

ANTIOXIDANT CAPACITY OF SOME PLANT FOODS AND BEVERAGES CONSUMED IN THE EASTERN REGION OF NIGERIA.

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Abstract

Today plant foods and beverages are receiving more scientific attention because of their potential to curb the effect of free radicals in the human system. The present study reports on the antioxidant potentials of some plants foods and beverages consumed in the Eastern Region of Nigeria. The study made use of the ferric reducing antioxidant power, phenolic and the flavonoid contents assays to assess the quality of the antioxidant potentials of the plant foods and beverages. Of the different classes of foods analyzed the following showed high antioxidant potentials: coffee for beverages, star apple for fruits, thyme for vegetable and spices, and raices for alcoholic beverages. Generally the vegetables and spices registered the highest antioxidant properties. The results obtained in this study could help consumers' choice based on the antioxidant capacity of the samples analyzed.

Keywords: Antioxidant, phenolic, ferric reducing antioxidant power, flavonoids, plant foods.

Introduction

Reactive oxygen species (ROS) are known to play a central role in the pathogenesis of degenerative diseases. They are involved in the oxidation of lipids, proteins, DNA damage and cellular degeneration related to cardiovascular disease (CVD), cancer, Alzheimer's and Parkinson's diseases (Clayson et al., 1994). These ROS are products of the system defense mechanism and normal metabolism. Current life style causes over production of free radicals and reactive oxygen species (Reddy et al., 2010). A well defined antioxidant system (enzymic and non-enzymic) coevolves with the aerobic metabolism to check the excesses of ROS (Niki et al., 1994). However, when the ROS overpowers the antioxidant defense, oxidative stress is eminent. Epidemiological studies have shown a convincing link between the antioxidant properties of plant derived polyphenolic compounds and their health promoting and disease preventing effect (Hollman et al., 1996, Kalt and Dufour 1997). Antioxidant compounds are found in plants with major defense mechanism against radical-mediated toxicity by preventing or attenuating the damages caused by reactive oxygen species (Farombi and Britton, 1999). The consumption of plant foods such as fruits and vegetables has been associated to a lower risk of degenerative diseases such as cancer, CVD, cataracts and immune dysfunction (Puttaraju et al., 2006). This protection is accounted for by the antioxidants in the plant foods (Collins, 2005).

Natural antioxidants protect from oxidative stress and associated diseases, therefore, play an important role in health care (Lopez et al., 2007). Plant foods (fruits, spices and vegetables) are important dietary sources of antioxidant polyphenols to humans (Vayalil, 2002; Agbor et al., 2005). There is a highly significant negative relationship between consumption of fruits and vegetables and ischemic heart diseases (Rimm et al., 1996). Fruits and vegetables are rich sources of vitamins (A, C and E), folates, carotenoides and dietary fibers. Fruits and vegetables are also rich in plants phytochemicals including flavonoids (antioxidant phytochemicals) (Agbor, 2009). Fruits and vegetables have been associated with prevention of obesity, lowering of plasma cholesterol, which is attributed to their fiber content, and reducing oxidative damage to biological molecules, enhancing immune responses, which are attributed to their antioxidant activity. Spices are food adjuncts used as flavoring, coloring, or seasoning agents. They are derived from barks (e.g., cinnamon) fruits (e.g., black pepper) and seeds (e.g., nutmeg). Several plant fruit, vegetables, and spices have been found to inhibit LDL oxidation *in vitro* by cupric ion and macrophages (Vinson et al., 1998; 2001a; 2005; DeWhalley et al., 1990; Mangiapane et al., 1992; Vinson et al., 1995a; Vinson et al 1995b; Agbor et al., 2010).

Traditionally, beverages include coffee, teas, red wine, beer, soda and cocoa products. However, today, fruit juices such as orange juice, pomegranate, guava, pineapple, apple juice, berry juices, which are rich in antioxidants, are bottled and ready to consume can also be classified as beverages. Of the traditional beverages, green teas, black teas, coffees, wine and cocoa are the most consumed worldwide followed by the pomegranates and the berries in the

United States. These are rich in polyphenolic phytochemicals such as theaflavin, epigallocatechin gallate, resveratrol, procyanidin, chlorogenic acids, caffeic acids etc, which have potential chemopreventive action attributed to their strong antioxidant activities. In comparing their antioxidant activity, Lee (2003) observed that cocoa had more phenolic phytochemicals and a higher antioxidant capacity than teas and red wine. Today the potential health benefits of teas are been documented on a scientific basis. There is scientific evidence relating regular consumption of green tea to reduced incidence of a variety of cancers, and other diseases in USA and United Kingdom (Alexis et al., 1999; Balentine et al., 1997, Dreostic et al., 1997; Setiawan et al., 2001; Wang et al., 2000).

The present study is aimed at evaluating the antioxidant capacity of some plant foods and beverages consumed in Eastern Region of Nigeria (Ibos).

Materials and Methods

Reagents Used: Folin-Ciocalteu (Sigma), DPPH (Sigma), TPTZ (Sigma), Catechin (sigma), Ferric Chloride (BDH), HCl (BDH), Acetic acid (BDH), Sodium Acetate (BDH). All reagents were of Analytical grade. All the samples i.e plant foods (Vegetables, Spices, fruits and breakfast cereals) and beverages (wines and beer) for analysis were bought from the Elele environ, Rivers State, Nigeria.

Sample preparation

Vegetables and Spices: The samples were cleaned and air dried at room temperature for 3 days. Samples were then blended to powder. 0.2 g of each sample was then dissolved in 10 ml of distilled H₂O and boiled for 90 mins with intermittent shaking after every 30 mins. This was allowed to cool and the volume adjusted to 10 ml by addition of distilled water. The prepared extracts were then stored at -20°C until analyzed.

Fruits: The fruits were cleaned and the peelings removed. The pulps each was blended and 9 g dissolved in 20 ml distilled H₂O. This was then centrifuged and aliquots transferred in to vials stored at -20°C until used.

Breakfast cereals: The breakfast cereals were prepared by dissolving 1g sample into 15 ml of distilled water and heated for 1 hr. After cooling, the sample volume was adjusted to 15ml and then centrifuged at 5000rpm. Supernatant was stored at -20°C.

Coffee, teas and cocoa products: The coffee and cocoa products were prepared according to the instruction on the label. That is 50g (a sachet) sample dissolved in 270ml boiling water for 5 mins. The tea samples were prepared as described in the label i.e. 2g dissolved in 270ml of boiling distilled water for 5 mins and allowed to cool. The supernatants of individual samples were collected and stored at -20°C until used.

Wines and Beers: The wine and beer samples were analyzed directly from their bottles without any further treatment. All samples were analyzed in triplicate.

Total phenolic content (TPC)

The total phenolic concentration in the sample was measured using the Folin-Ciocalteu reagent (Sigma Chemical Co., St. Louis, MO) diluted 5 times to 0.4N concentration (Vinson et al., 2001). The absorbance was measured at 750nm after 10 mins of reaction with the aid of a spectrophotometer (Genesys Model 4001, Milton Roy Company, USA) and catechin (Sigma) used as standard.

Total flavonoid content (TFC)

Total flavonoid content of extracts was estimated using the aluminium chloride colorimetric method of Chang et al. (2002). Each plant extract (0.5 ml, 1 mg/ml) in methanol was separately mixed with 0.1 ml of 10 % AlCl₃·6H₂O, 0.1 ml of NaCN and 2.8 ml of distilled water. The absorbance of the reaction mixture was measured at 415 nm after 30 mins. Total flavonoid content was expressed as catechin equivalent.

Ferric reducing antioxidant power

The Ferric Reducing Antioxidant Power (FRAP) of extracts was determined as earlier described by Benzie and Strain (1996). The FRAP reagent consisted of ten part acetate buffer (300 mM pH 3,6), one part of TPTZ (10mM in 400 mM of HCl, Sigma) and one part of ferric chloride (10 mM). Catechin was used as the standard and absorbance read at 593 nm.

Statistical Analysis

Results are presented as Mean \pm Standard Deviation. Correlations between one method and the other were established using the Pearson Product Moment Correlation analysis at 95% significance level ($P < 0.05$). The SigmaStat (Systat software, Richmond, CA) version 3.01 was used for this analysis.

Table 1. Fruits and alcoholic beverages analyzed

Common/native name	Botanical name
Banana	<i>Musa acuminata</i>
Orange	<i>Citrus sinensis</i>
Lime	<i>Citrus aurantifolia</i>
Cucumber	<i>Cucumis sativus</i>
Avocado	<i>Persea americana</i>
Mango	<i>Magnifera indica</i>
Pineapple	<i>Ananas comosus</i>
Star apple	<i>Chrysophyllum africanum</i>
Pawpaw	<i>Asiminia trilobata</i>
Brand names of beers and wines	Origin
BARON DE TENA	Spain
CASTILLO DE LIRIA	Spain
CUVEE SPECIALE	Spain
RAICES	Spain
VINO TINTO	Spain
STAR	Nigerian Breweries
SMIRNOFF ICE	Guinness Nigeria
GUINNESS	Guinness Nigeria
GORDON SRARK	Guinness Nigeria
GULDER	Guinness Nigeria

Table 2. List of vegetable and spices analyzed

Vegetables and spices	Botanical name	Uses
Uha (ora)	<i>Pterocarpus sovauxil</i>	Preparation of local soup
Green (inine)	<i>Amaranthus viridis</i>	Preparation of yam porridge and soup
Ugu (pumpkin leaf)	<i>Telferia occidentalis</i>	For soup preparation
Uziza (Uziza)	<i>Piper guineensis</i>	Soup preparation and flavorant
scent leaf (nchuanwu)	<i>Ocimum gratissimum</i>	Spice in food and medicinal
bitter leaf (onugbu)	<i>Vernonia amygdalina</i>	Soup preparation and medicinal
Garden Egg leaf (Akwukwo anara, afufa)	<i>Solanum spp</i>	Soup preparation
Ukazi (ukazi)	<i>Gnetum bulchozianum</i>	Soup preparation
Onions	<i>Allium cepa</i>	Widely used for cooking, add flavor to dishes like stews, roasts, soups, salads, and frying.
Garlic	<i>Allium sativum</i>	Used either dried or ground to flavor tomatoes sauces, stews, or salad dressing.
Ginger	<i>Zingiber officinale</i>	It is used dried and grounded to flavor bread, sauces.
Uda	<i>Xylopiya aethiopica</i>	Used for cooking and treatment of anal cancer.
Thyme	<i>Thymus vulgaris</i>	Used dried to flavor fish, poultry, meats, sauces, sausages.
black pepper	<i>Piper nigrum</i>	Used in cooking. E.g. soup, pepper soup.

Results and Discussion

The role of free radicals has been implicated in several diseases such as liver cirrhosis, atherosclerosis, cancer, aging, diabetes etc (Halliwell and Gutteridge, 1985). Thus compounds that can scavenge these free radicals

have a great potential to prevent or inhibit these diseases. Antioxidants are such compounds with radical scavenging activity. Different methods exist to assess the antioxidant potential of a compound or a substance. In the present study, we report on the antioxidant capacity of some sample fruits (9), teas (6), cocoa and coffee (7), breakfast cereals (8), vegetables and spices (10) and alcoholic beverages (10) as free polyphenol, flavonoid content and Ferric reducing antioxidant power (FRAP). Table 1-2 presents some of the different samples selected for analysis while the results are presented in Table 3-6. The samples presented different antioxidant capacities in relation to the methods of analysis and with respect of the different samples.

Table 3: Total Phenolic and Ferric Reducing Antioxidant Power (FRAP) (mg/g catechin equ.) of breakfast products

Samples	Phenolic content	FRAP
Teas		
Lipton y	13.23 ± 1.17 (1)	1.69 ± 0.07 (1)
Premium	9.05 ± 0.09 (2)	1.36 ± 0.0 (2)
Natural tea	4.84 ± 0.17 (6)	1.30 ± 0.01 (6)
Conlyl	8.50 ± 0.18 (3)	1.33 ± 0.0 (3)
Ginger	5.54 ± 1.08 (5)	1.32 ± 0.01 (4)
Pg	7.36 ± 1.00 (4)	1.31 ± 0.01 (5)
Cocoa and Coffee Products		
Concord instant chocolate	8.523 ± 2.53 (5)	1.63 ± 0.13 (3)
Blueboat choco	2.19 ± 1.07 (7)	0.39 ± 0.03 (7)
Ovaltine	8.26 ± 1.12 (6)	1.43 ± 0.02 (5)
Bournvita	28.93 ± 4.42 (4)	1.56 ± 0.02 (4)
Nestle Milo	45.49 ± 9.14 (2)	1.87 ± 0.04 (1)
Cowbell choco	38.49 ± 3.49 (3)	1.71 ± 0.07 (2)
Nescafe	45.73 ± 4.02 (1)	1.37 ± 0.00 (6)
Breakfast Cereals		
Jago oats	0.83 ± 0.11 (7)	ND
Quaker oats	0.58 ± 0.02 (8)	0.33 ± 0.04 (4)
Weetabix	2.62 ± 0.31 (5)	0.16 ± 0.08 (6)
Kellogs	4.54 ± 0.24 (3)	0.43 ± 0.08 (3)
Cornflakes	1.81 ± 0.11 (6)	0.067 ± 0.03 (7)
Golden morn	8.41 ± 0.72 (1)	0.26 ± 0.04 (5)
Cerelac	3.19 ± 1.00 (4)	0.82 ± 0.33 (2)
S.Flakes	5.11 ± 0.23 (2)	1.21 ± 0.41 (1)

Results are presented as Mean ± Standard Deviation, n = 3

() = ranking, ND = not detectable

Table 4. Total Phenolic, FRAP and Flavonoid content (mg/g catechin equ.) of fruit pulp (wet weight).

Common/native name	Phenolic content	FRAP	Flavonoid content
Banana	0.13±0.02 (8)	0.29±0.07 (4)	0.74±0.10 (6)
Orange	0.33±0.040 (5)	0.24±0.0 (6)	0.31±0.07 (8)
Lime	0.23±0.05 (7)	0.07±0.01 (9)	0.19±0.06 (9)
Cucumber	0.05±0.05 (9)	0.10±0.01 (8)	0.56±0.09 (7)
Avocado	0.32±0.02 (6)	0.80±0.08 (1)	2.46±0.05 (3)
Mango	0.54±0.02 (3)	0.24±0.0 (5)	0.77±0.12 (5)
Pineapple	0.41±0.14 (4)	0.19±0.01 (7)	1.05±0.09 (4)
Star apple	3.13±0.47 (1)	0.58±0.0 (2)	3.52±0.14 (1)
Pawpaw	0.57±0.11 (2)	0.40±0.02 (3)	3.02±0.14 (2)

Results are presented as Mean ± Standard Deviation, n = 3

() = ranking

Table 3 presents the Phenolic content, and Ferric Reducing Antioxidant Power (FRAP) (mg/g catechin equ.) of breakfast products. Considering the different classes of breakfast products, the coffee samples have the highest phenolic content followed by the cocoa products then the tea samples. The breakfast cereals tailed the classification. A similar pattern of classification holds when the ferric reducing antioxidant power (FRAP) of the various extracts was measured. The antioxidant capacity (phenolic content) of the Lipton y tea, premium, and conilyl tea were higher than those of Concord instant chocolate, blueboat choco and ovaltine for the cocoa products. A strong correlation was observed between the phenolic content and FRAP of the tea sample ($r= 0.890843$), to an average correlation in the cocoa and tea products ($r= 0.59383$) then to a very weak correlation in the breakfast cereals ($r= 0.344098$) data. This

Table 5. Total Phenolic content, Flavonoid content and Ferric Reducing Antioxidant Power (FRAP) (mg/g catechin equ.) of vegetables and spices

Common/native name	Phenolic content	Flavonoid content	FRAP
Uha (ora)	29.30 ± 2.17 (3)	56.49±8.14 (2)	10.01 ± 0.16 (8)
Green (inine)	25.75 ± 3.21 (6)	5.40±1.05 (8)	8.08 ± 0.46 (10)
Ugu (pumpkin leaf)	27.73 ± 2.82 (5)	40.23±2.98 (4)	10.48 ± 0.18 (7)
Uziza (Uziza)	23.13 ± 0.97 (8)	14.18 ±3.26 (5)	11.81 ±0.46 (5)
scent leaf (nchuanwu)	126.76 ±5.20 (2)	45.57± 8.93 (3)	23.45 ± 0.11 (1)
bitter leaf (onugbu)	28.43 ± 3.93 (4)	2.03 ± 0.17 (9)	11.08 ± 0.04 (6)
Garden Egg leaf (Akwukwo anara, afufa)	19.91 ± 2.43 (9)	0.68 ± 0.17 (10)	9.24 ± 1.32 (9)
Ukazi (ukazi)	15.70 ± 0.06 (10)	6.02 ± 0.87 (7)	3.28 ± 1.22 (14)
Onions	6.13 ±0.38 (12)	ND	4.15 ± 0.96 (13)
Garlic	4.35 ±0.89 (13)	ND	4.52 ± 0.57 (12)
Ginger	10.61± 2.11 (11)	ND	14.26 ± 2.56 (3)
Uda	23.36 ±2.11 (7)	7.73 ±0.56 (6)	14.00 ± 0.96 (4)
Thyme	134.55± 4.00 (1)	71.44 ±8.49 (1)	23.09 ± 0.06 (2)
Fresh pepper	3.20± 0.44 (14)	ND	5.48 ± 1.01 (11)

Results are presented as Mean ± Standard Deviation, n = 3

() = ranking; ND = not detectable

Table 6. Total Phenolic and flavonoid content, FRAP (mM catechin equ.) and % radical scavenging activity of beers and wines

Brand names of beers and wines	Phenolic content	FRAP	Flavonoid content
BARON DE TENA	2865.44 ± 319.52 (4)	252.44 ± 1.21 (4)	2556.44 ± 683.57 (3)
CASTILLO DE LIRIA	3988.18 ± 609.67 (2)	261.47 ± 1.88 (2)	2122.12 ± 267.85 (5)
CUVEE SPECIALE	3260.25 ± 356.74 (3)	260.67 ± 3.65 (3)	2207.63 ± 544.79 (4)
RAICES	4941.27 ± 278.06 (1)	271.63 ± 2.45 (1)	3930.30 ± 140.01 (1)
VINO TINTO	2057.32 ± 194.39 (5)	249.38 ± 1.01(5)	1238.84 ± 170.49 (6)
STAR	472.74 ± 4.90 (8)	194.06 ± 6.33 (8)	645.86 ± 232.65 (8)
SMIRNOFF ICE	15.51 ± 5.10 (10)	4.07 ± 4.34 (10)	205.91 ± 121.71 (10)
GUINNESS	1073.66 ± 131.82(7)	225.59 ± 2.31 (7)	2668.96 ± 185.64 (2)
GORDON SRARK	1548.03 ± 174.79 (6)	236.64 ± 0.37 (6)	399.44 ± 96.51 (9)
GULDER	434.36 ± 22.22 (9)	174.30± 5.33 (9)	669.49 ± 67.96 (7)

Results are presented as Mean ± Standard Deviation, n = 3

() = ranking

give an overall correlation of $r= 0.60871$ for the phenolic content and FRAP of the breakfast products analyzed. Hence the phenolic content of breakfast products determined by Folin Ciocalteu method may not be directionally propotional to their FRAP. Teas are high in catechins, which are powerful antioxidant compounds capable of scavenging reactive oxygen species. Tea is the most consumed beverage in the world. Scientific studies have shown that regular consumption of teas reduces the incidence of various cancers (Alexis et al., 1999; Balentine et al., 1997;

Driostic et al., 2001; Steiawan et al., 2001; Wang et al., 2000). Regular tea consumption has equally been reported to inhibit diabetic cataracts in streptozotocin-intoxicated rats (Vinson et al., 2005). Cocoa products are often viewed today as food or snack with little nutritional value. Chocolate (one of cocoa products) ranked third highest daily per capita antioxidant source (Vinson et al., 2006) in the United State of America. Cocoa powder at a human dose equivalent of two dark chocolate bars per day significantly inhibited atherosclerosis, lowered plasma cholesterol, and protected the low density lipoprotein from oxidation (Vinson et al., 2006).

Fruits and vegetables are rich sources of vitamins (A, C and E), folate, carotenoids and dietary fibers. Fruits and vegetables are also rich in plants phytochemicals including flavonoids (antioxidant phytochemicals). Fruits and vegetables have been associated with prevention of obesity, lowering of plasma cholesterol, which are attributed to their fiber content, and reducing oxidative damage to biological molecules, enhancing immune responses, which are attributed to their antioxidant activity. Earlier studies have indicated that consumption of fruits and vegetables prevent degenerative diseases caused by oxidative stress (Scalbert et al., 2005). Dietary polyphenol intakes from fruits and vegetables are known to reduce the risk of coronary heart disease and cancer (Block et al., 1992). For the analysis of the antioxidant capacity of a variety of fruits consumed in the Eastern Region of Nigeria, three different assay methods (phenolic, FRAP and flavonoid content mg/g catechin equ.) were used and results presented in Table 4. Based on the different methods applied the fruits had different antioxidant capacities. Considering the best three fruits of each method, the antioxidant capacity was in the order: star apple > papaw > mango for phenolic content; avocado > star apple > papaw for FRAP; and star apple > papaw > avocado for Flavonoid content. Overall, star apple appear to be the best fruit with high antioxidant capacities, because it appeared first in 2 different methods (Phenolic and flavonoid content) and second in FRAP. Pawpaw comes second because it appeared among the best three in all three methods. Avocado is considered in the third place because it appears among the best three in two methods. Mango which appeared only once (phenolic content) among the best three can be classified fourth. Pearson correlation analysis reveal a close relationship between the results obtained by FRAP and Flavonoid content ($r=0.794539$) and between the results obtained by Folin (for phenolic content) and Flavonoid content ($r=0.695912$) but a poor relation between the results of Phenolic content and FRAP ($r=0.444481$).

The total phenolic content, flavonoid content and FAP of vegetables and spices and their ranking are presented in Table 5. The results of Phenolic and Flavonoid content revealed thyme as the most potent antioxidant followed by scent leaf for phenolic content and uha for flavonoid content whereas fresh pepper was the least followed by garlic and onion. The flavonoid content of onion, garlic, ginger and black pepper was not detectable. Based on FRAP, scent leaf is the most potent antioxidant followed by thyme whereas ukazi had the least antioxidant capacity. Overall, thyme and scent leaf stands out as the samples with the highest antioxidant capacities. The phenolic content of black pepper was far lower than values obtained for black pepper from Cameroon (Agbor et al., 2005; 2006). Regardless of the assay method, the values were all correlated. Between FRAP and Phenolic content $r=0.878466$, 0.778952 for Phenolic content and Flavonoid content, and 0.669312 between FRAP and flavonoid content.

Table 6 presents the total phenolic, flavonoid content, and FRAP (mM catechin equ.) of some alcoholic beverages (beers and wines). Among the alcoholic beverages analyzed, the wines were the most potent compared to beers with the Raices wine standing out (highest antioxidant capacity) and Smirnoff Ice (beer) the least potent irrespective of the method applied. The difference between the antioxidant capacities of wine and beer is that the wines especially red wine are produced from grape which are high in antioxidant compounds such as flavonoids which are transferred to the wine. On the other hand, beers are made from barley, maize, or malt which may not be as rich in antioxidant but rich in starch. Also very little goes to waste in wine making as compared to beer processing. Correlation analysis reveal positive correlation between three methods with the strongest existing between phenolic content and flavonoid content ($r=0.80642$), then phenolic content and FRAP ($r=0.712918$) and then FRAP and flavonoids ($r=0.624204$). Low incidence of cardiovascular events has been associated with moderate wine consumption in spite of a diet high in saturated fat (Renaud and de Lorgeril, 1992). This has been associated with red wine because of its polyphenolic content such as quercetin, myricetin, and catechin (Rice-Evans et al., 1996). These polyphenols extracted from red wines have been shown to protect LDL from oxidation *in vitro* (Whitehead et al., 1995) and increased plasma antioxidant activity (Aviram, 1996; Maxwell et al., 1994). Red wine and its polyphenol consumption have been reported to significantly reduce LDL-C susceptibility to aggregation in apo E deficient mice compared to placebo (Hayek et al., 1997).

Generally lack of consistency in the correlation between the antioxidant capacity and the polyphenolic contents of natural products have earlier been reported (Agbor et al., 2005). Some authors (Ghiselli et al., 1998; Majo et al., 2008) have found a linear correlation between antioxidant capacity and total polyphenols contents of natural products. Our results are consistent with the claim that statistic correlation is only relevant between total polyphenols and the flavonoids fraction (Katalinic et al., 2004). We would have expected comparable antioxidant values ranking irrespective of the antioxidant method. But this was not the case in all three methods used for the analysis. The simple reason being that as earlier suggested (Agbor et al., 2005) in all the group of samples analyzed do not contain same kind of substances and the reagents of the methods are different. However, it may be possible to find a strong correlation between methods if the samples are from the same genus and with pure samples as was obtained in the case of wine and teas in the present study. For the other, the plants were from different families, hence the possibility that they contain different chemical constituents, making it difficult to establish a strong correlation.

Conclusion

All the samples analyzed showed some antioxidant potentials with coffee being the highest antioxidant source for beverages and scent leaf and thyme highest antioxidant source overall. Thus, vegetables and spices from the eastern region of Nigeria may provide the antioxidant needed from food. A vegetable rich diet and a glass of wine may just be enough antioxidant to keep the body safe from oxidative stress. The results obtained may help guide consumer's choice.

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