] IFF Benzie and JJ Strain. The ferric reducing ability of plasma (FRAP) as a measure of antioxidant power: The FRAP assay. *Anal. Biochem.* 1996; **239**, 70-6.
- [16] M Oyaizu. Studies on products of browning reactions: Antioxidant activities of products of browning reaction prepared from glucose amine. *Jpn. J. Nutr. Diet.* 1986; **44**, 307-15.
- [17] H Ohkawa, N Ohisi and K Yagi. Assay of lipid peroxides in animal tissue by thiobarbituric acid react. *Anal. Biochem.* 1979; **95**, 351-8.
- [18] BA Abiodun, A Adewale and OO Abiodun. Phytochemical and proximate analysis of some medicinal leaves. *Clin. Med. Res.* 2017; **6**, 209-14.
- [19] NK Achi, C Onyeabo, CA Ekeleme-Egedigwe and JC Onyeana. Phytochemical, proximate analysis, vitamin and mineral composition of aqueous extract of *Ficus capensis* leaves in South Eastern Nigeria. *J. Appl. Pharm. Sci.* 2017; **7**, 117-22.
- [20] A Islary, J Sarmah and S Basumatary. Proximate composition, mineral content, phytochemical analysis and *in vitro* antioxidant activities of a wild edible fruit (*Grewia sapida* Roxb. ex DC.) found in Assam of North-East India. *J. Invest. Biochem.* 2016; **5**, 21-31.
- [21] UD Akpabio and EE Ikpe. Proximate composition and nutrient analysis of *Aneilema aequinoctiale* leaves. *Asian J. Plant. Sci. Res.* 2013; **3**, 55-61.
- [22] IL Princewill-Ogbonna, PC Ogbonna and IB Ogujiofor. Proximate composition, vitamin, mineral and biologically active compounds levels in leaves of *Mangifera indica* (Mango), *Persea americana* (Avocado pea), and *Annona muricata* (Sour sop). *J. Appl. Sci. Environ. Manag.* 2019; **23**, 65-74.
- [23] OA Abolaji, AH Adebayo and OS Odesanmi. Nutritional qualities of three medicinal plant parts (*Xylopiya aethiopica*, *Blighia sapida* and *Parinari polyandra*) commonly used by pregnant women in the Western Part of Nigeria. *Pakist. J. Nutr.* 2007; **6**, 665-8.
- [24] MB Olaniyi, IO Lawal and AA Olaniyi. Proximate, phytochemical screening and mineral analysis of *Crescentia cujete* L. leaves. *J. Med. Plants Econ. Dev.* 2018; **2**, a28.
- [25] OM Iniaghe, SO Malomo and JO Adebayo. Proximate composition and phytochemical constituents of leaves of some *Acalypha* species. *Pakist. J. Nutr.* 2009; **8**, 256-8.
- [26] K Arunachalam and T Parimelazhagan. Evaluation of phenolic content, antioxidant activity, and nutritional composition of *Cordia evolutor* (Clarke) Gamble. *Int. J. Food Prop.* 2014; **17**, 226-38.
- [27] AOT Ashafa, DS Grierson and AJ Afolayan. *In-vitro* antioxidant activity of extracts from the leaves of *felicia muricata* thunb. an underutilized medicinal plant in the Eastern cape province, South Africa. *Afr. J. Tradit. Complement Altern. Med.* 2010; **7**, 296-302.
- [28] SDE Osagie-Eweka, NEJ Orhue and DO Ekhaguosa. Comparative phytochemical analyses and *in-vitro* antioxidant activity of aqueous and ethanol extracts of *Simarouba glauca* (Paradise tree). *Eur. J. Med Plant.* 2016; **13**, 1-11.
- [29] M Soheila, P Elham, M Mahmoodreza and V Mahmood. Evaluation of antioxidant potentials and α -amylase inhibition of different fractions of *Labiatae* plants extracts: As a model of antidiabetic compounds properties. *BioMed Res. Int.* 2017; **2017**, 7319504.

- [30] AG Engwa, M Unaegbu, OH Francis, IK Obiudu, FC Ugwu and NK Agbafor. *In vitro* and *in vivo* antioxidant activity of aqueous and ethanol leaf extracts of *Murraya Koenigii*. *Int. J. Pharmacog. Phytochem. Res.* 2016; **8**, 551-7.
- [31] E Suat, B Mahire, G Ahmet, O Fevzi and K Hatice. Antioxidant activity of aqueous and ethanol extracts of *crataegus meyeri* pojark leaves and contents of vitamin, trace element. *J. Chil. Chem. Soc.* 2017; **62**, 3661-67.
- [32] OR Molehin, OI Oloyede and AA Boligon. Comparative study on the phenolic content, antioxidant properties and HPLC fingerprinting of the leaf extracts of *Clerodendrum volubile* P. Beauv. *J. Appl. Pharm. Sci.* 2017; **7**, 135-40.
- [33] P Tiwari, B Kumar, M Kaur, G Kaur and H Kaur. Phytochemical screening and extraction: A review. *Int. Pharm. Sci.* 2011; **1**, 98 -106.
- [34] B Sultana, F Anwar and R Przybylski. Antioxidant activity of phenolic components present in barks of barks of *Azadirachta indica*, *Terminalia arjuna*, *Acacia nilotica*, and *Eugenia jambolana* Lam. trees. *Food Chem.* 2007; **104**, 1106-14.
- [35] S Dontha. A review on antioxidant methods. *Asian J. Pharm. Clin. Res.* 2016; **9**, 14-32.
- [36] ES Omoregie, K Oriakhi, EI Oikeh, OT Okugbo and D Akpobire. Comparative study of phenolic content and antioxidant activity of leaf extracts of *Alstonia boonei* and *Eupatorium odoratum*. *Niger. J. Basic Appl. Sci.* 2014; **22**, 91-7.
- [37] JA Badmus, OA Odunola, EM Obuotor and OO Oyedapo. Phytochemicals and *in vitro* antioxidant potentials of defatted methanolic extract of *Holarrhena floribunda* leaves. *Afr. J. Biotechnol.* 2010; **9**, 340-6.