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Antioxidant properties of aqueous and ethyl acetate extracts of some plants used as herbal tea in Tanzania

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ABSTRACT

Objectives: The purpose of this study was to evaluate antioxidant activity of *Rhus vulgaris*, *Sphaeranthus bullatus*, *Osyris lanceolata*, *Ocimum gratissimum, Cymbopogon citratus, Acacia nilotica,* and *Tylosema fassoglensis* plants that have been used as herbal teas in Tanzania for treatment of various ailments including bacterial and fungal infections.

Methods: Antioxidant activity of the aqueous (AQ) and ethyl acetate (ETA) plant extracts was assessed based on radical scavenging activity of the stable 1,1-diphenyl-2-picryl-hydrazyl (DPPH) on January 2017. Briefly, DPPH (0.2 mm) was obtained by dissolving 3.94 mg of DPPH in 50 ml of pure methanol. The stock solutions of the extracts were prepared in methanol. Serial dilution using 96 well plates was employed to determine radical scavenging activities of different concentrations.

Results: All plants demonstrated free radical scavenging activity ranging from 5.36% to 87.75% in different concentrations with the highest activity of 87.75% observed in *S. bullatus* aqueous extracts in its 500 mg/ml at 60 minutes and the lowest scavenging activity of 5.36% demonstrated by *T. fassoglensis* leaves ethyl acetate extracts in its 3.906 mg/ml. Scavenging activity was observed to change with polarity and time of reaction. Eighty five percent of AQ extracts exhibited the scavenging activity ranging from 80% to 87% at the concentration of 500 mg/ml compared to 39.3% that exhibited by ETA extracts at the same concentration. Total phenolic contents ranged from 57.7 ± 0.8 to 98.02 ± 1.1 mg gallic acid equivalent (GAE)/g dry weight.

Conclusion: The use of herbal tea from *S. bullatus, O. lanceolata, T. fassoglensis, A. nilotica, R. vulgaris, C. citratus,* and *O. gratissimum* has potential antioxidant benefits to human health, so it should be used to prepare herbal tea for management of diseases.

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Introduction

Antioxidants are substances that reduce oxidative stress in the body. Oxidative stress is caused by excess free radical like superoxide anions, hydrogen peroxide, nitric oxides, and peroxynitrites radicals. Excess free radicals is related to many chronic and degenerative diseases such as heart diseases, aging, cancer, acute lung injury, eye diseases, diabetes, respiratory distress syndrome, neuron degeneration, atherosclerosis, malaria, and microbial infections [1]. Body of human has system known as anti-oxidative defense system which balances excess free radical produced during various metabolism [2]. However, oxidative stress is caused by depletion of antioxidant level in the body [2]. In such condition, body requires antioxidant substances from outside like herbal food or medicines to scavenge on excess free radicals.

Plant materials have been used as a good source of antioxidant substances like polyphenols, saponin, flavonoids, lignans, sulfides, terpenoids, including allicin, anthocyanin, biochanin, carotenoids, curcumins, ellagic acid, epigallocatechin-3-O-gallate, phthalides, phytic acid, and sterols [3].

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For instance, *Camellia sinensis* contains antioxidant compounds like catechin derivatives and tannin [4] that are considered to induce apoptosis cell death in cancer [4].

Antioxidant materials from the plants have been shown to manage microbial infections. For instance, antioxidant substances were observed to manage *E. coli* infection in mice [5]. In Tanzania, various medicinal herbal teas have been used for management of diseases by different ethnic groups for instance, *Ocimum gratissimum* and *Spheranthus bullatus* are used to manage diarrhea which in most cases is caused by microbial infections. Ability of these plant species to manage disease can be caused by their antioxidant compounds. Therefore, this study was motivated to evaluate antioxidant activity of *R. vulgaris*, *S. bullatus*, *O. lanceolata, O. gratissimum, C. citratus, A. nilotica,* and *T. fassoglensis* plants used as medicinal herbal tea in Tanzania.

Rhus vulgaris

Rhus vulgaris, native to East Africa, is a plant whose leaves and fruits are used as herbal tea by people in Rorya district of Tanzania. The roots, barks, and fruits of the plant are used to treat dysentery, malaria, and management of sexual impotence and erectile dysfunction in East Africa [6]. It has also been reported that its fruits are used for treatment of cough, gastrointestinal disorder, syphilis, tooth ache immunity booster, small pox, swollen lymph, and prevention of infectious diseases in area around Lake Victoria in East Africa [7]. According to [8], *R. vulgaris* are used in Kakamega, Kenya for management of gonorrhea and fever. The aqueous (AQ) extract of the branches of the plant which are used as chewing stick in Uganda has been reported to possess antibacterial activity against *Streptococcus mutan* [9]. Although no study has documented on its secondary metabolites, the members of the family Anacardiaceae are known to contain tannins, triterpenes, flavonoids, and other phenolic compounds [10].

Sphaeranthus bullatus

Sphaeranthus bullatus is native to East Africa. The genus Sphaeranthus has been reported to contain more than forty spp. distributed mainly in Africa, Southern Asia, and Australia [11]. Dry powder of *S. bullatus* aerial parts is used as herbal tea in Northern Tanzania but is preferably taken with the intention of managing diarrhea; it is also used to treat asthenia (lack of energy) and to remove retained placenta in livestock [12]. Antimalarial and anticancer activity of *S. bullatus* collected from the Ngong Forest in Kenya has been reported [12]. Some plant species from genus *Sphaeranthus* have been phytochemically investigated in Egypt and a number of carvotacetone derivatives with antibacterial and antifungal properties were reported [13]. Leaves of *Sphaeranthus africanus* which is in the same genus with *S. bullatus* was found to possess compounds; chrysosplenol D, squalene, spinasterol, and stigmasterol that exhibited antibacterial activity against *Staphylococcus aureus* and *Pseudomonas aeruginosa* and antifungal activity against *Candida albicans, Trichophyton mentagrophytes,* and *Aspergillus niger*. *S. bullatus* has been reported to contain 3-acetoxy-7-hydroxy-5-tigloyloxy-carvotacetone, 3,7-dihydroxy-5-tigloyloxy-carvotacetone, 3-acetoxy-5,7-dihydroxy-carvotacetone, 3,5,7-trihydroxy-carvotacetone, and 5-glucopyranosyl-carvotacetone [14].

Ocimum gratissimum

Ocimum gratissimum is a well-known plant used in different parts of the world to treat conditions such as diarrhea, headache, ophthalmic, skin diseases, pneumonia, cough, fever, conjunctivitis, regulation of menstrual cycle, and respiratory infection [15]. In Tanzania, its leaves and flowers are used as herbal teas and also, to treat stomach problems. Previous studies from other parts of the world reported the main constituents of *O. gratissimum* as thymol, eugenol, and methyl chavicol, and other secondary metabolites such as alkaloids, tannins, and flavonoids [16].

Antimicrobial activity of *O. gratissimum* has been investigated in different parts of the world. Study performed by [17] in India found that leaves of *O. gratissimum* possess activity against *S. aureus*, *E. coli,* and *Klebsiella* spp. In Kenya, a comparison study was conducted on *O. gratissimum* from 13 different ecological zones, and it was observed that *O. gratissimum* found in Meru District had the highest antimicrobial activity compared to others [18].

Osyris lanceolata

Osyris lanceolata (Santalaceae) is a plant species native to South Africa, Zimbabwe, and East Africa mainly in Tanzania, Kenya, and Uganda [19]. The root bark of *O. lanceolata* is widely used in Same and Mwanga Districts as a herbal tea. While the stem bark powder is used to treat wounds, stomach aches, ulcers, diarrhea, and skin rashes in Kitui and

Kajiado areas in Kenya [20] and to treat malaria [21]. In South Africa, the stem bark of the plant is powdered, boiled in water, and used to manage fungal infections [22]; and the roots are used to treat erectile dysfunction by the Bapedi people in Limpopo Province of South Africa. In Venda, South Africa the root decoction is used to prepare porridge, while the roots and leaves are burned and the smoke is used to treat sterility and gynecological problems in women [23]. Previous studies performed in Botswana on the roots of *O*. *lanceolata* revealed the presence of Dihydro-β-agarofuran sesquiterpenes with antimicrobial activity against fungi and bacteria [13].

Cymbopogon citratus

Cymbopogon citratus native to India was introduced in Tanzania and is mainly used as a natural flavoring agent in tea. It is usually incorporated in the preparation of black and other herbal teas. Naik et al. [24] reported the antibacterial activity of *C. citratus* cultivated in India against *E. coli.* Antimicrobial activities of *C. citratus* in different ecological systems in the world against various bacterial and fungal species have been reported [25]. Various compounds have been reported in *C. citratus* that are mainly terpenes, alcohols, ketones, aldehyde, and esters. Some of the reported phytoconstituents are essential oils that contain citral α, citral β, nerol geraniol, citronellal, terpinolene, geranyl acetate, myrecene, and terpinol methylheptenone [26]. The plant also contains phytoconstituents such as flavonoids and phenolic compounds, which consist of luteolin, isoorientin 2´-O-rhamnoside, quercetin, kaempferol, and apiginin. Studies indicate that *Cymbopogon citratus* possesses various pharmacological activities such as anti-amoebic, antibacterial, antidiarrheal, antifilarial, antifungal, and anti-inflammatory properties. Various other effects like antimalarial, antimutagenicity, antimycobacterial, antioxidants, hypoglycemic, and neurobehaviorial have also been studied [27]. There is, however, no information about its antimicrobial activity in any of the ecological zones of Tanzania.

Tylosema fassoglensis

The tuber of *T. fassoglensis* is usually dried and used as tea in Rorya District of Tanzania. The tuber is also used to treat impotence, constipation, and diarrhea and to boost the immunity of HIV patients. The leaves are used in the management of boils and the seeds for the treatment of gastrointestinal problems, fever, anemia, and pneumonia [28]. Previous studies conducted in Kenya revealed that tubers of *T. fassoglensis* have mild activity against *C. albicans* and bacteria, namely *E. coli*, *S. aureus* and *Bacillus cereus* [29]. There is no study reported on the chemical constituents of the root of *T. fassoglensis*. Other species of the same family are known to contain phenolic and phytosteriods compounds [28].

Acacia nilotica

Acacia nilotica is widely distributed in Tanzania and is used for the management of malaria, measles in children, diarrhea, impotency, and gonorrhea [30]. Infusion made from the bark of *A. nilotica* is used to treat gonorrhea, dysentery, diarrhea, and pneumonia [30]. The same plant is used as herbal tea in some parts of Siha District in Tanzania for stimulation or excitement. It has also been reported to possess antibacterial activity against *S. aureus*, *Bacillus subtilis, Shigella sonneii*, *E. coli,* and antifungal activity against *Aspergillus flavus* in Pakistan [31]. Other studies from India [32] found that *A. nilotica* has antibacterial activity against both Gram-negative and Gram-positive bacteria. Phytochemical study has indicated that *A. nilotica* contains physterols, flavanoids, and saponins [32].

Plant species; *R. vulgaris*, *S. bullatus*, *O. lanceolata O. gratissimum, C. citratus, A. nilotica,* and *T. fassoglensis* have been used in different ethnic groups in Tanzania as medicinal herbal teas for refreshment and management of diseases. However, there is a little or no information in the literature concerning scavenging (antioxidant) activity of these plant species in Tanzania. Therefore, it was interest of this study to explore their antioxidant activity. Antioxidant activity of *Camellia sinensis* was also evaluated and compared to antioxidant activity of other plants.

Material and Methods

Plant materials

Plant materials were collected from Rorya, Same, Arumeru, and Siha districts in Tanzania based on the available ethno herbal tea information from personal communication with local users who use these plants as herbal tea in Rorya, Siha, Same, and Arumeru districts from October 2016 to January 2017. The collected plants were identified by a taxonomist in the herbarium Department of the Tropical Pesticide Research Institute, Arusha,

Tanzania. Voucher specimens were deposited at Nelson Mandela African Institution of Science and Technology, Arusha, Tanzania.

Preparation and extraction of the plant material

Leaves, roots, stem barks, and tuber (3 kg per sample) of the plant species were air dried under shade and then, pulverized into fine particles. For medium polar extraction, 250 g of pulverized material was sequentially macerated using ethyl acetate (ETA) for 48 hours, filtered using Whatman paper number 1 and solvents were removed under vacuo using a rotary evaporator. In the case of AQ extraction, the same pulverized material was soaked in boiled water (1,500 ml) maintained at 60°C in the incubator for 24 hours. The extract was sieved and then, centrifuged at 5,000 rpm for 10 minutes. Supernatant was collected and then, filtered using Whatman paper number 1. The process of centrifuge and filtration were repeated two times and final supernatant were collected and dried by freeze drier to eliminate water by sublimation. All extracts were stored in the deep freezer at −20°C.

Antioxidant activity

Antioxidant activity of the AQ and ETA plant extracts was assessed based on radical scavenging activity of the stable 1,1-diphenyl-2-picrylhydrazyl (DPPH) [6]. A DPPH (0.2 mm) was obtained by dissolving 3.94 mg of DPPH in 50 ml of pure methanol. The stock solutions of the extracts were prepared in methanol. Serial dilution using 96 well plates was employed to determine radical scavenging activities of different concentrations. First plates were filled with 100 µl of methanol followed by 100 µl of extracts on the first rows to make initial concentration of 1,000 µg/ml. After thorough mixing, 100 µl were drawn from the first row to subsequent rows making 100 µl of 500, 250, 125, 62.5, 31.25, 15.625, 7.81, and 3.906 µg/ml concentrations. The 100 µl of 0.2 mm DPPH was added and the resulting solution was monitored at 517 nm in every 30 minutes for an hour using Synergy HTX 15032320 Reader. All determinations were performed in triplicate. Ascorbic acid was used as standard. The absorbance of 0.2 mm of DPPH in methanol before the reaction with samples was used as blank. The radical scavenging activity of the extract was determined by the following formulae:

$$\text{Free-radical scavenging activity (\%)} = \text{A (blank)} - \text{A (extract)} / \text{A (blank)}$$

Total phenolic contents of AQ and ETA extracts of *S. bullatus, O. gratissimum, O. lanceolata, T. fassoglensis, C. citrates, A. nilotica, and R vulgaris* were measured using the Folin–Ciocalteu reagent. 0.5 ml of extract at appropriate dilutions was added to 2.5 ml of Folin–Ciocalteu reagent and 2 ml of Na_2CO_3 solution. The absorbance was measured at 560 nm, after incubation for 90 minutes in dark. The total phenolic content was expressed as mg Gallic acid equivalents per gram of dry weight [mg gallic acid equivalent (GAE)/g dry weight] through the calibration curve with gallic acid.

Results

Antioxidant activity of the AQ and ETA extracts of the plants tested showed that all the plants demonstrated free radical scavenging activity ranging from 5.36% to 87.75% in different concentrations (Tables 1–4). The highest activity of 87.75% was observed in *S. bullatus* aqueous (SBA) extracts at 500 mg/ml and the lowest scavenging activity of

Table 1. Antioxidant activity of AQ extracts of plants used as herbal tea in Tanzania at 30 minutes.

Conc (mg/ml)	Plant extracts													
	SBA	CSA	TFLA	OLA	TFRA	ANRA	ANBA	OGFLA	OGRA	RVRA	CCA	OGLA	RVLA	RVBA
3.906	43.12	49.53	17.57	41.99	35.95	29.41	41.56	27.54	44.98	43.74	28.35	38.01	41.56	43.23
7.81	44.8	51.46	33.33	46.54	67.08	41.62	43.55	27.66	47.23	48.6	35.51	41.93	45.73	47.2
15.625	45.98	51.59	48.1	48.16	71.84	63.36	43.86	29.53	47.79	49.78	39.31	54.27	45.67	49.45
31.25	46.04	56.32	60.37	53.89	71.99	81.18	45.36	47.91	50.53	51.59	46.11	68.97	45.67	50.7
62.5	46.79	61.43	82.37	54.21	73.12	81.43	45.67	50.59	51.15	51.09	62.93	80.81	45.78	52.69
125	47.1	69.97	82.93	54.58	80.3	82.49	45.73	63.67	53.77	56.46	80.75	83.8	49.86	55.5
250	48.66	78.5	83.61	64.74	82.23	82.87	50.28	72.15	61.37	56.6	81.68	83.93	50.28	57.64
500	87.25	81.56	84.86	85.61	87.21	83.49	80.62	75.14	68.1	80.25	83.18	85.42	80.62	80.11

*CSA = *C. sinensis aqueous*, OLA = *O. lanceolata* aqueous, TFLA = *T. fassoglensis* aqueous, ANBA = *A. nilotica* barks aqueous, OGFA = *O.gratissimum* flower aqueous, OGRA = *O. gratissimum* roots aqueous, RVRA = *R. vulgaris* aqueous, CCA = *C. citratus* aqueous, RVLA = *R: vulgaris* leaves aqueous, RVRB = *R. vulgaris* bark aqueous

5.36 mg/ml demonstrated by *T. fassoglensis* leaves ethyl acetate extracts at 3.906 mg/ml. It was observed that antioxidant activity increases with increase of time of the reaction. In general, there was a slight increase of scavenging activity percentage at 60 minutes than 30 minutes. About 71.43% of the extracts tested with highest concentration of 500 mg/ml exhibited scavenging activity ranging from 80% to 87% at 60 minutes whilst only 53.6% of the extract exhibited scavenging activity ranging from 80% to 87% at30 minutes.

Scavenging activity was also observed to change with polarity. About 85.0 % of AQ extracts exhibited the scavenging activity of 80% to 87.0% at

Table 2. Antioxidant activity of AQ extracts of plants used as herbal tea in Tanzania at 60 minutes.

Conc (mg/ml)	Plant extracts													
	SBA	CSA	TFLA	OLA	TFRA	ANRA	ANBA	OGFA	OGRA	RVRA	CCA	OGLA	RVLA	RVBA
3.906	45.11	50.22	53.08	44.36	57.86	6.67	39.56	36.82	43.8	41.93	41.25	35.83	16.01	28.54
7.81	47.41	52.27	58.38	47.1	64.3	37.82	69.91	74.33	47.73	44.55	41.5	36.57	33.46	42.12
15.625	47.98	52.96	63.55	48.6	69.59	38.57	76.88	77.63	48.6	46.79	42.8	37.13	48.97	64.8
31.25	48.16	57.76	72.34	54.45	72.44	44.86	78.57	77.69	48.66	48.85	43.8	37.88	62.49	80.69
62.5	48.6	61.37	74.52	55.76	73.98	53.4	78.69	77.82	50.4	49.22	49.35	38.32	81.5	81.74
125	48.91	70.84	84.58	56.88	81.19	82.52	78.82	79.13	53.96	56.53	53.58	83.76	82.62	82.62
250	51.03	78.94	85.7	65.73	82.23	82.87	79.07	79.63	61.25	55.61	62.49	83.95	83.86	82.93
500	87.54	81.77	85.85	85.61	87.26	83.55	80.78	79.75	68.29	80.88	85.36	87.29	83.99	83.99

*CSA = *C. sinensis* aqueous, OLA = *O. lanceolata* aqueous, TFLA = *T. fassoglensis* aqueous, ANBA = *A. nilotica* barks aqueous, OGFA = *O.gratissimum* flower aqueous, OGRA = *O. gratissimum* roots aqueous, RVRA = *R. vulgaris* aqueous, CCA = *C. citratus* aqueous, RVLA = *R: vulgaris* leaves aqueous, RVRB = *R. vulgaris* bark aqueous.

Table 3. Antioxidant activity of ETA extracts of plants used as herbal tea in Tanzania at 30 minutes.

Conc (mg/ml)	Plant extracts													
	SBE	CSE	OLE	TFLE	TFRE	ANBE	OGRE	ANRE	RVRE	CCE	OGFLE	OGLE	RVLE	RVBE
3.906	26.54	41.16	14.39	15.76	32.52	35.75	40.63	36.82	36.76	43	24.8	47.66	32.21	32.9
7.81	28.04	46.87	19.75	20	52.34	36.81	40.68	56.32	40.75	48.19	26.6	50.28	33.27	38.6
15.625	30.22	51.96	22.37	22.12	57.32	40.88	42.7	70.84	40.93	51.19	27.1	50.97	33.71	42.29
31.25	40	52.44	27.85	26.85	62.62	41.25	45.17	81.99	41.5	53.11	27.75	51.96	35.14	45.17
62.5	52.34	59.9	35.51	34.77	70.97	42.98	56.21	85.3	42.31	55.29	27.79	53.02	35.2	46.41
125	66.04	72.14	42.31	47.41	73.58	51.14	56.86	85.73	45.55	60.13	28.03	53.58	36.26	50.32
250	71.71	79.61	48.04	48.53	74.52	55.18	57.52	86.79	46.17	64.32	28.22	55.51	37.01	61.07
500	75.26	82.59	52.34	55.2	75.2	69.04	80.33	87.29	75.76	69.27	28.34	56.88	59.44	70.62

**S. bullatus* ethyl acetate, CSE = *C. sinensis* ethyl acetate, OLE = *O. lanceolata* ethyl acetate, TFLE = *T. fassoglensis* ethyl acetate, TFRE = *T. fassoglensis* root ethyl acetate, ANRE = *A. nilotica* ethyl acetate, ANBE = *A. nilotica* barks ethyl acetate, OGFE = *O.gratissimum* flower ethyl acetate, OGRE = *O. gratissimum* roots ethyl acetate, RVRE = *R. vulgaris* ethyl acetate, CCE = *C. citratus* ethyl acetate, OGLE = *O. gratissimum* leaves ethyl acetate, RVLE = *R: vulgaris* leaves ethyl acetate, RVRB = *R. vulgaris* bark ethyl acetate.

Table 4. Antioxidant activity of ETA extracts of plants used as herbal tea in Tanzania at 60 minutes.

Conc. (mg/ml)	Plant extracts													
	SBE	CSE	OLE	TFLE	TFRE	ANBE	ANRE	OGRE	OGFLE	RVRE	CCE	OGLE	RVLE	RVBE
3.906	44.98	47.53	35.7	5.36	35.95	40.21	36.82	40.16	24.8	36.96	46.23	25.23	7.85	39.15
7.81	47.23	49.46	40.25	19.44	55.08	40.89	56.32	40.65	26.6	41.01	50.9	27.48	25.92	39.91
15.625	47.79	50.59	41.18	23.24	69.84	41.14	70.84	40.98	27.1	41.09	51.21	34.89	26.36	42.45
31.25	50.53	51.32	41.37	31.84	74.89	42.12	81.99	41.72	27.75	42.23	53.64	42.99	27.66	45.13
62.5	51.15	61.43	43.05	44.61	76.45	42.39	85.3	42.14	27.79	43.71	58.26	43.12	29.22	46.38
125	66.04	69.97	44.67	67.6	80.93	46.28	85.75	42.25	28.12	45.61	62.93	50.28	33.46	47.8
250	71.77	79.61	48.6	75.26	85.23	55.76	86.81	57.54	28.22	48.29	64.8	55.46	37.77	64.12
500	78.1	80.56	80.44	81.31	86.11	80.32	87.35	80.33	28.41	81.64	71.03	63.61	59.74	78.92

*SBE = *S. bullatus* ethyl acetate, CSE = *C. sinensis* ethyl acetate, OLE = *O. lanceolata* ethyl acetate, TFLE = *T. fassoglensis* ethyl acetate, TFRE = *T. fassoglensis* root ethyl acetate, ANRE = *A. nilotica* ethyl acetate, ANBE = *A. nilotica* barks ethyl acetate, OGFE = *O.gratissimum* flower ethyl acetate, OGRE = *O. gratissimum* roots ethyl acetate, RVRE = *R. vulgaris* ethyl acetate, CCE = *C. citratus* ethyl acetate, OGLE = *O. gratissimum* leaves ethyl acetate, RVLE = *R: vulgaris* leaves ethyl acetate, RVRB = *R. vulgaris* bark ethyl acetate.

the concentration of 500 mg/ml compared to 39.3% that exhibited by ETA extracts at the same concentration.

Total phenolic contents of the AQ and ETA extracts of seven plants used as herbal tea were determined using the Folin–Ciocalteu method and the results are shown in Table 5. The total phenolic contents ranged from 57.7mg to 98.02 mg GAE/g dry weight. The highest phenolic contents was showed by *Sphaerunthus bullatus* aqueous extract (98.02 mg GAE/g dry weight), *Sphaerunthus bullatus* ethyl acetate extract (92.9 mg GAE/g dry weight) followed by *Tylosema fassoglesis* roots aqueous (91.9 mg GAE/g dry weight), *Rhus vulgaris* leaves (91.2 mg GAE/g dry weight), and *Ocimum graissimum* (90.2 mg GAE/g dry weight). The lowest phenolic content was observed in *Ocimum gratissimum* root ethyl acetate extract (57.7 mg GAE/g dry weight).

Discussion

In living system, free radical is generated as parts of the body normal metabolism [33]. Cells of a healthy human have intact oxidation processes to detoxify the cellular environment from oxidant and they create the equilibrium in oxidant and antioxidants from aerobic metabolism, hence, pro-oxidants produced are readily balanced by antioxidants in the same rate [34]. However, in some cases like infections, fasting, fever, and chemical mobilization of stored fats can result in the increase of free radicals than the available antioxidants [35]. This situation increases the level of reactive oxygen species (ROS) in the body. Presence of high level of ROS causes oxidative stress in the body which leads to diseases in the body such as diabetics, Parkinson, eye diseases, cancer, and atherosclerosis [36]. Number of plants has been reported to contain antioxidant substances [37].

In the present study, antioxidant activity of seven plants used as herbal tea by ethnic groups in Tanzania was evaluated. All plants exhibited the higher antioxidant ranging from 80% to 87.54% in at least one of their extracts tested with the concentration of 500 mg/ml. In general, antioxidant of AQ extract was slightly higher than ETA extracts except for *A. nilotica* roots ethyl acetate extracts. This study indicates that antioxidants compounds exist in polar form than in medium polar form as explained by [38] that reported that antioxidant activity increases with the polarity of the compounds.

Extracts namely SBA, *T. fassoglensis* tuber aqueous (TFRA) extract, *A. nilotica* roots aqueous (ANRA) extract, and *O. gratissimum* leaves aqueous (OGLA) extract possessed higher antioxidant activity close to ascorbic acid standard. Antioxidant activity of the plant is directly proportional to the amount of polyphenol compounds in it [39]. Polyphenols are good hydrogen donors that react with reactive oxygen species in a termination reaction which break the cycle of generation of new radicals. It was interesting in the present study that plants with higher phenolic contents also possessed higher antioxidant activity. The plant species (Table 5) *Sphaeranthus bullatus, Tylosema fassoglens* roots, and *Ocimum gratissimum* leaves that exhibited higher phenolic content also exhibited higher antioxidant activity. The family Asteraceae, Leguminosae, Fabaceae, and Lamiaceae which SBA, TFRA, ANRA, and OGLA, respectively belong to; have been reported to be good source of phenolic compounds [40].

Conclusion

Antioxidants are compounds that reduce free radical in the body. High level of free radical in the body may lead to several diseases. Antioxidant can be obtained from the natural sources or synthetics. Natural antioxidants can be obtained from the plant products such as herbal teas. In the present study, it was found that over 70% of plant extracts tested have higher antioxidant activity. Therefore, it was concluded that the use of herbal tea from *Sphaeranthus bullatus, Osyris lanceolata, Tylosema fassoglensis, Acacia nilotica, Rhus vulgaris, Cymbopogon citratus,* and *Ocimum gratissimum* has potential benefits to human health, so it should be used to prepare herbal tea for management of diseases.

Table 5. Total phenolic contents of AQ and ETA extracts (mg GAE/g dry weight) of plants uses as herbal teas in Tanzania.

Extracts	SB	TFL	OL	TFR	ANR	ANB	OGR	RVR	CC	OGL	RVL
AQ	98.02 ± 1.1	75.2 ± 0.8	74.7 ± 1.3	91.9 ± 0.9	78.1 ± 0.3	78.7± 1.4	59.9 ± 0.1	71.3± 1.2	79.2 ± 1.8	90.2 ± 1.2	91.2 ± 1.1
ETA	92.9 ± 1.3	71.5± 0.7	69.8 ± 0.4	87.4 ±1.3	76 ± 0.1	76 ± 1.9	57.7 ± 0.8	71.1 ± 0.3	78.8 ± 0.9	90.2 ± 1.2	88.6 ± 1.5

*SB = *Sphaerantus bullatus*, OL = *Osyris lanceolata*, TFR = *Tylosema fassoglensis* roots, ANR = *Acacia nilotica* roots, ANB = *Acacia nilotica* barks, OGR = *Ocimum gratissimum* roots, RVR = *Rhus vulgaris* roots, CC = *Cymbopgon citrates*, OGL = *Ocimum gratissimum* leaves, RVL = *Rhus vulgaris* leaves, CS = *Camellia cinensis*.

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