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Phenolics, Antioxidant Capacities and Physical Parameters of Cashew Nuts of Different Cashew Accessions

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ABSTRACT

Different tissues of raw cashew nut, namely whole nuts (kernel+testa), kernel and testa (skin), of 26 selected cashew accessions were examined for content of total phenolics and total antioxidant capacities (TAC). Ferric Reducing Antioxidant Power (FRAP) assay was used to evaluate TAC, whereas the total phenolic content was determined by Folin-ciocalteu method. Physical parameters of selected cashew nut were also determined. In testa of all selected cashew accessions, the TAC and contents of total phenolic were significantly higher than those in whole cashew nuts and kernels. The significantly lowest TAC and contents of total phenolic were observed in kernel of all selected cashew accessions. The present study showed a significantly strong correlation (R^2 = 0.99, $p<0.0001$) between TAC the total phenolics of cashew nut extracts. The results indicated that cashew testa was significantly high in TAC and total phenolics when compared to whole cashew nut and kernel; it is thus recommended to utilize as a health promoting and disease preventing ingredient.

KEYWORDS: Antioxidant capacity, Cashew nut, Kernel, Physical parameters, Phenolics, Testa

INTRODUCTION

There is currently considerable interest in the antioxidant capacity of the human diet for its potential to prevent of chronic diseases such as cancer, cardiovascular disease, diabetes and Alzheimers's disease (Christen, 2000; Hu, 2003; Kris-Etherton *et al.*, 2002; Liu, 2003). Epidemiological studies have shown that there is an inverse association between diet rich in fruits vegetables, grains and nuts and chronic diseases (Block *et al.*, 1992; Adom and Liu, 2002; Knekt *et al.*, 2002). Antioxidant compounds present infoods may help to protect cellular systems in the human body from oxidative damage and thus lower the risk of chronic diseases (Kaur and Kapoor, 2001).

Cashew (*Anacardium occidentale* L.) is one of the most important tree nuts and rank third in international trade after hazelnuts and almonds. It is grown commercially for cashew nut production in Vietnam, India, Brazil, Nigeria, Tanzania, Indonesia and Sri Lanka. Since cashew is hardy crop, resistant to drought, presently the commercial cultivation of cashew is expanding in Northern and Eastern parts of Sri Lanka where plenty of uncultivated lands are available after civil war. In 2011, the total cultivated extent of cashew was 27,068 ha out of which 20,299 ha were bearing. The annual production cashew nut was 6,000 Mt in 2011 (Anon, 2012).

Phenolic substances have been proposed as important contributors to the total antioxidant capacity (TAC) of tree nuts (He *et al.*, 2011; Chandrasekara and Shahidi, 2011). Much attention has recently been paid to the possible health benefits of dietary phenolic phytochemicals that exhibit antioxidative, antibacterial, antiviral, anticarcinogenic, antiinflammatory and vasodilatory actions (Duthie *et al.*, 2000; Breinholt, 1999).

The importance and health benefit of fruit and vegetable consumption in prevention of chronic diseases have been well documented. The attention paid to health benefits of tree nut consumption has been little compared to that for fruits and vegetables. There were several investigations on the antioxidant capacity and phenolic contents of processed cashew nuts, cashew apple, cashew leaf extracts, and CNSL. However, a very few researches have yet investigated the phenolic contents and antioxidant activities of different tissues of raw cashew nuts. Therefore, this study was carried out to determine TAC and total phenolic contents of raw whole cashew nuts, kernels, and testa of different accessions.

MATERIALS AND METHODS

Location

The experiment was carried out in the laboratory of the Department of Plantation Management, Wayamba University of Sri Lanka, Makandura, Gonawila (NWP) from January to April 2013.

Sample Preparation

Mature nuts of 26 cashew accessions grown in Cashew Seed Garden, Eluwankulama belongs to Sri Lanka Cashew Corporation were selected for this study. The raw cashew nuts were peeled manually and recovered whole nuts (kernel+ testa), kernels and testa (skin). Each sample was ground separately by using a coffee bean grinder to obtain fine power and defatted by blending with hexane (1:5, w/v, 30 min, two times) at room temperature. Defatted samples were sealed in aluminum bags and kept in refrigerator until further analysis.

Chemicals and Reagents

Folin-ciocalteu reagent, Gallic acid, 2,4,6-trypyridyl-2-try-azine (TPTZ), 6-hydroxy-2,5,7,8-tetramethyl-chroman-2-carboxilic acid (Trolox) and Ferric chloride ($FeCl_3.6H_2O$) were purchased from sigma Aldrich Chemicals Co. (St. Louis, Mo). All other chemicals used were of analytical grade.

Determination of Physical Parameters

Fresh weight, length, width and thickness of nuts and kernels of cashew (n=10) of each accessions were recorded separately. Shelling percentage of cashew nuts of selected accessions was also calculated.

Extraction of Phyto-chemicals

Phyto-chemicals were extracted by using the method which is previously explained by Chandrasekara and Shahidi (2011) with slight modification. Defatted meal (kernel 0.5 g, whole nut 0.25 g and testa 0.2 g) was weighted into 15 ml centrifuge tube and vortex with 5ml of 80% ethanol for 15 min. Then it was placed in a water bath at 60 ^{0}C for 40 min by shaking at 10 min intervals. Supernatant was collected after centrifugation of the resulting slurry for 5 min at 4000 rpm. Extraction procedure was carried out for twice. All of the cashew samples were extracted and analyzed in triplicate.

Determination of Total Phenolics

Total phenolics were measured using colorimetric Folin-Ciocalteu method, as described previously (Abeysinghe *et al.*, 2007; Cai *et al.*, 2004). Four milliliters of distilled water and 0.5 ml of known diluted extract were placed in a test tube. Folin-Ciocalteu reagent (0.5 ml) was added to the solution and allowed to react for 3 min. The reaction was neutralized with 1 ml saturated sodium carbonate. Absorbance at 760 nm was recorded after 2 hr incubation at 30 ^{0}C using a spectrophotometer (Shimadzu, UV Mini 1240, Japan). Gallic acid was used as standard and data expressed as milligramgallic acid equivalents (GAE) per gram of cashew sample in fresh weight (FW).

Determination of Total Antioxidant Capacity

The procedure described by Benzie and Strain (1996) was followed. Briefly, the FRAP reagent contained 2.5 ml of a 10 mmol/l TPTZ solution in 40 mmol/l HCl plus 2.5 ml of 20 mmol/l $FeCl_3$ and 25 ml of 300 mmol/l acetate buffer, pH 3.6 was prepared freshly. Aliquots of 100 µl sample supernatant were mixed 900 µl FRAP reagent and the absorbance of reaction mixture at 593 nm was measured by using spectrophotometer (Shimadzu, UV Mini 1240, Japan) after 4 min. The trolox was used as the standard solution and the final result was expressed as the concentration of antioxidents having a ferric reducing ability equivalent to that of trolox (TE) mg/g fresh weight (FW) of cashew samples.

Statistical Analysis

Values shown in table and graphs were the mean of three replicates ± SD. Significance was evaluated by analysis of variance (ANOVA), followed by Duncan's multiple-range test ($p<0.05$). The linear regressions were also performed and the correlation coefficient (R^2) and probability (P) values were used to show correlations and their significance (SAS, 2009).

RESULTS AND DISCUSSION

Physical Parameters

Average fresh weight, length and width of raw cashew nut (Kernel + shell) and kernel and shelling percentage cashew nut are presented in the Table 1. The highest average fresh weight of nut (11.39 g) and kernel (3.37 g) were recorded in accession SLCCN 14 whereas; lowest average fresh weight of nut (4.53 g) and kernel (1.77 g) were observed in SLCCN 8 and SLCCM 2 respectively. SLCCN 2 had the highest average length of nut (4.03±0.12 cm) and kernel (3.29±0.10 cm) whereas; lowest average length of nut (2.61±0.27 cm) and kernel (2.39±0.16 cm) were recorded in SLCCN 8. The average width of nut and kernel of selected cashew accessions varied from 3.09±0.17 cm to 1.71±0.08 cm and 1.38±0.22 cm to 0.90±0.07 cm respectively. SLCCN 8 had highest shelling percentage (45.05%) whereas lowest shelling percentage of cashew nut (24.32%) was observed in SLCCN 19.

Total Phenolics

There was significant variation in contents of total phenolics in whole cashew

Table 1. Physical parameters of raw cashew nut (Kernel with shell) and kernel

Cashew Accession	Raw nut (Kernel + shell)			Kernel			Shelling percentage
	Ave Fresh weight (g)	Ave Length (cm)	Ave width (cm)	Ave Fresh weight (g)	Ave Length (cm)	Ave width (cm)	
SLCCN 2	10.56	4.03±0.12	2.12±0.10	2.79	3.29±0.10	1.26±0.05	26.41
SLCCN 4	9.75	3.82±0.25	2.25±0.35	2.68	2.93±0.28	1.38±0.22	27.52
SLCCN 5	7.44	3.46±0.29	2.21±0.11	2.02	2.76±0.09	1.27±0.35	27.13
SLCCN 7	9.01	3.25±0.17	2.04±0.08	2.66	2.59±0.12	1.15±0.05	29.55
SLCCN 8	4.53	2.61±0.27	1.71±0.08	2.04	2.39±0.16	1.02±0.12	45.05
SLCCN 9	9.40	3.97±0.11	2.28±0.07	2.44	2.86±0.15	1.30±0.09	25.98
SLCCN10	9.22	3.59±0.08	2.22±0.11	2.59	2.75±0.09	1.23±0.09	28.13
SLCCN12	6.60	3.15±0.17	1.88±0.06	2.29	2.59±0.12	1.12±0.06	34.69
SLCCN14	11.39	3.87±0.16	2.50±0.09	3.37	3.10±0.12	1.33±0.08	29.61
SLCCN15	10.34	3.55±0.07	2.25±0.14	2.77	3.03±0.12	1.24±0.06	26.79
SLCCN16	7.05	3.34±0.06	1.94±0.06	2.33	2.70±0.09	1.05±0.09	33.08
SLCCN17	6.93	3.09±0.15	2.01±0.08	2.40	2.49±0.08	1.17±0.05	34.68
SLCCN19	8.98	3.86±0.24	2.12±0.10	2.18	2.91±0.11	1.14±0.06	24.32
SLCCN20	8.89	3.68±0.22	2.06±0.13	2.82	2.86±0.18	1.08±0.16	31.75
SLCCN21	6.47	3.31±0.09	1.93±0.07	2.03	2.56±0.14	0.90±0.07	31.31
SLCCN22	7.99	3.31±0.11	2.05±0.06	2.92	2.81±0.07	1.25±0.03	36.58
SLCCN23	9.58	3.79±0.12	2.24±0.11	3.36	3.15±0.13	1.36±0.08	35.03
SLCCM 1	11.37	3.93±0.17	2.34±0.11	2.94	2.94±0.23	1.09±0.15	25.82
SLCCM 2	7.04	3.28±0.10	1.81±0.12	1.77	2.51±0.14	0.95±0.05	25.15
SLCCM 3	9.85	3.83±0.14	2.08±0.13	3.05	3.04±0.14	1.13±0.05	30.91
SLCCM 4	8.85	3.58±0.13	2.09±0.08	2.63	2.83±0.12	1.17±0.04	29.72
SLCCM 5	8.59	3.75±0.10	2.13±0.09	2.40	2.74±0.16	1.11±0.07	27.98
SLCCM 7	10.37	3.84±0.12	2.18±0.06	2.70	2.99±0.18	1.19±0.08	26.08
SLCCM 9	5.49	3.34±0.27	1.89±0.08	1.94	2.67±0.21	1.11±0.09	35.41
SLCCM10	8.61	3.53±0.16	2.04±0.09	3.06	2.92±0.16	1.25±0.07	35.61
SLCCM12	10.00	3.91±0.16	3.09±0.17	2.82	2.90±0.12	1.19±0.06	28.15

Means with the same letter represent non-significant differences ($p<0.05$)

nuts, kernels and testa of all selected cashew accessions (Table 2). Contents of total phenolic were significantly higher in testa than in whole nuts and kernels of all cashew accessions. The significantly lowest contents of total phenolic were observed in kernel of all selected accessions. Similar results were also reported by Chandrasekara and Shahidi (2011). As far as the whole nut and testa are concerned SLCCM 2 had significantly highest total phenolic contents with 7.07 ± 0.20 mg GAE/g FW and 399.70 ± 3.21 mg GAE/g FW respectively. In Kernel significantly highest total phenolic content (1.55±0.03mg GAE/g FW) was observed in SLCCN 9 whereas, SLCCM 3 had significantly lowest total phenolic content (0.31±0.03mg GAE/g FW).

***Total Antioxidant Capacity* (TAC)**

The TAC varied significantly among whole cashew nuts, kernels and testa of all selected varieties (Table 2). TAC in testa were also significantly higher than in whole nuts and kernels for all selected accessions with the highest TAC found in testa of SLCCM 9 (591.50 ± 43.77 mg TE /g FW). The significantly highest TAC in whole nut (92.67±3.40 mg TE /g FW) and kernel (1.01 ± 0.06 mg TE /g FW) were observed in SLCCM 2 and SLCCN 9 respectively.

The present analysis showed a significantly strong correlation (R^2 = 0.99, $p<0.0001$) between TAC the total phenolics of cashew nut extracts (Figure 1). Chandrasekara and Shahidi (2011) have also determined significantly high correlation between TAC and total phenolic contents of Cashew nut extracts. A strong correlation between TAC and total phenolic contents in this study further confirming that phenolic constituents of cashew nut extracts are the major contributor to TAC of cashew nut.

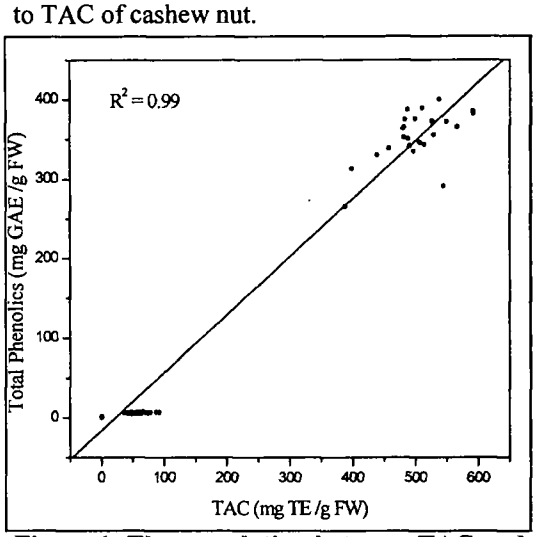

Figure 1. The correlation between TAC and total phenolic contents of cashew nut extracts

Table 2. Total phenolic content and total antioxidant capacity of whole nut, kernel and testa of different cashew accessions

Cashew Accession	Total Phenolic Content (mg GAE/g of Defatted Meal)			Total Antioxidant Capacity (mg TE/g Defatted Meal)		
	Whole nut	Kernel	Testa	Whole nut	Kernel	Testa
SLCCN 2	4.91±0.04 c	0.92±0.01 e	264.60±11.46 c	49.02±4.31 b	0.84±0.01 b	387.83±21.75 c
SLCCN 4	5.21±0.13 b	1.36±0.07 b	350.00±19.34 b	55.56±5.39 b	1.00±0.05 a	488.50±47.45 b
SLCCN 5	5.37±0.26 b	1.22±0.04 c	386.87±15.21 b	63.33±11.52 b	0.91±0.07 b	487.50±11.76 b
SLCCN 7	4.97±0.32 c	0.93±0.03 e	374.97±32.16 b	56.27±10.74 b	0.86±0.03 b	499.33±41.29 b
SLCCN 8	6.86±0.10 b	0.78±0.03 e	371.93±30.96 b	66.44±18.44 b	0.69±0.07 c	525.50±35.51 b
SLCCN 9	6.26±0.13 b	1.55±0.03 a	341.37±7.48 b	46.89±5.55 b	1.01±0.06 a	490.67±19.51 b
SLCCN10	6.68±0.43 b	0.83±0.04 e	374.50±31.87 b	57.16±10.20 b	0.73±0.07 b	482.83±9.75 b
SLCCN12	6.22±0.31 b	1.42±0.15 b	371.23±28.64 b	37.20±4.11 c	1.01±0.14 a	490.67±19.75 b
SLCCN14	5.74±0.24 b	0.95±0.05 e	371.47±33.38 b	45.78±3.17 b	0.90±0.01 b	527.33±42.61 b
SLCCN15	6.72±0.17 b	0.75±0.04 e	290.97±22.75 b	71.47±2.97 b	0.76±0.02 b	544.17±53.45 b
SLCCN16	6.16±0.06 b	0.41±0.01 e	329.70±4.26 b	52.67±5.78 b	0.71±0.05 b	439.17±22.09 b
SLCCN17	6.42±0.18 b	1.25±0.01 c	334.37±1.07 b	48.93±3.37 b	0.97±0.04 b	496.67±11.86 b
SLCCN19	6.76±0.08 b	0.95±0.07 e	345.33±16.70 b	67.56±4.03 b	0.99±0.04 a	506.33±10.32 b
SLCCN20	6.07±0.37 b	0.63±0.12 e	338.57±7.29 b	52.49±7.38 b	0.78±0.10 b	457.67±8.37 b
SLCCN21	5.88±0.12 b	0.98±0.05 d	312.90±14.96 b	41.91±4.73 b	0.86±0.02 b	398.83±21.17 b
SLCCN22	6.57±0.09 b	1.26±0.02 c	365.17±34.01 b	58.53±15.89 b	0.95±0.02 b	481.83±1.04 b
SLCCN23	6.37±0.05 b	0.75±0.03 e	363.30±30.29 b	54.71±4.53 b	0.84±0.04 b	480.33±17.27 b
SLCCM 1	6.22±0.08 b	0.77±0.08 e	388.27±3.45 b	58.36±4.77 b	0.90±0.18 b	510.50±9.01 b
SLCCM 2	7.07±0.20 a	0.86±0.02 e	399.70±3.21 a	92.67±3.40 a	0.82±0.10 b	537.33±39.37 b
SLCCM 3	6.51±0.27 b	0.31±0.03 f	342.53±16.11 b	77.91±4.31 b	0.69±0.04 c	513.50±19.05 b
SLCCM 4	6.03±0.13 b	0.44±0.02 e	351.87±13.65 b	56.93±1.54 b	0.71±0.07 b	481.17±20.26 b
SLCCM 5	6.90±0.09 b	0.83±0.01 e	370.07±2.02 b	87.33±1.33 b	0.84±0.05 b	528.00±59.11 b
SLCCM 7	4.91±0.15 c	0.36±0.05 e	384.30±6.30 b	58.93±0.35 b	0.71±0.08 b	591.17±43.77 a
SLCCM 9	6.42±0.06 b	0.75±0.07 e	381.50±8.25 b	62.58±3.70 b	0.82±0.06 b	591.50±43.77 a
SLCCM10	5.91±0.18 b	0.75±0.05 e	365.17±13.69 b	56.53±4.39 b	0.79±0.09 b	566.50±15.17 b
SLCCM12	6.34±0.23 b	0.63±0.01 e	354.67±40.84 b	73.38±2.87 b	0.80±0.04 b	528.83±34.41 b

Means with the same letter represent non-significant differences ($p<0.05$); GAE=gallic acid equivalent; TE= trolox equivalent.

This study revealed that testa had significantly higher total phenolics and TAC than kernel and whole nut. Many researchers reported that the outer layers such as peels, shells and hulls or skin of plant materials contain higher phenolic content and antioxidant activity (Wolfe and Liu, 2003; Abeysinghe *et al.*, 2007), thus acting as defense mechanism to pathogens, parasites and predators. The cashew testa is a waste product of cashew processing industry. We suggested that cashew testa powder could be a valuable addition to health food products. A small amount could greatly increase phyto-chemical content and antioxidant capacity of foods.

CONCLUSIONS

In summary, the present study indicates that Phenolic constituents are the major contributors to the TAC of cashew nut extracts. The cashew testa was significantly high in TAC and total phenolics when compared to whole cashew nut and kernel; it is thus recommended to utilize as a health promoting and disease preventing ingredient.

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