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Phenolic content and antioxidant activity of some under-utilized Nigerian yam (*Dioscorea spp.)* and cocoyam (*Xanthosomamaffa* (*scoth*)) tubers

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Abstract: *Yams (Dioscorea species) and cocoyam (ariods) are major staples that are widely consumed in tropical and subtropical countries, especially Nigeria.Up till now, there is limited information on the phenolic compounds and antioxidant activity of yams and cocoyam species in this tropical region.Three under-utilized Nigerian yams (Dioscoreacayenensis, Dioscoreadumetorum, Dioscoreabulbifera) and cocoyam (Xanthosomamaffa (Scoth)) were analyzed for total polyphenols, total flavonoids and antioxidant activities applying three commonly used assays: DPPH, ABTS, and ORAC. Correlation analysis wasperformed to determine the contribution of polyphenols and flavonoids toantioxidant activities. The total polyphenol content of the samples ranged from 7.02 to 163.37mg Gallic Acid Equivalent(GAE/100gFW), while the total flavonoid content of the samples ranged from 3.14 to 155.38mg Catechin Equivalent(CE/100gFW). The antioxidant activities evaluated by DPPHassay ranged from 88.17 to 729.39 Trolox Equivalent (TE/100gFW), whileABTSvalues ranged from 32.49 to 756.0 Trolox Equivalent (TE/100gFW)and ORAC assay ranged from 459.29 to 669.45mg Trolox Equivalent (TE/100gFW) respectively. Significant correlation was observed between total polyphenols and DPPH radical scavenging activity (R^2=0.897);total polyphenols and ABTS(R^2=0.931),andbetween total polyphenols and ORAC (R^2=0.707). The correlation between total flavonoid and DPPH(R^2=0.992), and between total flavonoidand ABTS(R^2=0.744) respectively. The polyphenol, flavonoid and antioxidant activity of Xanthosomamaffa (Scoth) were higher and significantly different (P<0.05) from the yamsDioscoreaspecies. Extracts from these under-utilized yams and cocoyam tubers can play a considerable role in boosting immunity against human diseases caused by free radical reactions like cancer, cardiovascular disease, diabetes and aging.*

Keywords:*Antioxidant activity, Dioscoreaspp, Flavonoids, Polyphenol, Xanthosomamaffa (Scoth).*

I. Introduction

Yams and cocoyam are root crops of *Dioscorea genus* and aroids of the *Araecea*family. They are among the most important staple foods in the tropical and subtropical countries, especially Nigeria where the yearly production and consumption per inhabitant is among the highest in the world[1-3]. The important edible tubers of *Dioscoreas*pecies are *D. rotundata* (white yam), *D. alata* (water yam), *D.esculenta* (chinese yam), D. *cayenensis* (yellow yam), *D. dumetorum* (trifoliate yam), and *D.bulbifera* (aerial yam).Thearoid tubers are *Xanthosoma* and*Colocasia*species which are collectively called cocoyam [4].

Yam and cocoyam production not only contribute to the subsistent economy among the rural farmers, they are the major source of calories, essential micro-nutrients and phytochemical compounds. Some of these micronutrients are iron, zinc, ascorbic acid, pro-vitamin A carotenoids, polyphenol and flavonoids [1,5-10].

Studies in yams indicate low to high content of polyphenol and antioxidant activities [11-13]. Polyphenols are groups of compounds that are chain-breaking antioxidants. They scavenge free radicals and stop the propagation of free radical chain reactions [14]. The antioxidant activity of phenolic phytochemicals is mainly as a result of their redox potential which results from mechanisms like free radical scavenging activity, metal chelating activity, and singlet oxygen quenching ability, thus protecting the cells against oxidative damage caused by reactive oxygen species [15]. Several physiological effects have been reported in yam extractsdue to the presence of phenolic phytochemicals. Theyinclude reducing of blood lipid [16], lowering of blood sugar [17], antioxidant activity [6,8],anti-mutagenic activity [18],and anti-allergic activity [19].Yam extract is also said to be protective against toxicity and lipid peroxidation caused by some chemicals such as CCL4 [7]. Yams and cocoyam also contain some amounts of other useful antioxidants such as vitamin C and carotenoids [10,20]which exerts useful physiological effects.

Although Nigeria is the largest producer and consumer of yams and cocoyam, report on the quantity of phenolicphytochemical and antioxidant activities in various species of the fresh yams and cocoyam tubers is scarce unlike in other tropical regions of the world [6,8,12].However, Ozoet al. {1}, Martin and Ruberte [21],

Farombiet al.[7], Adebayo et al. [22]have revealed that*Dioscorearotundata*specieprocessed yam flour diet (elubo) used to prepare Amala, a reconstituted browned yam flour diet consumed in the Southern region of Nigeria contain phenolic phytochemicals.

To improve human nutrition through abundant food supply for energy and growth is important, research on staple crops rich in antioxidant phytochemical isneeded for the proper functioning of the mind and the organs of the body as well asfor prevention of diseases. Therefore, the total polyphenols,flavonoidsand antioxidant activities of some under-utilized Nigerian yams and cocoyam tubers were investigated. The aim of this study is to provide informationon the content of total polyphenols, flavonoids and antioxidant activities of some under-utilized Nigerian yams and cocoyam tubers in order to further promote their consumption and utilization as free radical scavengers.

II. Materials And Methods

2.1Chemicals

Galic acid, Catechinhydrate,Folin-Ciocalteu's phenol reagent,AAPH (2,2´-azobis(2-amidinopropane)dihydrochloride), DPPH(2,2-diphenyl-1-picrylhydrazyl), ABTS(2,2´-azino-bis-(3-ethylbenzothiazoline-6-sulponic acid)diammonium salt),and Fluorescein sodium salt were purchased from Sigma Chemical (MO, USA). Other chemicals used, namely, Acetone, Sodium nitrite, Aluminum chloride, Petroleum ether and Alcohol were of analytical grade.

2.1.1 Samples.

Three species of*Dioscorea* namely, *D.cayenensis* (yellow yam), *D.dumetorum* (trifoliate yam), *D.bulbifera* (aerial yam) and one cocoyam,*Xanthosomamaffa (Scoth)* (yellow cocoyam) were collected from afarmer at AmaekeUtutu,Abia State, Nigeria, after harvesting at full physiological maturity in January, 2012. They were without defects.

2.1.2 Sample preparation.

Sample preparation and analysis was carried out at Nutrition Quality Laboratory, International Centre for Tropical Agriculture, Cali, Colombia (CIAT).Tuber samples (aerial yam, trifoliate yam, yellow yam and yellow cocoyam) were washed with deionized water andpeeled immediately. The samples were diced into small cubes, pulverized (homogenized) using a blender (RetschGrindomix, USA) at 1000rpm for 30 seconds. Each sample was packaged in separate cellophane bag, filled with nitrogen gas and stored at -70^0C.
After 24h, the frozen samples were lyophilized at -30^0C (Labconco Corporation, Kansas City, MO), pulverized into powder and stored at -70^0C for subsequent use.

2.1.3Extraction of phenolic compounds.

Trials using different solvents in different proportions (water, ethanol, methanol, acetone, ethanol/water (50:50 v/v), ethanol/water (70:30 v/v),methanol/water (50:50 v/v), methanol/water (70:30 v/v), acetone/water (50:50 v/v), acetone/water (70:30 v/v)) were carried out in order to determine the extraction potency that was best and compatible with the solubility of phenolic compounds in the yams and cocoyam tuber matrix. The matrix and cellular tissue of yams and cocoyam are different from that of other vegetables already documented with different extraction solvents. Acetone and deionized water (50:50 v/v) were chosen as the best solvent of extraction to penetrate the cell wall and matrix of the yams and cocoyam tuber samples.

A quantity of 0.5g of theground powdered sample was mixed with 5 ml of the extracting solvent acetone/deionized water (50:50 v/v) in a 50 ml BD Falcon tubes using Ultra Turax (1Ka T18 basic Staufen, Germany) for 10 seconds and then capped and re-mixed in a Vortex mixer (Fisher Scientific, USA) for 1 minute. They were then placed on a multi-purpose rotator (Barnstead International, USA) for 30 minutes at 600rpm. Subsequently, the samples were centrifuged at 4^0C for 5 minutes, and at 6000rpm (Eppendorf Centrifuge 5804R Hamburg, Germany). Two (2) ml of sample extract was collected and stored in the dark at 4^0C for the determination of total polyphenols, flavonoidsand antioxidant activities with the protocols of ABTS, DPPH, and ORAC assays.

2.1.4 Determination of total polyphenol.

Total polyphenols (TP) content was determined following the method suggested by Jayaprakashaet al.[23]using Folin-Ciocalteu reagent with a minor modification. In a 2ml Eppendorf tube, 780µl deionized water, 20µl sample extract, and 50µl Folin-Ciocalteu reagent (1:1 v/v) with water were added and mixed. After 1 minute, 150µl Sodium carbonate (0.2g/ml) was added, and the mixture was allowed to stand at room temperature in the dark for 1h. Then, 300µlofthe mixture was carefully introduced into a 96 well plate using Eppendorf micropipette.

The absorbance was read at 750nm (μQuant, Biotech Instruments,USA)). The total polyphenol concentration was calculated from a calibration curve, using Gallic acid (1mg/ml) as standard (200 – 1000mg/L).

2.1.5Determination of total flavonoid.

Total flavonoids (TF) content was determined using the method of Yong et al [24] with some modifications. In a 2ml Eppendorf tube, 660μl deionizedwater, 80μl sample and 30μl Sodium nitrite (50mg/ml), and 30μl Aluminum chloride (100mg/ml in methanol) were added and mixed. After 5 minutes, 200μl of 1M Sodium hydroxidewasadded. Then, 300μl of the mixture was transferred into the 96well plate andread at 500nm immediately. The total flavonoid concentration was calculated from a calibration curve using Catechin as standard (50 – 800mg/L).

2.1.6Antioxidant activity determined by DPPH

The ability to scavenge DPPH free radicals was determined according to the method of Brand-Williams et al.[25] with some modifications. The stock solution was prepared by dissolving 24mg DPPH with 100mL methanol. It was stored at – 20^0C over-night. The working solution was obtained by mixing 10mL stock solution with 45mL methanol to obtain an absorbance of 1.1$\pm$0.0.2 units at 517nm using the spectrophotometer (μQuant, Biotech Instruments, USA). Sample (yams and cocoyam) extracts (100μL) were allowed to react with 1900μL of the DPPH solution for 1h. Thereafter 300μL of the reaction mixture was added into the 96well plate andread at 517nm. The standard curve was linear between 150 – 500μM Trolox. Results were expressed in mgTrolox Equivalent (TE/g) fresh weight. Additional dilution was needed if the DPPH value measured was over the linear range of the standard curve.

2.1.7Antioxidant activity determined by $ABTS^{\cdot+}$radicalcation.

For ABTS assay, the method of Arnao et al.[26]was adopted with some modifications. ABTS radical cation($ABTS^{\cdot+}$) was produced by reacting 38.4mg ABTS and 6.6 mg potassium persulphate in 10mL of deionized water and allowing the mixture to stand in the dark at room temperature (about 29^0C)for 12 – 16h before use. The $ABTS^{\cdot+}$ stock solution was diluted with ethanol to obtain an absorbance of 1.1 $\pm$ 0.02 at 734nm. In the 96 well plate, 30μL of sample extract or Trolox standard and 200μL $ABTS^{\cdot+}$ solution were added together and allowed to react for 6 minutes before taking absorbance at 734nm (μQuant, Biotech Instruments, USA). Data was expressed as Trolox Equivalent Fresh Weight (TE/gFW). The Trolox standard curve was linear between 50 – 400μM Trolox.

2.1.8Antioxidant activity assay by oxygen radical absorbance capacity(ORAC).

The ORAC assay was performed as described by Huang et al.[27] 130mg AAPH (2,2′-azobis(2-amidinopropane)dihydrochloride) was dissolved in 3ml PBS of 75mM (pH7.4) to a final concentration of 153mM and made fresh daily. A fluorescein stock solution ($4x10^{-3}$mM) was dissolved in 75mM PBS (pH7.4) and stored. The fluorescein stock solution was diluted 1:1000 with PBS (pH7.4). To the experimental 96 wells, 150μL fluorescein diluted solution was added. In addition, blank wells received 25μL of 75mM PBS (pH7.4), while standards received 25μL of Trolox dilution and sample wells received 25μL of sample extracts (diluted at 1:100). Reaction was initiated by adding 25μL of AAPH reagent with shakingduration for 8 seconds. A Multi-Mode Micro-plate Reader, Synergy™ HT, Biotech InstrumentINC, USA, with injectors was used with 485/20nm excitation filter and a 530/25nm emission filter. The number of Kinetic cycles is 30 and Kinetic interval is 60 seconds.

ORAC values were calculated as described by Cao and Prior [28]. The Area under the Curve (AUC) and the Net AUC of the standards and samples were determined using Equations (i) and (2), respectively. Results were expressed as Trolox Equivalent fresh weight (TE/gFW)

$$AUC = 0.5 + (R_2/R_1) + (R_3/R_1) + (R_4/R_1) \ldots\ldots + 0.5\,(R_n/R_1) \text{---(1)}$$

Where R_1 is the fluorescence reading at initiation of the reaction and Rn is the last measurement.

$$\text{Net AUC} = \text{AUC sample} - \text{AUCblank} \text{ --- (2)}$$

2.1.9 Statistical Analysis

All tests were carried out in triplicate and means were separated using LSD at $P<0.05$. Analysis of variance (ANOVA) and Pearson correlation analysis wereperformed by PROD.GLM in SAS(SAS,2003) [29].

III. Result And Discussions.

Trials using different solvents in different proportions were carried out to determine the best extraction potency for the food matrix (yams and cocoyam) in order to measure the phenolic compounds and antioxidant activity from the tuber extracts. Extracts from acetone/ water (50:50 v/v) (result not shown) possessed the best extraction potency and was the solvent combination used in this study. To determine the effect of extraction solvent on phenolic compounds and antioxidant activity measurements, Gallic acid equivalent, Catechin equivalent and Trolox equivalent for total polyphenols, total flavonoids, DPPH, ABTS and ORAC values were first obtained.The R^2, slopes, intercepts and the mean CV´s of the standard calibration curves (Gallic acid (TP), Catechin (TF), Trolox (DPPH, ABTS, and ORAC) that measured the acetone/ water (50:50 v/v) yams and cocoyam tuber extracts are shown in Table 1. In all the methods, R^2 values were high for the solvent, acetone/ water (50:50 v/v), indicating a high dose-response linear curve. The slopes and intercepts of Gallic acid and Catechin were not significantly different. There was an indication that Gallic acid and Catechinstandards behave alike in acetone/water (50:50 v/v) solvent for the yams and cocoyam tissue extracts. Similarly for theTrolox standard, the slope and intercept for antioxidant activity DPPH and ABTS were not significantly different.This meaning that like Galic acid and Catechin, DPPH and ABTS behave alike in the solvents used for extraction. ORAC method showed a significantly different slope and intercept from DPPH and ABTS methods, suggesting a different behavior in the solvent of extraction. Nevertheless, the results from the Trolox calibration curve and the antioxidant activity assay measurements on theyams and cocoyam tuber (acetone/water (50:50 v/v)) extract are very high.The mean percentage coefficient of variation (%CV) for each calibration curve is also presented in Table 1. The mean percentage CVs are acceptable. The observation is that the results presented in Figs. 1 and 2 have good reproducibility and precision. This is in agreement with the fact that results of phenolic compounds and antioxidant activity should to be measured by the same method using the same solvent[30].

The results of the percentage moisture content, total polyphenols and total flavonoids are presented in Fig 1.Wide variations exist in the results of the percentage moisture content, polyphenols and flavonoids contents of the yams and cocoyam tuber species analyzed.The total polyphenol content ranged from 7.02 to 163.37 mg GAE/100gfw. *Xanthosomamaffa (Scoth)* had the highest amount of total polyphenols, while *D. cayenensis* was the lowest. There was significant difference ($p<0.05$) in the total polyphenols of the yams and cocoyam tubers examined (Fig.1). The total flavonoid content varied from 3.14 to 155.38 mg CE/100gfw (Fig. 1). *Xanthosomamaffa (Scoth)* had the highest flavonoid content while *D. cayenensis* was least. Significant difference ($p<0.05$) existed in the flavonoid content of the tubers evaluated.

In this study, the total polyphenols and flavonoids of *Xanthosomamaffa (Scoth)(*cocoyam) was significantly higher($P<0.05$) than those of *Dioscorea*yam tubers. In previous studies on yams from Nigeria, phenolic content (mgCE/100g fresh yam) of *D.cayenensis* (27.0), *D.dumetorum* (86.0),*D.bulbifera* (423) and *D.rotundata* (243)were reported as pooled fractions determined on LH-20 chromatogram [1&7]. Comparing with results on yams from other countries, the total phenolic content evaluated from seven varieties of Philippine yamsranged from 20.1 to 127.8mg GAE/100gfw [8],four Nepal yam species varied from 13 to 166mg Phenol/100gfw [6], while 8mgGAE/100gfwwas reported for white-fleshed*D.alata*and 26mgGAE/100gfw was also reported for red fleshed *D.alata*yams from Fiji [9]. The total polyphenols values obtained in this study is in agreement with the range values reported by Cornagoet al. [8], Bhandari and Kawabata [6], and Lakoet al. [9], probably becauseFolin-Ciocalteuphenol reagent and Gallic acid standard were used rather than LH-20 chromatogram fractions [1&7],which may have interference with non-phenolic and inorganic compounds resulting into higher phenolic content. The minor difference in the comparison of the values reported in literature may be due to different geographical locations, weather variations, differing agricultural practices, assay methods and extracting solutions. The synthesis and accumulation of phenolic compounds in plants, and consequently, antioxidant activity, is influenced greatly by genotype [31],which may contribute to the varying phenolic contents obtained from different species of yams and cocoyam used in this study. The result indicates that at 65 to 69% moisture, more polyphenols and flavonoids were extracted (Fig. 1). Cornagoet al.[8]also showed that the total phenolic content of yam samples was higher at moisture (%) range of 67 to 72. It could bethat the composition of foods, especiallyfat and fiberthat affects the percentage moisture can directlyinfluence the extraction and quantification of total phenols. The total flavonoids and total polyphenols in the yams and cocoyam tuber extracts showed a positive linear correlation of $R^2=0.864$. Phenolic such as catechins, epicatechins, chlorogenic acids, leucoanthocyanidins, and anthocyanins are reported to be present in yams and cocoyam cultivated in the tropics [1,7&21]. Polyphenols and flavonoids are natural antioxidants present in plant foods. They are secondary metabolites that havehealth benefits with potentials for the prevention of carcinogenesis, cardiovascular diseases, diabetes, inflammation, atherosclerosis, and aging. Their mode of action is linked to free radicalscavenging [22&32]. Polyphenols also contribute to the flavor, color and shelf stability of foods [6].

The antioxidant activity expressed as DPPH (2,2-diphenyl-1-picrylhydrazyl), ABTS (2,2´-azino-bis-(3-ethylbenzothiazoline-6-sulponic acid) diammonium salt) and ORAC (oxygen radical absorbance capacity) values of the under-utilized yams and cocoyam are shown in Fig. 2. These assays measure the combined effects of different antioxidants found in the yams and cocoyam tuber extracts. The free radical scavenging activity assayed by DPPH ranged from 88.17 to 729.30 mg Trolox Equivalent/100g fresh weight, and the values assayed by ABTS varied from 32.49 to 756.01 mg Trolox Equivalent/100g fresh weight (Figure 2). In both methods, the antioxidant activity of *Xanthosomamaffa (Scoth)* was stronger than the three yam species, whereas *D.cayenensis*was lower than that of other yam tuber species examined. The result of antioxidant activity of the yams and cocoyam tubers extract measured by ORAC-fluorescein (ORAC – FL) method is shown in Fig. 2. The peroxyl radical chain-breaking ability on antioxidants of the yams and cocoyam tubers extract measured by ORAC assay ranged from 459.29 to 699.45mg Trolox Equivalent/100g fresh weight. The ORAC value of Xanthosomamaffa (Scoth) (cocoyam) was stronger than that of the three yam species, while *D. cayenensis* was lowest and significantly different ($p<0.05$) from that of other yam species.

Yams (*Dioscorea spp*.) extracts have been reported to possess more than 70% antioxidant activity [13]. Because there are many types of antioxidant compounds in yams and cocoyam extracts that might contribute to the total antioxidant activity, it became important to consider the influence of different antioxidant compounds on antioxidant activity in the yams and cocoyamtubers. To this effect, correlation analysis between the antioxidant components (polyphenols and flavonoids) and antioxidant activity (DPPH, ABTS, and ORAC) were performed (Table 2).From the data (Table 2), the antioxidant activity appeared to be largely influenced by the polyphenols and flavonoids contents of the yams and cocoyam extracts. A high significant linear correlation was observed between the antioxidant activity and total polyphenols and flavonoids. ABTS, DPPH and ORAC were highly correlated with polyphenols while ABTS and DPPH were highly correlated with flavonoids (Table 2). Correlation coefficients with total polyphenols were 0.931, 0.897 and 0.707 respectively for ABTS, DPPH and ORAC. Correlation coefficients with total flavonoids were 0.744, 0.992 respectively for ABTS and DPPH.The highest correlation coefficient was found between total polyphenols and ABTS radical cation scavenging activity (0.931, $p<0.01$), and total flavonoids gave the strongest positive correlation with DPPH radical scavenging activity (0.992, $p<0.01$). Among the assay methods, there were high correlation coefficients between ABTS and DPPH (0.814);ABTS and ORAC (0.781) respectively (Table 2). Different antioxidant assays were used in this study in order to determine the antioxidant activities of all potent compounds of the yams and cocoyam tuber extracts.The results of these assays are quite high indicating high antioxidant activities both throughscavengingof free radicals byelectron transfer (DPPH and ABTS) and hydrogen atom transfer (ORAC) mechanisms.The extracts from these tubers can donate protons (H^+) to quench free radicals which play significant role in the onset and complications of some major degenerative diseases.Other reports in literature alsoattributedpolyphenolsand flavonoids to bethe main phytochemicals responsible for the antioxidant activity, such as fruits and vegetables [33]; nectarines, peaches and plums [34];guava fruits [35];*actidinidia*fruits [36]; plums and apples [37]; yams [7&12]. Bhandari and Kawabata [6] also reported appreciable antioxidant activityin wild yam tubers from Nepal usingDPPH assay, but there wasno significant correlations between the total polyphenol content and antioxidant activity of their yam extracts.Our study andthat of Cornagoetal.[8]on yams show positive high correlations revealing the major contribution oftotal polyphenols and flavonoids to antioxidant activity.*Xanthosomamaffa(Scoth*) possessed the highest amounts of polyphenols, flavonoids and strongest antioxidant activities. It´s values were higher than most reports in literature.

Phenolic compounds influence antioxidant activity measurements, interfere with the oxidation process by reacting with free radicals (ROS), chelate pro-oxidant metal ions, scavenge oxygen, and prevent oxidative degradation of lipids [38-39]. Dietary antioxidants fromyams and cocoyam tuber extracts may be important in ameliorating disease conditions attributed to free radicals, hence the steady supply ofantioxidants from these compounds can augment or boost the effect of endogenous antioxidants(catalase, dismutase, glutathione) defense mechanisms in the bodyto prevent free radical mediated oxidative stress among yam and cocoyam consumers.

IV. Conclusions

Our results show thatyams and cocoyam tuber extracts possess antioxidant which canwork to prevent the negative effects of free radicals reactions among the yams and cocoyam consumers. Significant correlationwas observed between the yams/cocoyam polyphenols, flavonoids and DPPH, ABTS, and ORAC radical scavenging activities.This indicates that the phenolic compounds were responsible for their antioxidant activities. Yams and cocoyam extracts may therefore be helpful in the management and or the prevention of some major degenerative diseases like cancer, cardiovascular disease, diabetes and age related problems. However, further studies are needed to isolate and characterize the individual phenolic compounds in order to fully appreciate their antioxidant scavenging potentials and mechanisms.

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Table 1:The slope, intercept, R^2 and Mean CV (%) for Gallic acid, Catechin and Trolox standard calibrations curves (Y=ax+b) for (total polyphenol, total flavonoids and DPPH, ABTS and ORAC in acetone/water (50:50 V/V) yams/cocoyam tuber extracts.

Assay	R^2	Slope	Intercept	Mean CV (%)
Gallic acid (polyphenol)	0.9969	1.4145	0.0661	2.25
Catechin (flavonoids)	0.9948	1.683	0.0367	2.84
Trolox (DPPH)	0.9255	0.0012	0.0373	11.36
Trolox (ABTS)	0.9895	0.002	-0.0493	7.47
Trolox (ORAC)	0.8226	0.1773	0.1076	

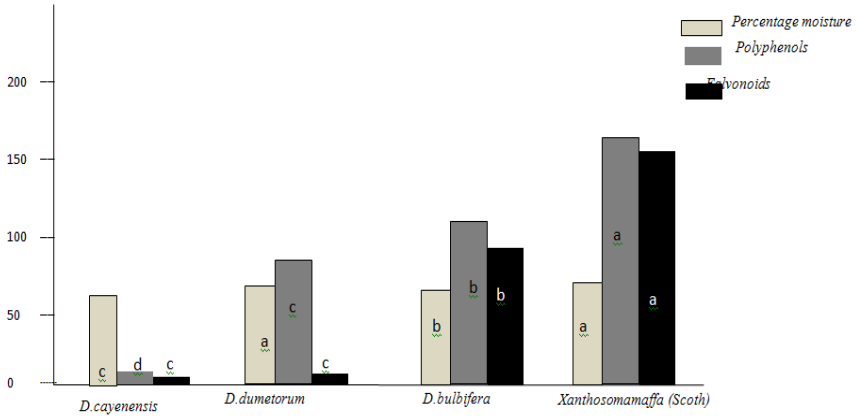

Fig.1 Percentage moisture, Polyphenol and flavonoid in yam species and cocoyam.Values are means of triplicate determinations. a-d mean significant difference at P<0.05.

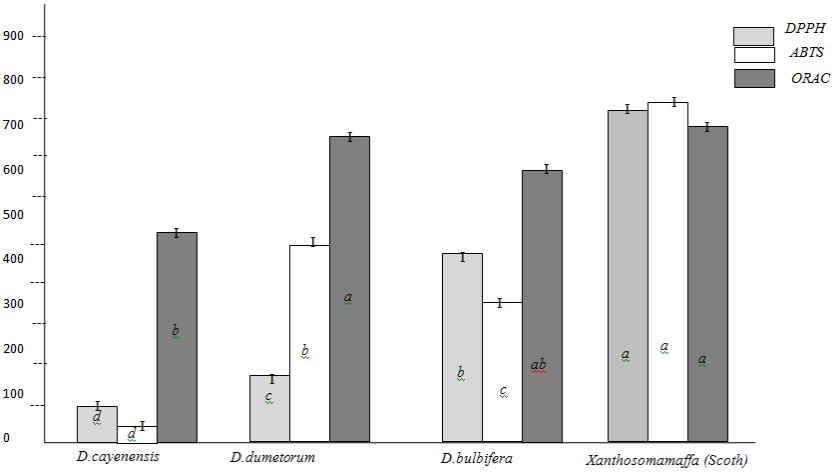

Fig.2 Radical scavenging activity of yams/cocoyam tuber extracts measured by DPPH, ABTS and ORAC assays. Values are means of triplicate determinations. a-d mean significant difference at P<0.05.

Table 2. Pearson's Correlation Coefficient of total polyphenols, flavonoids and antioxidant activity determined by DPPH, ABTS and ORAC assays for yams (*D. cayenensis, D. dumetorum, D. bulbifera spp*.) and cocoyam (*Xanthosomamaffa (Scoth)* tuber extracts.

	TP	TF	ABTS	DPPH	ORAC
TP	1.0000				
TF	0.86430**	1.0000			
ABTS	0.93106**	0.74433*	1.0000		
DPPH	0.89716**	0.99254**	0.81456**	1.0000	
ORAC	0.70774*	0.44899ns	0.78178*	0.51191ns	1.0000

TP = total polyphenols, TF = total Flavonoids, ABTS = antioxidant capacity measured in ABTS assay, DPPH = antioxidant capacity measured in DPPH assay, ORAC = antioxidant capacity measured in ORAC assay, ns = not significant, * and ** = significant at $P<0.05$ or $P< 0.01$.