Research Article

PHYTOCHEMICALS AND ANTIOXIDANT ACTIVITY OF TESTA EXTRACTS OF COMMERCIAL WET AND DRY COCONUTS AND CAKES

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ABSTRACT

Coconut testa is the brown colored outer thin layer covering the coconut kernel. It is a by-product obtained in the coconut processing industries through paring of wet coconuts to make products like virgin coconut oil, snow ball coconut, desiccated coconut and coconut milk. A study was carried out for the phytochemical screening and antioxidant activity of testa extracts. The wet coconut testa (WCT), copra testa (CT), copra cake (CC), wet coconut whole (WCW) and copra whole (CW) were investigated for the presence of phytochemicals and antioxidants. The extracts were found to contain carbohydrates, amino acids, glycosides, triterpenes, tannins, flavonoids, phenolics, and saponins. The IC_{50} values (0.06-0.5 mg/ml) and reducing power were (0.5-9 g equivalent of TBHQ/100 g) of extracts indicate its antioxidant potential. The extracts contained phenolic acids, flavonoids, and total tocopherols. These studies indicated that the extracts from wet coconut testa had high antioxidant activity and contained many phytochemicals when compared to other coconut testa extracts.

Keywords: Coconut testa, Copra cake, Antioxidant activity, Ethanolic extract, Phytochemical screening.

INTRODUCTION

Coconut has been used for the preparation of many foods and beverages other than oil extraction. The fruit contains kernel in the form of a cavity which encompasses coconut water. Testa is the thin layer covering the coconut kernel. As the coconut matures, the thickness of testa increases and gives a brown color to the bottom layer of the kernel. In industries, testa is removed during the production of virgin coconut oil, desiccated coconut and coconut milk. The testa if not removed, produces brown color to the oil and dull appearance to other products. Hence, it is formed as one of the by-products in coconut processing industries. Testa contains oil and has a bitter taste due to polyphenols and is used as animal feed. The polyphenols have antioxidant properties and hence, the natural antioxidant concentrate can be prepared from coconut testa that can be incorporated as an ingredient in foods.

Polyphenols are ubiquitous in food and are shown to act as antioxidants, free radical scavengers and peroxidation inhibitors.¹ Phenolics rich crude extracts from plant materials are of great interest in the food industry as they prevent lipid peroxidation improving the nutritional quality of food. It also provides protection from coronary heart disease and cancer and therefore it is gaining attention in all the fields as the trend of the future is going towards functional food having specific health effects.² Flavonoids belong to polyphenols which are abundantly found in fruits and vegetables. It gives color, taste, prevent oxidative damage and protect enzymes and vitamins. There are different classes of flavonoids that include flavonols, flavones, flavonones, anthocyanidins and isoflavonoids.³

Bhanger *et al.*⁴ in their work, have shown that rice bran is a good source of antioxidants for stabilization of cookies. Renuka Devi

and co-workers⁵ have reported that the phytochemical extracts from defatted rice bran had antioxidant potential in the oil system and were effective in inhibiting the lipid oxidation. Suja *et al.*⁶ worked on the antioxidant efficacy of sesame cake extract on different vegetable oils and showed that the extract from sesame cake had a better antioxidant effect than BHT at 200 ppm.

Work was done where the coconut testa was used as a source of edible oil wherein the composition of oil extracted from testa and kernel were studied earlier.⁷ These studies indicated that the coconut testa had more of natural antioxidants that include tocopherols, tocotrienols and phenolics compared to the coconut kernel oil. Apart from this, the composition of coconut water and kernel at different stages of maturity was reported in an earlier paper.⁸ As a continuation of the work, the testa extracts from commercial wet and dry coconuts and cakes were screened for the phytochemicals and their antioxidant activity were evaluated.

METHODS AND MATERIALS

Wet coconut and copra were purchased from the local market. The testa was separated from both wet coconut and copra. Copra Cake (CC) was collected from Srikalpa Industries, Kumbala, Kerala. Wet coconut testa (WCT), copra testa (CT), wet coconut whole (WCW) and copra whole (CW) were purchased from the local vendor and pared manually in the laboratory to obtain the respective testa. WCT, CT, CC, WCW and CW were used for extraction and extracts investigated for various parameters. Standard glucose, bovine serum albumin, quercetin, tocopherols, gallic acid, tannic acid, hydroxybenzoic acid, chlorogenic acid, vanillic acid, syringic acid, coumaric acid, caffeic acid, ferulic acid, cinnamic acid and TBHQ were procured from Sigma

Chemicals Co., St. Louis, USA. Analytical grade chemicals and reagents were used.

Extract preparation

The coconut samples were dried and defatted according to AOCS 945.16.⁹ A 5.0 g of dried and defatted sample was taken in a round bottom flask (250ml capacity) with 40 ml of food grade ethanol and fixed with a condenser on a water bath. The ethanol was allowed to boil for the extraction of reddish colored material. The supernatant ethanol extract was decanted into a previously weighed round bottom flask and the residue was re-extracted four times with fresh ethanol till there is no color in the boiling ethanol. The ethanol extracts were pooled together and desolventized under vacuum at 40-45 °C using a rotary evaporator to get the gummy concentrate of a reddish color. Finally, the flask was again weighed to get the percentage extract.

Colorimetric estimation of total sugars

Total sugars of the samples were analyzed according to the phenol-sulfuric acid method. Different aliquots (0.01-1.0ml) of sample dissolved in water were pipetted into tubes and were made up to 2 ml with distilled water. One milliliter of 5 % phenol solution was added followed by 5 ml of concentrated sulfuric acid directly against the liquid surface as it helps in proper mixing. The tubes were incubated for 10 minutes and kept in water bath at 25 to 30 °C for 10 to 20 minutes. The obtained pale yellow-orange color was read at 490 nm using a UV-Visible spectrophotometer (Shimadzu model UV -1601). Blank was prepared by substituting distilled water for the sample. The total sugars content was calculated by using the calibration curve prepared using standard glucose (10-80µg range).¹⁰

Colorimetric estimation of proteins

The samples were estimated for protein content according to Lowry's method using bovine serum albumin (BSA) as protein standard.¹¹

Phytochemical screening of extracts

The analysis for phytochemicals were carried out according to the standard methods.¹² Qualitative tests were done for carbohydrates (Molisch's test, Fehling's test and iodine test), alkaloids (Wagner's test), protein and amino acids (Biuret test and Xanthoproteic test), glycosides (sodium hydroxide reagent test, cardiac glycosides and Keller Killiani test). Tests for steroids (Salkowski test and Liberman-Burchardt test), triterpenes (Salkowski test and Liberman-Burchardt test), tannins (ferric chloride test and lead acetate test), flavonoids (ferric chloride test, alkaline reagent test and lead acetate test), phenolics (lead acetate test and ferric chloride test) and saponins (foam test and froth test) were performed.

Antioxidant activity of the extracts

Radical scavenging activity (RSA)

Radical scavenging activity and presence of hydrogen donors in the extracts were examined by the reduction of 2, 2-diphenyl- 1-picrylhydrazyl free radicals (DPPH) in methanol. A methanolic solution of DPPH radicals was prepared freshly at a concentration of 10⁻⁴ M according to Ramadan et al.¹³ with minor modifications. A known amount of extract was dissolved in methanol, and different aliquots were pipetted into test tubes.

Four ml DPPH methanolic solution was added to each of the test tubes and mixed thoroughly. The test tubes were kept in dark for 15 min. A blank of pure methanol without DPPH radicals was measured at 515 nm using a UV-visible spectrophotometer (model UV-1601, Shimadzu Corporation, Japan). RSA against DPPH radicals was evaluated from the absorbance differences of methanolic DPPH solution with or without sample (control) and the percent inhibition was estimated using the following equation:

$$\% \text{ Inhibition} = \frac{\text{absorbance of control} - \text{absorbance of test sample}}{\text{absorbance of control}} \times 100$$

The RSA of the samples were expressed as IC₅₀ value. The radical scavenging (g equivalent of TBHQ/100 g) was calculated against the standard TBHQ.

Reducing power assay (RPA)

The reducing power assay was done according to the method of Oyaizu¹⁴ with some modifications. Different aliquots of the extracts samples were dissolved in distilled water and made up to 1 ml. To this 2.5 ml of 0.2 M phosphate buffer (6.6 pH) and 2.5 ml of 1 % (w/v) potassium ferricyanide were added. The tubes were kept for incubation at 50 °C for 20 min. After incubation 2.5 ml of 10 % (w/v) trichloroacetic acid, 2.5 ml distilled water and 0.5 ml 0.1 % (w/v) ferric chloride. The tubes were mixed properly and read spectrophotometrically at 700 nm. Blank was prepared by replacing the sample with distilled water. The reducing power (g equivalent of TBHQ/100 g) was calculated against the standard TBHQ.

Total Phenolics Content (TPC)

Different aliquots of sample were mixed with 0.2 ml of FC reagent and were kept for 3 minutes. About 1 ml of 15 % Na₂CO₃ solution was added and made up to 7 ml with distilled water. The tubes were incubated for 45 minutes, centrifuged at 380 g (2000 rpm) for 10 minutes at room temperature and absorbed at 765 nm using a UV-Visible spectrophotometer, (Shimadzu model UV - 1601). The TPC (mg/100 g) was calculated against the standard gallic acid. Distilled water was used as the blank.¹⁵

Total Flavonoids Content (TFC)

Determination of total flavonoid content was done according to the aluminum chloride colorimetric method. Different aliquots of the samples were mixed with 2 ml of distilled water. After 5 minutes 3 ml of 5 % sodium nitrite (NaNO₂) and 0.3 ml of 10 % aluminum chloride were added. Two ml of 1 M sodium hydroxide was added after 6 minutes and the final volume was brought to 10 ml with distilled water. Absorbance was read at 415 nm using UV-Visible spectrophotometer, (Shimadzu model UV-1601). The TFC (g/100 g) was calculated against the standard quercetin.¹⁶

Determination of individual phenolic acids composition by HPLC

The analysis of phenolic acids in the extracts was performed using a Waters Atlantis C18 (250 mm x i.d. 4.6 mm, 5 µm) Bondapack column. Isocratic elution was carried out with a mobile phase consisting of water: methanol (82:18 v/v) containing 2% (v/v) acetic acid, at a flow rate of 1 ml/ min. Phenolic acids were detected using a PDA detector and the HPLC profiles were obtained at 280 nm and 320 nm. A known

amount of extract was dissolved in 1 ml methanol, vortexed and the supernatant was injected. The injection volume was 10 µl for all samples. Identification of phenolic acids was based on retention times in comparison with standards.¹⁷

Analysis of tocopherols and tocotrienols of the samples by HPLC

Tocopherol and Tocotrienols were assayed from the extracts by HPLC according to the AOCS method O.M.No. Ce 8-89.⁹ The analysis of tocopherols and tocotrienols was obtained by normal phase HPLC separation on a silica column (Lichrosorb Si60 5 µm) employing Shimadzu HPLC system consisting of LC-10A pump, injector fitted with 20 µl loop and fluorescence detector. A known amount of extract was dissolved in 0.5 ml hexane, vortexed and the supernatant was injected. An isocratic mobile

phase with hexane: isopropyl alcohol (99:5:0.5, v/v) was used at the flow rate of 1 ml/min. The excitation wavelength of 290 nm and an emission wavelength of 330 nm were kept for the fluorescence detection of all the peaks. The tocopherols and tocotrienols were identified using standard tocopherol and expressed as α -tocopherol equivalents.

Statistical analysis

All the analyses were carried out in quadruplet and the data obtained for each parameter were expressed as mean $\pm$ SD. One-way ANOVA was used to evaluate significant differences among the coconut testa extract samples.¹⁸ A two-tailed p-value was determined to show the significant differences at a p-value < 0.05 .

Table 1: Composition of coconut testa extracts

Sample	Yield (%)	Total sugar (%)	Protein (%)
WCTE	22.0 $\pm$ 0.7 ^a	50.9 $\pm$ 1.5 ^a	30.4 $\pm$ 2.3 ^a
CTE	25.0 $\pm$ 0.7 ^b	72.0 $\pm$ 1.6 ^b	10.4 $\pm$ 0.7 ^b
CCE	28.3 $\pm$ 0.4 ^c	68.0 $\pm$ 1.7 ^b	4.2 $\pm$ 0.6 ^c
WCWE	20.2 $\pm$ 0.3 ^d	54.3 $\pm$ 1.6 ^a	4.4 $\pm$ 0.3 ^{cd}
CWE	31.2 $\pm$ 0.2 ^e	88.5 $\pm$ 2.9 ^c	2.2 $\pm$ 0.2 ^{cd}

Values reported are mean $\pm$ SD (n=4). The values with different superscripts in the rows are significantly different at $p < 0.05$. WCTE Wet Coconut Testa Extract, CTE Copra Testa Extract, CCE Copra Cake Extract, WCWE Wet Coconut Whole Extract, CWE Copra Whole Extract

Table 2: Phytochemical screening of coconut testa extracts

Phytochemicals	Tests	WCTE	CTE	CCE	WCWE	CWE
Carbohydrates	Molisch's test	++	+	+	+	+
	Fehling's test	++	+	+	+	+
	Iodine test	-	-	-	-	-
Alkaloids	Wagner's test	-	-	-	-	-
Amino acids	Biuret test	++	+	+	+	+
	Xanthoproteic test	++	+	+	+	+
Glycosides	Sodium hydroxide reagent test	++	+	+	-	+
	Cardiac glycosides test	-	-	-	-	-
	Keller killiani test	-	-	-	-	-
Steroids	Salkowski test	-	-	-	-	-
	Lieberman- Burchardt test	-	-	-	-	-
Triterpenes	Salkowski test	++	+	+	+	+
	Lieberman- Burchardt test	++	+	+	+	+
Tannins	Ferric chloride test	+	+	+	+	+
	Lead acetate test	+	+	+	+	+
Flavonoids	Ferric chloride test	-	-	-	-	-
	Alkaline reagent test	++	+	+	+	+
	Lead acetate test	++	+	+	+	+
Phenolics	Lead acetate test	++	+	+	+	+
	Ferric chloride test	++	+	+	+	+
Saponins	Foam test	++	+	+	+	+
	Froth test	++	+	+	+	+

Values reported are mean $\pm$ SD (n=4). ++ indicates faster color change, WCTE Wet Coconut Testa Extract, CTE Copra Testa Extract, CCE Copra Cake Extract, WCWE Wet Coconut Whole Extract, CWE Copra Whole Extract

Table 3: Antioxidant activity (RSA and RPA), total phenolics content and total flavonoid content of coconut testa extracts

Sample	IC ₅₀ (mg/ml)	RPA (g/100 g)	TPC (g/100 g)	TFC (g/100 g)
WCTE	0.06 $\pm$ 0.0	9.2 $\pm$ 0.2 ^a	6.3 $\pm$ 0.3 ^a	12.6 $\pm$ 0.2 ^a
CTE	0.3 $\pm$ 0.0	3.0 $\pm$ 0.2 ^b	1.3 $\pm$ 0.1 ^b	2.3 $\pm$ 0.1 ^b
CCE	0.5 $\pm$ 0.0	1.2 $\pm$ 0.0 ^c	0.8 $\pm$ 0.1 ^c	1.4 $\pm$ 0.1 ^c
WCWE	0.4 $\pm$ 0.0	0.8 $\pm$ 0.1 ^d	0.3 $\pm$ 0.0 ^d	1.4 $\pm$ 0.2 ^c
CWE	0.5 $\pm$ 0.0	0.6 $\pm$ 0.0 ^d	0.2 $\pm$ 0.0 ^d	0.5 $\pm$ 0.1 ^d

Values reported are mean $\pm$ SD (n=4). IC₅₀-Inhibition concentration to 50 %. The values with different superscripts in the rows are significantly different at $p < 0.05$. WCTE Wet Coconut Testa Extract, CTE Copra Testa Extract, CCE Copra Cake Extract, WCWE Wet Coconut Whole Extract, CWE Copra Whole Extract. RPA, TPC and TFC were expressed as TBHQ, gallic acid and quercetin respectively.

Table 4: Phenolic acids composition of coconut testa extracts

Phenolic acids (mg/100 g)	WCTE	CTE	CCE	WCWE	CWE
Gallic acid+Tannic acid	123.3±1.2 ^a	33.6±0.6 ^b	nd	nd	nd
Hydroxybenzoic acid	17.2±0.8 ^a	42.8±0.8 ^b	0.2±0.0 ^c	1.1±0.2 ^{cd}	0.8±0.1 ^{cd}
Chlorogenic acid	15.5±0.4 ^a	3.5±0.3 ^b	0.4±0.0 ^c	nd	Traces
Vanillic acid	18.5±0.8 ^a	nd	nd	5.5±0.4 ^b	1.5±0.2 ^c
Syringic acid	3.2±0.1 ^a	nd	nd	0.6±0.1 ^b	nd
Coumaric acid	nd	nd	nd	nd	nd
Caffeic acid	3.7±0.5 ^a	2.3±0.2 ^b	0.5±0.0 ^c	0.3±0.0 ^{cd}	0.1±0.0 ^{cd}
Ferulic acid	9.7±0.5 ^a	12.7±1.2 ^b	1.3±0.2 ^c	0.2±0.0 ^{cd}	0.1±0.0 ^{cd}
Cinnamic acid	4.1±0.6 ^a	5.8±0.4 ^b	0.2±0.0 ^c	0.1±0.0 ^c	Traces
Total	195.2±1.5 ^a	100.7±2.6 ^b	2.6±0.2 ^c	7.8±0.6 ^d	2.5±0.4 ^c

Values reported are mean ± SD (n=4). The values with different superscripts in the rows are significantly different at p<0.05. WCTE Wet Coconut Testa Extract, CTE Copra Testa Extract, CCE Copra Cake Extract, WCWE Wet Coconut Whole Extract, CWE Copra Whole Extract, nd not detected

Table 5: Tocopherols and tocotrienols composition of coconut testa extracts

Samples	Tocopherols (mg/100 g)			Total T	Tocotrienols(mg/100 g)			Total T ₃	Total (T+T ₃) mg/100 g
	αT	β+γ-T	δT		αT ₃	β+γ-T ₃	δ T ₃		
WCTE	4.3±0.2 ^a	nd	12.6±0.9 ^a	16.9±0.6 ^a	2.0±0.3 ^a	25.1±0.9 ^a	5.2±0.5 ^a	32.3±1.6 ^a	49.2±1.3 ^a
CTE	8.1±0.6 ^b	0.6±0.1 ^a	5.3±0.8 ^b	14.0 ±0.6 ^b	1.2±0.2 ^b	nd	3.5±0.4 ^b	4.7±0.5 ^b	18.7±0.6 ^b
CCE	Traces	0.4±0.0 ^a	0.8±0.1 ^c	1.2±0.1 ^c	nd	nd	nd	nd	1.2±0.1 ^c
WCWE	3.8±0.6 ^c	2.3±0.3 ^b	nd	6.1 ±0.4 ^d	0.7±0.1 ^c	nd	nd	0.7±0.1 ^c	6.8±0.3 ^d
CWE	1.0±0.1 ^c	3.9±0.6 ^c	2.6±0.4 ^d	7.5±0.4 ^e	nd	nd	nd	nd	7.5±0.4 ^d

Values reported are mean ± SD (n=4). The values with different superscripts in the rows are significantly different at p<0.05. WCTE Wet Coconut Testa Extract, CTE Copra Testa Extract, CCE Copra Cake Extract, WCWE Wet Coconut Whole Extract, CWE Copra Whole Extract, nd not detected

RESULTS AND DISCUSSION

The compositions of coconut testa extracts are reported in Table 1. Copra whole extract (CWE) (31.2 %) had more yield followed by Copra cake extract (CCE) (28.3 %), Copra testa extract (CTE) (25.0 %), Wet coconut testa extract (WCTE) (22.0 %) and Wet coconut whole extract (WCWE) (20.2 %). Total sugar content was found to be high in CWE (88.5 %), followed by CTE (72.0 %), CCE (68.0 %), WCWE (54.3 %) and WCTE (50.9 %). Protein content of WCTE (30.4 %) was more when compared with CTE (10.4 %), CCE (4.2 %), WCWE (4.4 %) and CWE (2.2 %).

All the extracts were found to have phytochemicals like carbohydrates, amino acids, glycosides, triterpenes, tannins, flavonoids, phenolics, and saponins. WCTE extract was showing a fast and immediate reaction for all the tests. It indicates the presence of highest concentration and extractability of phytochemicals in the WCTE. The extracts were negative for alkaloid and steroid tests (Table 2).

DPPH is a free radical used to study the radical scavenging activity of some natural products. The amount of antioxidant required to decrease the initial DPPH radical concentration by 50 % in 15 min is the IC₅₀ (Inhibition concentration by 50 %). Lower the IC₅₀ value higher the radical scavenging activity. The free radical scavenging activity of WCTE was found to be higher when compared to other coconut samples. The IC₅₀ of WCTE was at a concentration of 0.06 mg/ml, CTE was 0.3 mg/ml, CCE was 0.5 mg/ml, WCWE was 0.4 mg/ml and CWE was 0.5 mg/ml (Table 3). The 50 % inhibition of DPPH radical was obtained with a significantly lower concentration of WCTE. The positive control TBHQ showed IC₅₀ at a concentration 3 µg/ml. Though WCTE was showing low activity when compared to TBHQ, it showed that the extract have the ability to donate a proton and acts as a potential free radical scavenger.

The antioxidant activity of the coconut extract samples was studied by reducing power assay. The antioxidant present in the extract have the ability to reduce ferric ion (Fe³⁺) to ferrous ion (Fe²⁺) which forms a blue complex that is absorbed at 700 nm. The result revealed that the WCTE (9.2g/100 g) had high

reducing power when compared to CTE (3.0 g/100 g), CCE (1.2 g/100 g), WCWE (0.8 g/100 g) and CWE (0.6 g/100 g) (Table 3). Higher the activity, greater the reducing power. The activity of the extract is due to the ability to donate a proton.

The phytochemicals were responsible for the antioxidant activity of the extract. Phenolic acids and flavonoids are known to have antioxidant activity among phenolics. They are the major contributors in reducing oxidative stress. The difference in the structure of various classes of flavonoids influenced antioxidant activity of flavonoids.¹⁹ The TPC and TFC of the different coconut extracts were tabulated (Table 3). The TPC of WCTE was highest, and CWE was the lowest. The TPC of WCTE, CTE, CCE, WCWE and CWE were 6.3 g/100 g, 1.3g/100 g, 0.8 g/100 g, 0.3 g/100 g and 0.2 g/100 g respectively. TFC of WCTE was 12.6 g/100 g, CTE was 2.3g/100 g, CCE was 1.4 g/100 g, WCWE was 1.4 g/100 g and CWE was 0.5 g/100 g. The result showed that the WCTE had the highest TFC. A similar work was done on *Nerium oleander* leaves and *Momordica charantia* leaves extracts.²⁰

The phenolic acids composition of extracts is presented in Table 4. Phenolic acids include gallic+tannic-, hydroxybenzoic-, chlorogenic-, vanillic-, syringic-, caffeic-, ferulic- and cinnamic-acids. The phenolic acid composition of WCTE, CTE, CCE, WCWE, and CWE were 195.2 mg/100 g, 100.7 mg/100 g, 2.7 mg/100 g, 7.7 mg/100 g and 2.5 mg/100 g respectively. WCTE was rich in gallic+tannic acid (123.3 mg/100 g), CTE had 42.8 mg/100 g of hydroxybenzoic acid, CCE had 1.3 mg/100 g of ferulic acid, WCWE had 5.5 mg/100 g of vanillic acid, and CWE had 1.5 mg/100 g of vanillic acid. Gallic acid was found to have antioxidant and pro-oxidant activity.²¹ Prakruthi et al.⁷ had reported that the oil from coconut testa contained higher total phenolic acids than the oil from the kernel.

The tocopherols composition of extracts is represented in Table 5. The tocopherols content of WCTE was 49.2 mg/100 g, CTE was 18.7 mg/100 g, CCE was 1.2 mg/100 g, WCWE was 6.8 mg/100 g and CWE was 7.5 mg/100 g. WCTE was rich in β+γ T₃ (25.1 mg/100 g) followed by δT (12.6 mg/100 g). Total T₃ (32.3 mg/100 g) was more when compared to total T (16.9 mg/100 g). CTE had 8.1 mg/100 g αT and 5.3 mg/100 g δT

followed by 3.5 mg/100 g δT_3 and 1.2 mg/100 g αT_3 . Total T (14.0 mg/100 g) of CTE was more when compared to total T_3 (4.7 mg/100 g). CCE had 0.4 mg/100 g βT and 0.8 mg/100 g δT . WCWE and CWE had 6.1 mg/100 g and 7.5 mg/100 g of total T respectively. Work on coconut testa oils had shown that the oil from CT and WCT contained 22.3 mg/100 g and 100.1 mg/100 g of T and T_3 content.⁷Prakruthi et al.,⁸ in their work showed that the phenolics content increased in coconut water (CW) (1.4–4.3 mg/100 g) and coconut kernel (CK) with maturity (18.5–24.8 mg/100 g). The CW and CK had a higher amount of phenolics (1.4–4.3 mg/100 g and 18.5–24.8 mg/100 g respectively) and total tocopherols of CK (0.14–0.59 mg/100 g) when compared to CCP.

CONCLUSION

In conclusion, WCTE serves to be a good natural antioxidant source of phenolic acids, flavonoids, tocopherols and tocotrienols when compared to other coconut extracts. The WCTE extract contained less sugar content and high protein content than the other coconut extracts. This study showed that the WCTE possesses a significant free radical scavenging activity in vitro. In future, this can be further explored by in vivo studies. Reports on phytochemical screening, antioxidant activity, phenolic acids and tocopherol composition of coconut testa extracts have not been reported so far. A large amount of coconut testa is getting wasted in the virgin coconut oil industries as it imparts a yellowish color to the oil, in desiccated coconut and coconut milk extraction industries. Therefore, coconut testa can be utilized for the extraction of phytochemical-rich extracts and used as an ingredient of food materials to obtain beneficial health effects.

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