EAS Journal of Nutrition and Food Sciences
Abbreviated Key Title:EAS J Nutr Food Sci
ISSN: 2663-1873 (Print) & ISSN: 2663-7308 (Online)
Published By East African Scholars Publisher, Kenya

Volume-4 | Issue-3 | July-Aug; 2022 | DOI:10.36349/easjnfs.2022.v04i03.001

OPEN ACCESS

Original Research Article

Antioxidant Potential of Some Plant Foods Commonly Consumed in Cameroon

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Article History
Received: 26.05.2022
Accepted: 30.06.2022
Published: 08.07.2022

Journal homepage:
https://www.easpublisher.com

Quick Response Code

Abstract: Plant foods contain antioxidants and their efficiency in the management of non-communicable diseases like cancer, diabetes, cardiovascular diseases, and neurodegenerative diseases has long been proven. Nonetheless, the antioxidant potential of plant foods is continuously being studied with the aim of valorizing those foods that are still not well known. As such, the aqueous filtrates of forty-eight (48) plant foods currently consumed in Cameroon were screened for antioxidant potential. Their polyphenol content, ability to scavenge the 2,2'azinobis (3ethylbenzo-tiazoline-6-sulfonic acid) diammonium salt (ABTS) free radicals as well as their Ferric reducing antioxidant potential (FRAP) were assessed. Seven of these plant foods which exhibited very high antioxidant capacity in their filtrates were selected and their aqueous and hydroethanolic extracts prepared for antioxidant evaluation using six methods notably, FRAP, polyphenol, scavenging of ABTS, 1, 1-Diphenyl-2-Picrilhydrazyl (DPPH) and Nitric oxide (NO) free radicals as well as metal chelating capacity. It was found that; *Raphia farinifera* (Raffia fruit), *Spondias cytherea* Sonner (*Casmango*) fruit, *Manihot utilissima* (Cassava leaf), *Solanum scabrum* (small leaf Garden huckle berry), *Cola verticillata* (*Bamiléké* Kola) and *Colocasia esculenta* (*Taro* leaf) portayed very high antioxidant potential. The evaluation of their antioxidant capacity showed that all seven selected foods could be considered for studies related to the management of age-related diseases, especially *R. farinifera*, *Cola verticillata* and *S. scabrum*.

Keywords: Antioxidant, antioxidant capacity, free radical scavenging, plant foods.

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INTRODUCTION

Non communicable diseases are the leading cause of death globally with about 41 million deaths each year, equivalent to 71% of all deaths globally (WHO, 2021). They are strongly influenced by four main behavioral risk factors: tobacco use, insufficient physical activity, harmful use of alcohol, and unhealthy diet (GBD, 2016). In 2017, 11 million deaths and 255 million DALYs were attributable to dietary risk factors, with 2 million deaths worldwide attributable to low fruit and vegetable consumption (GBD *et al*., 2019). Adequate consumption of fruits and vegetables reduces the risk for cardiovascular diseases, and some nutrition-related cancers like stomach and colorectal cancers (Aune *et al*., 2017; Zurbau *et al*., 2020; Feng *et al*., 2022) and this is partly associated to their high antioxidant content (Adeyanju *et al*., 2021). An antioxidant is any substance that, when present at low concentrations significantly delays or prevents the oxidation of cell content like proteins, lipids, carbohydrates, and DNA (Halliwell, 2007). Some examples include glutathione, vitamin C, vitamin E, carotenoids, bilirubin, albumin, uric acid, flavonoids, and polyphenols all non-enzymatic and catalase, superoxide dismutase, gluthation peroxydases (Baiano *et al*., 2015; Oliveira *et al*., 2018; Moussa *et al*., 2019; Irato *et al*.., 2021). They can act by scavenging reactive oxygen species, inhibiting their formation, binding transition metal ions, preventing the formation of OH, and/or preventing the decomposition of lipid peroxides (Santos-Sánchez *et al*., 2019). Antioxidants are thus exploited in the fight against oxidative stress, which is a

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condition characterized by an imbalance between the prooxidant (free radicals) and antioxidant systems. Oxidative stress is identified as the root cause of the development and progression of several diseases (Kasote *et al*., 2015). Free radicals are produced during many different endogenous and exogenous processes and mitochondria are the main source of endogenous reactive oxygen species (ROS) produced at the cell level (Martemucci *et al*., 2022). Although the body has an endogenous antioxidant defense system, an exogenous supply of antioxidants from the diet is essential to maintain an equilibrated oxidative balance. Fruits and vegetables contain different antioxidant compounds, whose activities have been established in recent years (Aune *et al*., 2017; Feng *et al*., 2022). In Cameroon, surveys have shown that the incidence of non-communicable diseases is lower in rural areas where there is higher consumption of fruits and vegetables compared to urban areas where diets have greatly been modified in favour of high energy and modernized diets (Ntentie *et al*., 2014). Cameroonian markets have high amounts of fruits and vegetables, but their consumption is still moderate (Kamda *et al*., 2021). More attention needs to be drawn on the importance of plant foods, notably fruits and vegetables, to increase their consumption. With the aim of valorizing fruits and vegetables present in Cameroonian local markets, we decided to evaluate the antioxidant potential of some plant foods highly available for consumption.

METHODOLOGY

The study was carried out in 2 steps. Firstly, the antioxidant capacity of aqueous filtrates of forty-eight plant foods was determined; secondly, those with the best activity were selected for further evaluation of antioxidant potential.

Collection of food plant materials

48 food plants recorded in Table 1 were harvested or bought in several markers or different localities of the country for the evaluation of their antioxidant potential.

Table 1: List of 48 plant foods used for evaluation of the antioxidant potential after preparation of filtrates

Scientific name	Common name	Part of the plant used
Ananas comosus	Pineapple	Fruit
Annona muricata	Soursop	Fruit
Citrullus lanatus	Dark-green watermelon	Fruit
Citrullus lanatus	Lime-light watermelon	Fruit
Malus domestica	Lime-light apple	Fruit
Malus domestica	Sundown apple	Fruit
Spondias cytherea Sonner	Unripe golden Apple (*casmango*)	Fruit
Spondias cytherea Sonner	Ripe golden Apple (*casmango*)	Fruit
Carica papaya	Solo Papaya	Fruit
Carica papaya	Wild papaya	Fruit
Citrus sinesis	Orange	Fruit
Citrus paradisi	Pomelo	Fruit
Citrus maxima	Grape fruit	Fruit
Citrus hystrix	kaffir lime	Fruit
Citrus limon	Lime	Fruit
Citrus tangerina	Tangerine	Fruit
Citrus reticulata	Mandarine	Fruit
Canarium schweinfurthii	Black plum	Fruit
Vitex doniana Sweet	African black olive	Fruit
Cola acuminata	Male kola nut	Seed
Cola verticillata	Bamileke kola	Seed
Garcinia kola	Bitter kola	Seed
Bucholzia Cariacera	Lion kola	Seed
Musa paradisiacal	Dwarf red banana	Fruit
Musa balbisiana	Yellow dwarf banana	Fruit
Musa acuminata	Giant cavendish banana	Fruit
Passiflora ligularis	Yellow passion fruit	Fruit
Lycopersicon esculentum	Garden tomato	Fruit
Lycopersicon lycopersicum	Tomato	Fruit
Abelmoschus manihot tetraphyllus	Village okro	Fruit
Abelmoschus caillei	White okro	Fruit
Brassica oleaccea	Green cabbage	Bulb
Brassica oleaccea	Red cabbage	Bulb
Vernonia bamendae	Sweet bitterleaf	Leaf

Scientific name	**Common name**	**Part of the plant used**
Hibiscus sabdariffa	Roselle	Flower
Corchorus olitorius	Jute mallow (*Kelen-kelen*)	Leaf
Colocasia esculenta	Taro leaf	Leaf
Cucumis melo	Melon leaf	Leaf
Gnetum africanum	Eru	Leaf
Manihot utilissima	Cassava leaf (*Kwem*)	Leaf
Raphia farinifera	Raffia	Fruit
Solanum aethiopicum	Beti garden eggs	Fruit
Solanum aethiopicum	Bamileke garden eggs	Fruit
Solanum scabrum	Garden huckle berry (*Njapchieu*)	Leaf
Solanum scabrum	Garden huckle berry (*Njama njama*)	Leaf
Solanum macrocarpon	African eggplant	Leaf
Talinum triangulare Willd.	Waterleaf	Leaf
Telfairia occidentalis	Fluted pumkin (*Okonghobon*)	Leaf

Preparation of filtrates

Aqueous filtrates were prepared according to the following protocol: 2 g of each sample was weighed and grinned using a mortar and pistil, and then 8 ml of distilled water was added into each sample. The mixture was then centrifuged at 3400rpm for 5 minutes. The supernatant of each tube was transferred into its corresponding prelabelled Eppendorf tube and stored at -25°C.

Preparation of extracts of selected foods

Based on the antioxidant potential of the filtrates, seven (7) plant foods (Table 2) were selected for further evaluation of antioxidant activity. They were harvested and shade dried until obtention of constant weight and powdered using an electric grinder. Aqueous and hydroethanolic extracts were prepared for each selected sample. The proportion of powdered plant material to solvent was 1:6. Hydroethanolic extracts were prepared by 48 H maceration in 50% ethanol diluted with distilled water, while aqueous extracts were prepared by 24 H infusion of dried material in distilled water. The obtained filtrates were dried using an air drier at 40°C after which they were stored at 4°C for further use.

Evaluation of Phenolic content of filtrates and extracts

The Folin-Ciocalteau method (Singleton *et al*., 1965) was used for evaluation of polyphenolic content of filtrates and extracts. Results were expressed as µgeqcat/g fresh material or extract.

Evaluation of total antioxidant capacity of filtrates and extracts

Total antioxidant capacity was evaluated through the determination of the Ferric reducing antioxidant potential (FRAP) of the filtrates and extracts using the method described by Benzie and Strain (Benzie and Strain, 1996). Cathechin was used as the reference antioxidant for filtrates with results expressed in µgeqcat/g fresh material, meanwhile vitamin C was used for extracts and results expressed as mMeqvitc/g of extract.

Evaluation of scavenging capacity of filtrates and extracts of plant foods

The method that involves the generation of ABTS free radicals was used to evaluate the scavenging power of filtrates and extracts (Re *et al*., 1999). Obtained results were expressed in µgeqVitE/g fresh material for filtrates.

Scavenging capacity of the extracts of the selected plant foods

The protocol described by Katalinie *et al*. (2004) was used for the scavenging of DPPH (1, 1-Diphenyl-2-Picrilhydrazyl) free Radical by extracts.

The Scavenging of nitric oxide (NO) was realized according to the method of Shah *et al.* (1994).

Determination of the IC50 of the extracts

The inhibition percentage for each free radical was computed using the following formula:
% of inhibition= ((Abs1-Abs2)/ Abs1) × 100, where; Abs1= absorbance of control, Abs2= absorbance of sample.

The IC50 for the scavenging of each free radical by each extract was determined and corresponded to the concentration of the extract that led to 50% inhibition of the free radical in µg/ml of extract.

Metal chelating capacity of extracts

The method exploited was that described by Dinis *et al.* (1994). Percentage of inhibition was calculated as follows;
% of inhibition= ((Abs1-Abs2)/ Abs1) × 100, where; Abs1= absorbance of control, Abs2= absorbance of sample.

The IC50 corresponded to the concentration of the extract that led to 50% of chelation of metal in µg/ml of extract.

Table 2: Selected foods used for evaluation of antioxidant capacity

Common name	Scientific name	Origin	Harvesting period
Raffia fruit	*Raphia farinifera*	Foumban (West region)	March
Golden Apple (*casmango*)	*Spondias cytherea* Sonner	Sa'a (Centre region)	May
Cassava leaf (*Kwem*)	*Manihot utilissima*	Yaounde (Centre region)	March
Garden huckle berry (Njama-njama)	*Solanum scabrum*	Babangui (North West region)	March
Taro	*Colocasia esculenta*	Yaounde (Centre region)	April
Bamileke kola	*Cola vercillata*	Bamena (West region)	April
Fluted pumkin (Okonghobon)	*Telfairia occidentalis*	Yaounde (Centre region)	March

Statistical Analysis

The software SPSS 16.0 for Windows was used for analyses. Analysis of variance (ANOVA) was used to compare means. Results were presented as means ± standard error. The LSD test was used to analyze results. Results were considered significant when $p < 0.05$. Pearson's correlation was used to compare the methods. Microsoft Office Excel was used to plot graphs.

RESULTS

Antioxidant power of filtrates of plant foods

Table 3 presents the antioxidant capacity of the filtrates of 48 plant foods in Cameroon. During this evaluation, foods of the same species/family, notably dark green and light green, *C. lanatus*; unripe and ripe *S. cytherea*; *L. esculentum* and *L. lycopersicum*; *A. manihot tetraphylus* and *A. caillei*; *C. tangerina* and *C. reticulata*; *M. paradisiacal*, *M. acuminata* and *M. balbisiana* all showed similar total antioxidant power. On the contrary, limelight and sundown *M. domestica*; wild and solo, *C. papaya*; *C. paradisi* and *C. maxima*; *C. limon* and *C. hystrix*; bêti and bamileke *S. aethiopicum*; *C. verticillata* and *C. acuminata*; red and green *B. oleaccea* and large (*njapcheu*) and small leaf (*njama-njama*) *S. scabrum* all showed significantly different potential ($p<0.05$) even though of the same species/varieties. The highest antioxidant capacity using this method was obtained with the filtrate of *R. farinifera* (6788.28 µgeqcat/g fresh mat) and it was significantly higher than for all other samples except *M. utilissima*. It was *C. lanatus* with an antioxidant content of 922.66 µgeqcat/g fresh matter that was found to be the lowest compared to all other filtrates.

The amount of polyphenols in each filtrate was considered when screening samples for antioxidant capacity. The samples of the same family that had similar concentrations were; Dark-green and Lime-light *C. lanatus*; unripe and ripe *S. cytherea*; *M. acuminata* and *M. paradisiacal*; *L. esculentum* and *L. lycopersicum*; *C. tangerina* and *C. reticulate*; *C. acuminata* and *C. verticillata*; *A. manihot* and *A. caillei*. Others like limelight and sundown *M. domestica*; savage and solo, *C. papaya*; *C. paradisi* and *C. maxima*; *C. limon* and *C. hystrix*; Beti and Bamileke *S. aethiopicum*; red and green *B. oleaccea*; njama-njama and njapcheu *S. scabrum*; *M. paradisiacal*, *M. acuminata* and *M. balbisiana* all had significantly different concentrations ($p\leq0.05$). As was observed with FRAP, the lowest polyphenol content was found in Dark green *C. lanatus* (18.00 µgeqcat/g fresh matter) and it was found to be similar to limelight *M. domestica*, *M. paradisiacal*, *M. acuminata*, *L. lycopersicum*, *L. esculentum*, light green *C. lanatus*, Bamileke *S. aethiopicum* and *C. schweinfurthii* ($p\geq0.05$). The highest concentration was obtained with *C. verticillata* (25603.66 µgeqcat/g fresh mat). This value was found to be significantly higher than that of the other samples ($p\leq0.01$) except for *C. acuminata* ($p=0.2$).

The *in vitro* scavenging of ABTS free radicals was used to screen filtrates antioxidant potential. For samples of the same family, the activity was found to be similar for the following species/varieties; limelight and sundown, *M. domestica*; dark green and light green, *C. lanatus*; ripe and unripe *S. cytherea*; savage and solo *C. papaya*; *M. paradisiacal* and *M. acuminate*; *C. paradisi* and *C. maxima*; *L. lycopersicum* and *L. esculentum*; *C. limon* and *C. hystrix*; *C. tangerina* and *C. reticulata*, beti and bamileke *S. aethiopicum*, *C. verticillata* and *C. acuminata*, *A. manihot* and *A. caillei* ($p>0.05$). While other families notably red and green *B. oleaccea*; *njapcheu* and *njama-njama*, *S. scabrum*; *M. paradisiacal*, *M. balbisiana* and *M. acuminata* showed significantly different activies from one another ($p<0.05$). The lowest activity was seen with *G. kola* (35.00µgeqcat/g fresh mat). This activity was not lower than for *A. muricata*, dark-green *C. lanatus*, limelight and sundown, *M. domestica*, unripe and ripe, *S. cytherea*, savage *C. papaya*, *P. ligularis*, *M. paradisiacal*, *C. maxima*, *M. acuminata*, *L. lycopersicum*, *L. esculentum*, solo *C. papaya*, *C. hystrix*, *C. limon*, *C. reticulata*, beti *S. aethiopicum*, *C. tangerina*, light green *C. lanatus*, *C. paradisi*, *C. sinesis*, bamileke *S. aethiopicum*, *C. schweinfurthii*, *B. Cariacera* and *H. sabdariffa* ($p>0.05$). The highest activity was obtained with *C. acuminata*, but this activity was not seen to be higher than that of *C. verticllata* ($p>0.05$).

Table 3: Antioxidant power of filtrates of 48 plant foods consumed in Cameroon

Scientific name	**Common names**	**Part of the plant used**	**Total phenolic content (µgeqcat/g fresh material)**	**FRAP (µgeqcat/g fresh material)**	**Scavenging of ABTS (µgeqVitE/g fresh material)**
Ananas comosus	Pineapple	Fruit	957±0.00	1536.33±9.81	5852.33±37.88
Annona muricata	Soursop	Fruit	1576.66±74.87	1999.66±10.36	193.00±68.94
Citrullus lanatus	Dark-green watermelon	Fruit	18.00±3.09	922.66±18.16	341.33±152.73
Citrullus lanatus	Lime-light watermelon	Fruit	48.33±29.95	1038.00±1.54	120.00±35.47
Malus domestica	Lime-light apple	Fruit	135.33±29.95	1189.00±12.03	411.66±99.11
Malus domestica	Sundown apple	Fruit	4430.33±1455.72	1425.33±20.51	159.33±55.46
Spondias cytherea Sonner	Unripe casmango	Fruit	4247.66±149.75	2193.33±31.51	213.33±64.03
Spondias cytherea Sonner	Ripe casmango	Fruit	3986.33±569.58	2201.66±30.00	427.00±128.58
Carica papaya	Solo Papaya	Fruit	1750.66±104.82	2845.0±100.09	161.00±38.08
Carica papaya	Wild papaya	Fruit	1557.33±164.73	2014.00±39.09	2466.00±579.10
Citrus sinesis	Orange	Fruit	1383.33±29.95	2491.66±108.54	232.33±55.51
Citrus paradisi	Pomelo	Fruit	1112.66±194.68	2296.00±107.00	157.66±92.19
Citrus maxima	Grape	Fruit	1480.00±44,92	3023.00±67.46	270.00±31.91
Citrus hystrix	kaffir lime	Fruit	1296.33±74.87	2510.33±96.16	156.00±37.12
Citrus limon	Lime	Fruit	1557.33±104.82	2198.33±59.22	141.66±42.86
Citrus tangerina	Tangerine	Fruit	1586.33±59.90	2709.00±19.91	183.33±62.29
Citrus reticulata	Mandarine	Fruit	1431.66±149.75	2578.33±95.20	293.66±79.48
Canarium schweinfurthii	Black plum	Fruit	4818.00±0.00	1891.66±27.71	9928.00±540.89
Vitex doniana Sweet	African black olive	Fruit	19.66±8.50	1107.00±20.95	146.66±69.56
Cola acuminata	Male kola nut	Seed	25603.66±449.78	2568.66±703.48	20293.66±6097.88
Cola verticillata	Bamileke kola	Seed	25381.00±374.90	3198.66±63.14	19178.66±5734.75
Garcinia kola	Bitter kola	Seed	2805.66±794.21	2772.33±568.00	35.00±15.82
Bucholzia Cariacera	Lion kola	Seed	3095.66±434.80	1670.33±8.50	256.00±62.02
Musa paradisiacal	Dwarf red banana	Fruit	217.00±23.23	1380.33±49.00	293.66±79.48
Musa balbisiana	Yellow dwarf banana	Fruit	3531.33±14.97	1348.33±6.77	4653.33±682.71
Musa acuminata	Giant cavendish banana	Fruit	328.66±29.95	1484.66±31.65	281.00±55.79
Passiflora ligularis	Yellow passion fruit	Fruit	715.33±74.87	1713.33±130.20	419.00±59.17
Lycopersicon esculentum	Garden tomato	Fruit	232.00±44.92	1484.33±25.30	197.66±49.31
Lycopersicon lycopersicum	Tomato	Fruit	241.66±14.97	1573.66±52.07	150.00±44.28
Abelmoschus manihot tetraphyllus	Village okro	Fruit	424.66±419.31	1124.66±36.88	4847.33±367.35
Abelmoschus caillei	White okro	Fruit	4247±389.88	1025.00±32.23	5578.00±989.47
Brassica oleaccea	Green cabbage	Leaf	3657.00±44.92	1041.00±11.73	6560.33±387.28
Brassica oleaccea	Red cabbage	Leaf	6328.00±44.92	2945.33±82.44	12813.66±258.63
Vernonia bamendae	Sweet bitterleaf	Leaf	6734.33±494.70	2219.33±47.63	16810.33±5091.34
Hibiscus sabdariffa	Roselle	Flower	5495.66±59.90	3536.33±17.58	111.66±42.33
Corchorus olitorius	Jute mallow (*Kelen-kelen*)	Leaf	3773.00±89.85	1427.66±68.68	11278.33±3476.87
Colocasia esculenta	Taro leaf	Leaf	6918.66±149.75	2883.33±15.90	12873.00±150.12
Cucumis melo	Melon leaf	Leaf	5854.33±14.97	2925.33±73.51	13431.66±961.76
Gnetum africanum	Eru	Leaf	15240.00±44.92	2825.33±11.53	11315.33±687.33
Manihot utilissima	Cassava (Kwem)	Leaf	10750.33±255.10	6645.66±485.22	17738.66±5343.43
Raphia farinifera	Raffia	Fruit	15953.57±93.00	6788.28±815.55	13628.42±4034.07
Solanum aethiopicum	Beti garden eggs	Fruit	1325.33±254.58	1650.33±44.91	55.66±19.84
Solanum aethiopicum	Bamileke garden eggs	Fruit	88.66±2.58	1013.33±5.24	105.33±48.51
Solanum scabrum	Garden huckle berry (*Njapchieu*)	Leaf	8495.33±284.53	3476.66±34.55	16804.00±5096.33
Solanum scabrum	Garden huckle berry (*Njama njama*)	Leaf	6821.33±135.29	2957.66±67.27	14265.00±1170.24
Solanum macrocarpon	African eggplant	Leaf	4567.00±1140.20	1259.33±16.88	11862.66±3610.24
Talinum triangulare Willd.	Waterleaf	Leaf	3241.33±59.90	1075.33±20.59	10043.66±3001.15
Telfairia occidentalis	Fluted pumkin (*Okonghobon*)	Leaf	5741.00±215.33	2580.66±57.47	16842.33±5066.37

Correlations between antioxidant screening methods

Correlation analyses were carried out to determine the relationship between the methods chosen for screening of filtrates. As shown in Figure 1, the correlation between polyphenol content and FRAP (R2 = 0.2845) was found to be significant. This implies that, for most of the samples, the higher the polyphenol content, the higher the antioxidant potential.

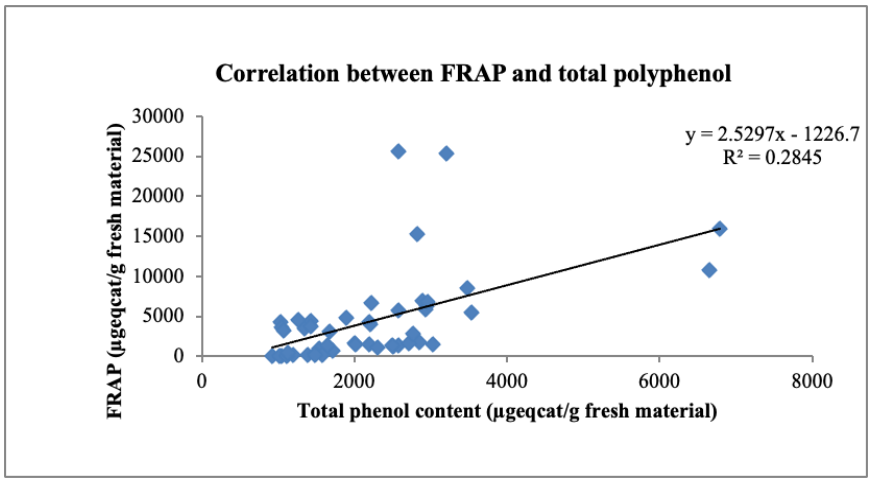

Figure 1: Correlation between total phenol content and FRAP of samples

The correlation between polyphenol content and scavenging of ABTS was assessed and showed a positive correlation between the two (R2=0.5829). For most of the samples, scavenging of ABTS free radicals was more important in samples containing high amounts of polyphenols (Figure 2).

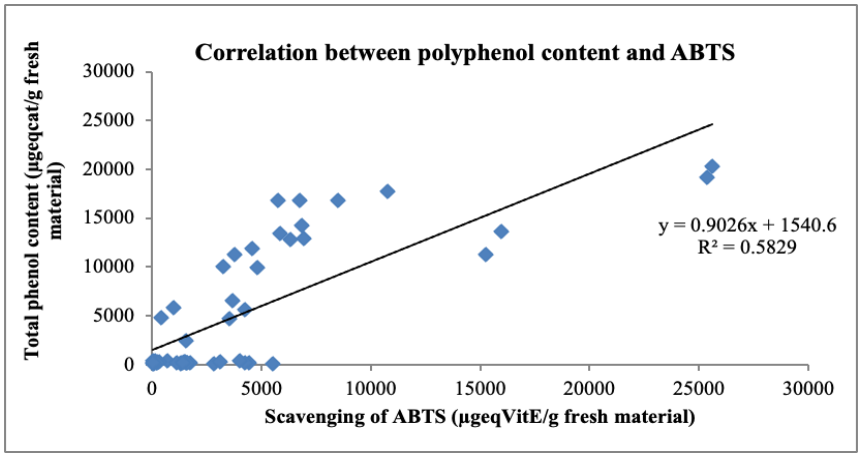

Figure 1: Correlation between total polyphenol content and scavenging of ABTS free radical of filtrates

A positive correlation (R2=0.2035) was also noticed between FRAP and scavenging of ABTS free radicals as shown in Figure 3. The higher the antioxidant potential, the higher the scavenging capacity.

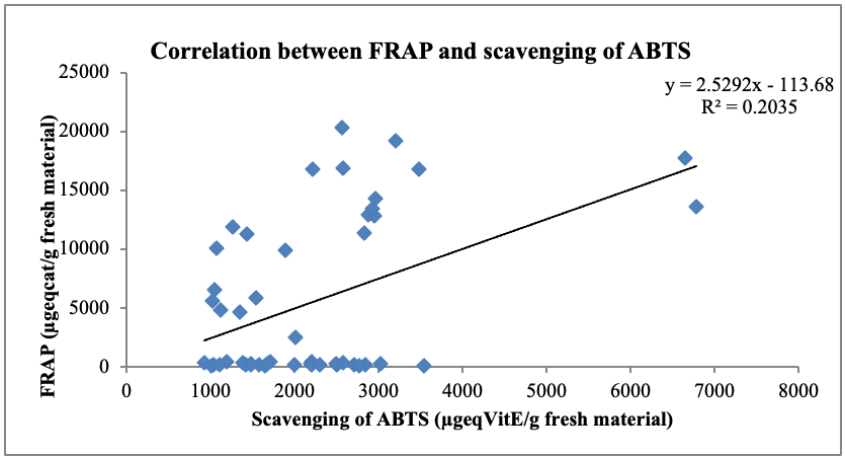

Figure 3: Correlation between FRAP and scavenging of ABTS of screened filtrates

Based on the antioxidant method used for screening, foods with higher antioxidant capacity were selected for further evaluation after preparation of their extracts.

Polyphenol Content of aqueous and hydroethanolic extracts of the selected food plants

Polyphenol content of hydroethanolic and aqueous extracts varied depending on the extraction solvent used and the species of the biological material. In general, hydroethanolic extracts (HE) contained more polyphenols than aqueous extracts (AE). Four out of the seven food plants showed higher polyphenol content with HE extracts. The highest polyphenol content was obtained with the HE of *C. verticillata* (2714.09mMeqcat/g of extract) followed by the HE of *R. farinifera* (2113.75 mMeqcat/g of extract) ($p \leq 0.05$).

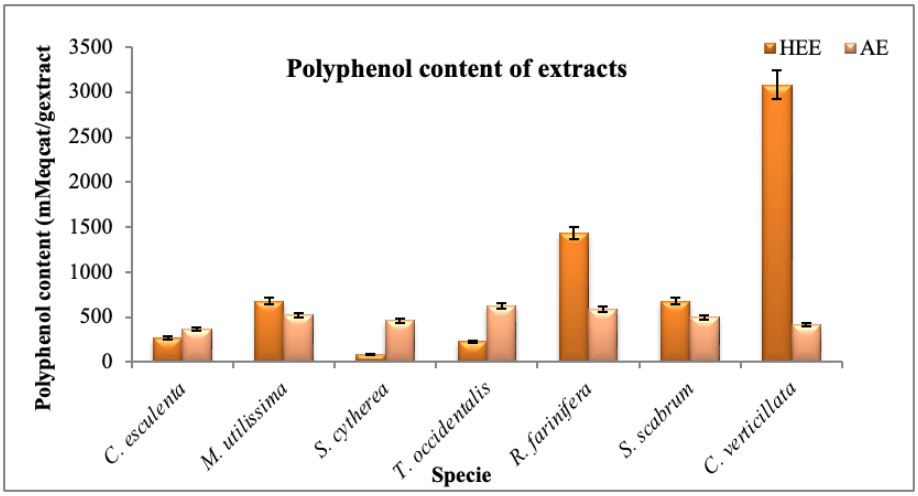

Figure 4: Phenolic content of selected food
HEE=hydroethanolic extract; AE= aqueous extract

Total antioxidant potential of prepared extracts

The FRAP of the extracts was similar to the polyphenolic content with variations in concentration depending on the solvent of extraction and the species as seen in Figure 5. The best FRAP was observed with HE of *C. verticillata* (2714.09 mMeqvitc/g of extract) followed by *R. farinifera*, *S. scabrum* and *M. utilisima* but the difference between *S. scabrum* and *M. utilissima* was not significant ($p \geq 0.05$). Like polyphenol content, the best concentrations were observed with HEs. Nevertheless, for *C. esculenta* and *T. occidentalis*, the FRAPs were higher with the AE rather than with HE. The least overall FRAP was obtained with AE of *S. cytherea* (10.5mMeqvitc/g of extract).

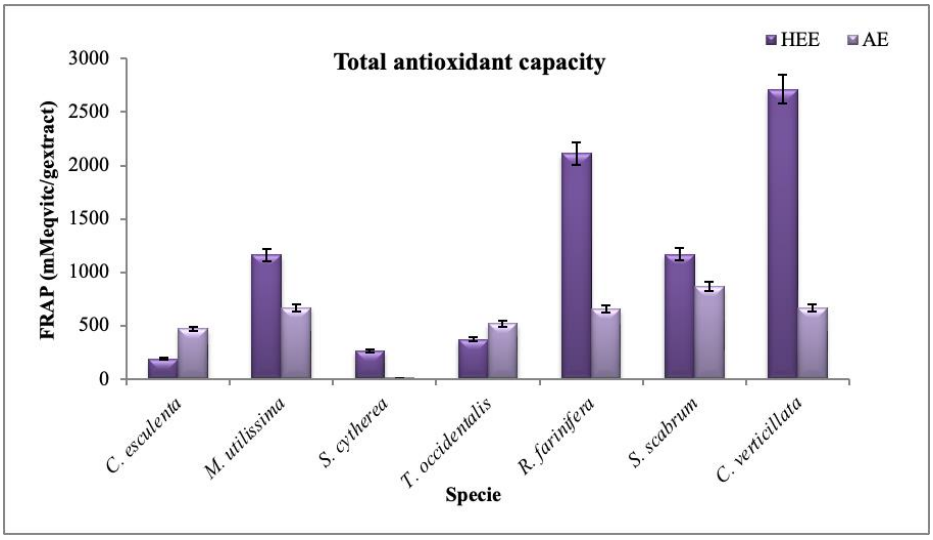

Figure 5: FRAP of 7 selected plant foods
HEE=hydroethanolic extract; AE= aqueous extract

Evaluation of metal chelating properties of extracts

The metal chelation ability of the extracts was recorded in Figure 6. The best IC50 was obtained with the AE of *T. occidentalis* (2.05µg/ml) followed by the HE of *M. utilissima* (10.21µg/ml) and then the AE of *S. scabrum* (12.19µg/ml). In general, HE showed better IC50s compared to AE (5 species of the 7).

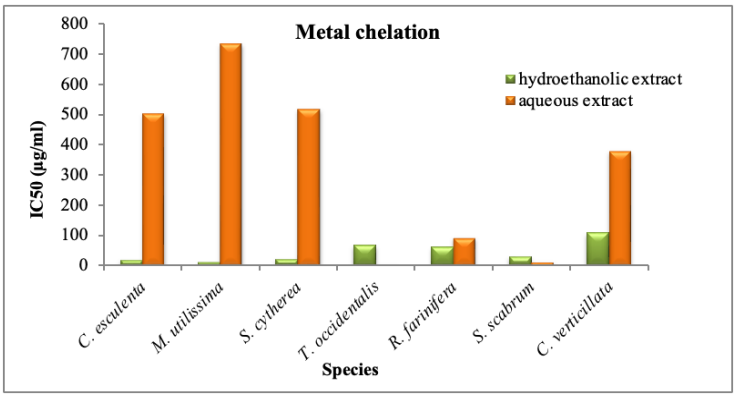

Figure 6: Metal chelating properties of 7 plant foods highly consumed in Cameroon

ABTS scavenging capacity of extracts

Looking at the scavenging of ABTS radicals by hydroethanolic and aqueous extracts, out of the 7 species tested, 5 (*C. esculenta*, *R. farinifera*, *M. utilissima*, *C. verticillata* and *S. scabrum*) showed better results with HE compared to 2 (*S. cytherea* and *T. occidentalis*) with AE. The best IC50s were got with the HE of *C. verticillata* (364.35µg/ml), *S. scabrum* (365.67µg/ml) and *R. farinifera* (684.45µg/ml). The worst were found to be with both HE (15721.28 µg/ml) and AE of *S. cytherea* (5632.30 µg/ml), and AE of *C. esculenta* (5527.42µg/ml). For AE, the best IC50s were obtained with *T. occidentalis* (1750.02µg/ml), *C. verticillata* (2151.73µg/ml) and *M. utilissima* (2543.13µg/ml) (Figure 7).

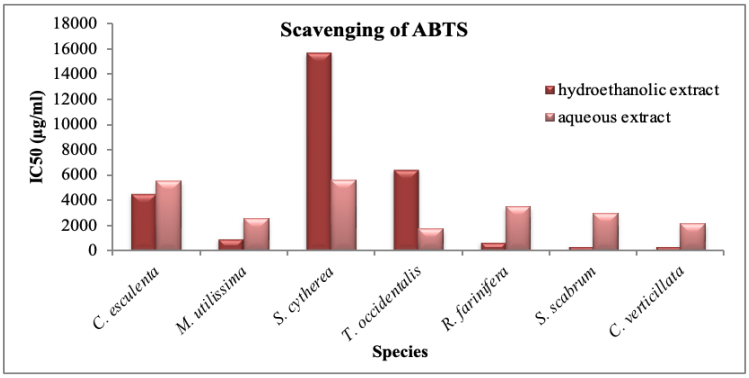

Figure 7: Capacity of food extracts to scavenge ABTS

Scavenging of DPPH free radical of the 7 selected food plants

Figure 8 is a representation of the ability of the extracts to scavenge DPPH. The lowest IC50 was found with the HE of *C. verticillata* (281.13µg/ml) followed by HE of *R. farinifera* (482.37µg/ml) and *S. scabrum* (804.82µg/ml). The highest were obtained with HE of *C. esculenta* (13056.48µg/ml), AE of *S. cytherea* (5467.12µg/ml), and AE of *M. utilissima* (4963.03µg/ml). With AE, the best IC50s were obtained with *T. occidentalis* (891.48µg/ml), *R. farinifera* (2141.06µg/ml) and *C. verticillata* (2810.31µg/ml).

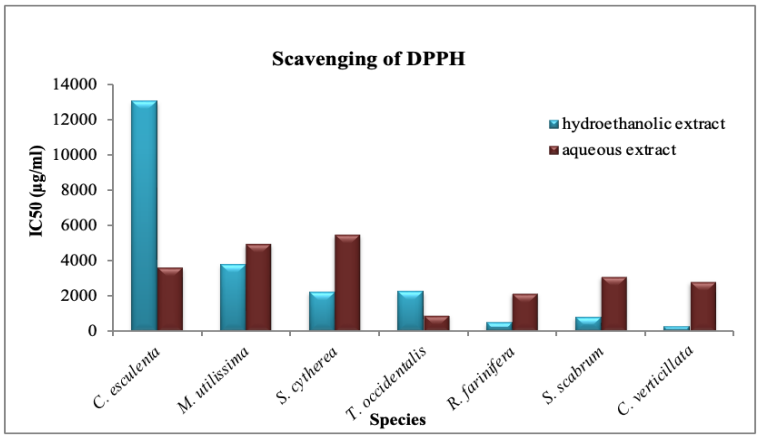

Figure 8: IC50s of extracts obtained by scavenging of DPPH radical

Scavenging of NO by extracts of the 7 selected plant foods

The best IC50s were obtained with HE of *M. utilissima* (20.43µg/ml), *R. farinifera* (30.24µg/ml), and *C. verticillata* (60.96µg/ml). For all species, hydroethanolic extracts showed the better IC50s compared to their corresponding aqueous extracts. For all aqueous extracts, best results were obtained with *C. esculenta* (388.31µg/ml), *M. utilissima* (475.53µg/ml) and *C. verticillata* (493.97µg/ml) (Figure 8).

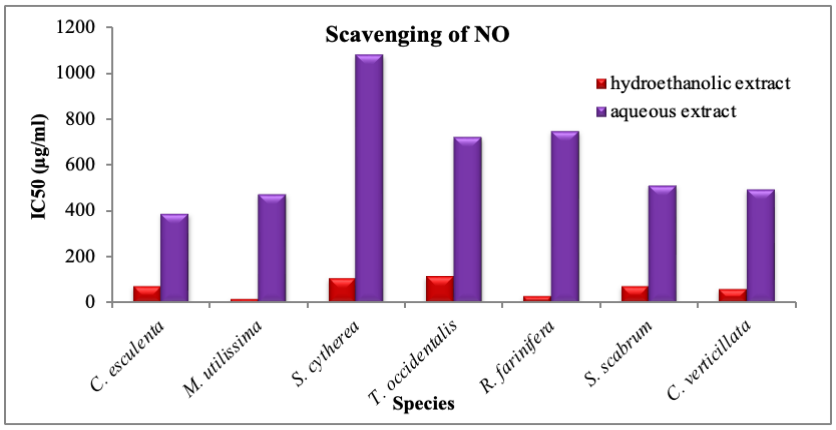

Figure 9: IC50s of extracts obtained by scavenging of NO radical

DISCUSSION

Oxidative stress is known to be a major contributor to several clinical diseases and disorders (Kasote *et al*., 2015) such as cancer (Hayes *et al.* 2020), cardiovascular diseases (D'Oria *et al*., 2020), neural disorders (Singh *et al*., 2019), Alzheimer's disease (Misrani *et al*., 2021), mild congnitive impairment (Nantachai *et al*., 2022), alcohol induced liver disease (Delli *et al*., 2021) ageing (Jiao *et al*., 2020) and atherosclerosis (Förstermann *et al*., 2017). Antioxidants reduce oxidative stress in cells and are therefore very useful in the management of many human diseases (Santos-Sánchez *et al*., 2019). The results of the evaluation of the antioxidant potential of the filtrates of 48 plant foods show that Cameroonian food plants are rich in antioxidants. All tested samples showed important amounts of antioxidants according to the FRAP method, which is one of the most rapid antioxidant tests and is very useful for routine analysis. Amounts as high as 6788.28 µgeqcat/g fresh material were obtained (*R. farinifera*) (Table 1). Another method exploited for the screening of antioxidants in 48 plant foods was the ability of the prepared filtrates to scavenge the ABTS radical. It helps more in the measurement of antioxidant activity than antioxidant concentration (Dasgupta *et al*., 2014). All samples scavenged ABTS free radicals, the lowest activity being 35.00µgeqcat/g fresh material with *G. kola*. As plant phenolics constitute one of the major groups of compounds acting as primary antioxidants or free radical terminators, the polyphenolic content of the food plants was screened. More than 4000 phenol compounds (flavonoids, monophenols, and polyphenols) are found in vascular plants and a positive relationship has been found between antioxidant activity and polyphenolic content of plants (Stagos, 2019; Hanuka *et al*., 2020; Dobrinas *et al*., 2021). Current data in literature on the relationship between the polyphenol content of plants and their antioxidant activity are sometimes contradictory. Some authors have observed such a high correlation between the two (Hanuka *et al*., 2020; Piluzza *et al*., 2011), while others found little or no correlation (Dibacto *et al*., 2021). In this study, the correlation was found to be significant between polyphenol content and FRAP (Figure 1) and polyphenol content and scavenging of ABTS radicals (Figure 2). This implies that in general, the more a sample contains polyphenols, the more important its antioxidant capacity was. There was an equally positive correlation between FRAP and scavenging of ABTS (Figure 3).

At the end of this screening, seven food plants were selected considering their high polyphenol content, FRAP, and the scavenging of ABTS radicals. The selected species included, *T. occidentalis*, *C. verticillata*, *S. cythera*, *R. farinifera*, *M. utilissima*, *S. scabrum*, *C. verticillata*. The evaluation of the antioxidant potential of their extracts showed different activities depending on the method used. This difference can be explained by the fact that they contain different types of secondary metabolites, in different proportions, thus reacting differently to the antioxidant properties evaluated (Kasote *et al*., 2015). In fact, many authors have proven that polyphenols of different nature possess different antioxidant activities (Stagos, 2019; Hadjadj *et al*., 2020). For the same species the amount of polyphenols (Figure 4) varied depending on the solvent used for extraction. Of all evaluated species, four showed high polyphenol contents with 50% ethanol as extracting solvent, while the remaining three were got with water as solvent. Shi *et al*. (2003) proposed that a two-time extraction using water and/or ethanol could be a more economical and less risky means of obtaining polyphenols from plant materials

compared to more toxic solvents like methanol. For the preparation of AE, infusion was used rather than maceration because it has been proven that heating increases rentability in polyphenol extraction (Song, 2001). Nonetheless, this cannot always be true, especially when considering volatile solvents like ethanol. The other solvent exploited for extraction was 50% ethanol. This percentage has been shown to produce very good extractability results (Shi *et al*., 2003; Seo *et al*., 2014). Comparing the polyphenol content of our extracts, we found that HE of *C. verticillata* and *R. farinifera* showed very high amounts of polyphenol (2714.09 and 2113.75mMeqcat/g extract respectively) and as such can be exploited for the industrial production of polyphenols. The amount of polyphenols in a sample is not always indicative of its antioxidant capacity (Stagos, 2019; Hadjadj *et al*., 2020); reason why antioxidant power was measured.

The DPPH free radical was exploited in this study (Figure 8). Upon accepting an electron, it forms a stable molecule, reason why it is exploited in the determination of radical scavenging activity of natural products (Adjimani *et al*., 2015. The HE of *C. verticillata* (281.13µg/ml), *R. farinifera* (482.37µg/ml), and *S. scabrum* (804.82µg/ml) and AE of *T. occidentalis* (891.48µg/ml) showed the lowest IC50s. In general, polyphenol content was negatively correlated to the IC50s of the extracts (Dobrinas *et al*., 2021; Hadjadj *et al*., 2020; Ciulca *et al*. 2021) but this was not always true. As an example, *S. cythera* showed higher IC50 with its AE even though it is this extract that presented higher the polyphenol content when compared to its corresponding HE. This implies that IC50 was higher than polyphenol content. This is in support of the hypothesis proposed by some authors who stated that DPPH kinetics is proportional to the amount of available OH groups present in the phenolic compound (Chen *et al*., 2020). This implies that a plant can have a low amount of polyphenols but the phenolic compounds are rich in OH groups leading to higher free radical scavenging capacity. The number and position of the hydroxyl groups on the chemical structure determine the potential of phenolic compounds as antioxidant molecules (Cosme *et al*., 2020).

Scavenging of ABTS is amongst the three methods that were standardized by the First International Congress on Antioxidant Methods in June 2004 for antioxidant evaluation protocols (Prior *et al*., 2005). In general, more interesting IC50s were obtained with HE and the most important were with C. verticillate, followed by *S. scabrum* and then *R. farinifera* (Figure 7). The HE of *C. verticillata* showed significantly very high polyphenol content (2714.09µg/ml ext) compared to *S. scabrum* (677.71µg/ml extract) but their ability to scavenge ABTS free radicals was significantly the same (364.35 and 365.67µg/ml extract; $p>0.05$). Moreover, *R. farinifera* had high polyphenol content compared to *S. scabrum*, but its IC50 was also higher. This supports the fact that certain polyphenols have been associated with certain antioxidant capacities (Stagos, 2019; Hanuka *et al*., 2020; Piluzza *et al*., 2011; Hadjadj *et al*., 2020).

Another radical used for the evaluation of antioxidant potential was nitric oxide (Figure 9). In humans, like in all mammals, NO is an important cellular signaling molecule involved in many physiological and pathological processes (Benjamin *et al*., 2020). However, abnormally high levels could have negative effects; expression of NO has been associated with various carcinomas (Somasundaram *et al*., 2019), hepatic failure (Iwakiri *et al*., 2018), diabetes (Tais *et al*., 2016) just to name these few. The hydroethanolic extract of *M. utilissima* showed the lowest IC50 (20µg/ml) even if its polyphenolic content was the 3rd least important. All hydroethanolic extracts showed lower IC50s compared to their corresponding aqueous extracts. the hydroethanolic solvent, has been shown to be a better extracting solvent than water (Shi *et al*., 2003; Seo *et al*., 2014).

Antioxidants act either by scavenging free radicals, by chelating metals, or by interacting with other antioxidants (Baiano *et al*., 2015; Stagos, 2019). It is important to evaluate most of these mechanisms of action when evaluating antioxidant power. As concerns metal chelation (represented in Figure 6), the method established by Dinis and collaborators (Dinis *et al*., 1994) is a reliable method and was exploited in this work.

No single assay accurately reflects the mechanism of action of all radical sources or all antioxidants in a complex system (Prior *et al*., 2005), at least two methods should be employed to evaluate the total antioxidant activity of a sample, due to various oxidative processes. FRAP was added to the antioxidant methods used in evaluating antioxidant potential. This method showed concentrations as high as 2700mMeqvitC/g extract (HE of *Cola verticillata*). Nevertheless, very low concentrations were also obtained like with the AE of *S. cythera* (10.5mMeqvitc/g ext).

Conclusion

All the 48 plant foods collected showed some antioxidant potential with all the three methods (FRAP, polyphenol content and scavenging of ABTS). In general, there was a positive correlation between the methods used for evaluating antioxidant power of filtrates of all 48 samples. Seven of the forty-eight plant foods notably: *R. farinifera*, *S. cytherea*, *T. occidentalis*, *M. utilissima*, *S. scabrum*, *C. verticillata* and *C. esculenta* were proven to have important antioxidant potential evaluated using six antioxidant methods. Taking into consideration all tests, *R. farinifera*, *C. verticillata* and *S. scabrum* appeared to be very good sources of antioxidants.

Authors Contributions: MAM-A and OJE designed the study, NFR and ABK analysed the data, NFR, MAM-A, and YJA wrote the manuscript, DPG, DHT, MI and FTH carried-out the experimentations and biochemical analyses.

Competing Interest: The authors in this paper declare no conflict of interest

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Cite This Article: Mbong Angie Mary-Ann, Ntentie Françoise Raïssa, Djiokeng Paka Gildas, Dimodi Henriette Thérèse, Azantsa Boris Kingué, Youvop Janvier Aimé, Makamwe Inelle, Fotso Tiénou Huiny, Oben Julius Enyong (2022). Antioxidant Potential of Some Plant Foods Commonly Consumed in Cameroon. *EAS J Nutr Food Sci*, *4*(3), 78-90.