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Research Article

Phytochemical Screening and Quantitative Determination of Antioxidant Properties of Watermelon Rinds and Seeds

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Abstract:

In this present age of food insecurity, it is essential to source for agricultural waste that can be nutritionally beneficial to humans and animals. Watermelon rinds and seeds are regarded as agricultural wastes which need to be utilized for human and animal nutrition. This research work is aimed at examining the extractive values, qualitative and quantitative determination of phytochemicals and antioxidants properties in watermelon rinds and seeds and their solvent extracts using six different solvents. The rinds and seeds of watermelon fruits were obtained, rinsed, cut into smaller pieces, air-dried, ground into powdery sample, and sieved with 40 mm mesh size. 20 g each of sample was extracted using 200 mL of six different solvents (acetone, chloroform, ethyl acetate, ethanol, methanol and water) for 72 h. Each solvent extract was screened for twelve phytochemicals (flavonoid, phenol, reducing sugar, tannin, saponin, alkaloid, volatile oil, quinone, cardiac glycoside terpenoids, steroids and phlobatannin). The extractive values of watermelon rinds ranged from 1.51±0.26% to 13.56±0.20% while that of watermelon seeds ranged from 3.54±0.16% to 10.17±0.19% in all the six solvents used. Acetone and methanol had the higher extractable phytochemicals (41.67%) in watermelon rinds while methanol, ethyl acetate and ethanol (58.33 – 66.67%) had the highest extractable phytochemicals in watermelon seeds. Water and methanol extracts of watermelon rinds had higher total phenol, DPPH and Iron (Fe2+) chelation assay than raw sample of watermelon rinds. Water and methanol extracts of watermelon rinds had higher iron (Fe2+) chelation assay and ferric reducing antioxidant power (FRAP) than raw sample of watermelon seeds. Methanol extract of watermelon seeds had higher total flavonoid, total phenol and DPPH than raw sample of watermelon seeds.

Key words: phytochemicals; antioxidant properties; solvent extracts; watermelon rinds and seeds

Introduction

Watermelon belongs to the cucurbitaceae or gourd family. It is an herbaceous trailing plant with stems as long as 400 cm. the roots are shallow (40-50 cm) and extensive (60-90 cm), with taproot and many lateral roots (ITFNET, 2021). Temperature range of 24-27 0C is considered as optimum for the growth of the vines (Kumar et al, 2020). They are characterized by five-angled stems, coiled tendrils, and alternate leaves. Curcurbits are usually monoecious meaning they produce separate male and female flowers on the same plant (IUE, 2021). The juice or pulp from watermelon is used for human consumption while rind and seeds are major solid wastes. Different carotenoids patterns were observed in red-fleshed and yellow-fleshed watermelon. The red-fleshed watermelon varieties contain high lycopene and varying amount of β-carotene (Tadmor et al. 2005). Watermelon is a warm season crop grown mainly in sub-tropical and hot-arid regions. It requires a long growing season in the subtropics, but fast growing in the tropical regions (ITFNET, 2021). Watermelon (Citrullus lanatus) botanically considered as the fruit is belonging to the family Cucurbitaceae (Edwards et al., 2003). Watermelon rind is also high in citrulline, an amino acid the body uses to make another amino acid, arginine (used in the urea cycle to remove ammonia from the body). Watermelon seeds are known to be highly nutritional; they are rich sources of protein, vitamins B, minerals and fat among others as well as phytochemicals (Braide et al., 2012).

Watermelon plants need a long and warm growing season of at least 70 to 85 days, depending on the variety to produce sweet fruit (Almanac, 2021). Watermelon plants need an area with full sun to develop completely. Watermelon grows best in fertile, well-draining, sandy loam soils (UIE, 2021). Most soils benefit from incorporating a few inches of organic compost before planting and some fertilizer as well. Watermelon plants need lots of space to grow and spread out (UIE, 2021). Watermelon is drought tolerant because it has a deep-root system. They can thrive in both humid and semi-arid environments but may develop fungal foliage diseases in humid areas more frequently than in dry areas. They grow best when day time temperatures fall between70-80 oF and nighttime temperatures fall between 65-70 oF. Watermelon are planted preferably in a soil between pH 6.0-7.0 which makes it slightly acidic (Almanac, 2021). It can also tolerate a pH of 5.5-7.5 (Tropical, 2021).

Watermelons are used for a variety of purposes and some of the traditional uses of watermelon include using the seeds in treatment of urinary tract infections, bed wetting, dropsy and renal stones., watermelon rinds are fermented, blended and consumed as juice and its high antioxidant activities have been reported on food products via microbial fermentation (Oseni and Okoye, 2013; Salah et al., 1995), watermelon leaves are being cooked and used as vegetables (Tropical. 2021), extracting edible oil from water melon seeds (Facciola, 1990)., utilizing watermelon seed in cosmetics, for making soap and for lighting (Rosengarten, 1984). Face masks made from the fruit are used as a cosmetic on delicate skins (Chiej, 1984), and using emulsion of the seeds and crushed leaves as an excellent cataplasm anti-inflammatory agent in treatment for intestinal inflammation (DeFilipps et al., 2021).

There is very limited literature available on the types of phytochemicals and the antioxidant properties present in the watermelon rinds and seeds. The phytochemical screening and antioxidant properties on rinds and seeds of watermelon are usually limited to about two solvent extracts. The extraction of high-value bioactive compounds from watermelon rinds and seeds may lead to the development of new agro-waste-based industries which can create employment. Hence the focus of this research is to determine the solvent extractive values using six different solvents (chloroform, acetone, ethyl acetate, ethanol, methanol and water), phytochemicals in each of the solvent extracts of watermelon seed and rinds as well as determining the antioxidant properties of two extracts with highest extractive values of watermelon seeds and rinds.

Preparation and extraction of water melon rinds and seeds

Water melon rinds and seeds were separately obtained and cut into smaller pieces for easy air-drying. The dried samples were ground separately using electric blending machine (Solitarire Mixer Grinder VTCL Heavy Duty 750 Watts) and each part was sieved with 40 mm mesh size. Each of the powdered samples was divided into portions, packed in air tight containers labelled appropriately prior to extraction. 20 g of each sample was extracted separately with 200 mL of each solvent (acetone, chloroform, ethyl acetate, ethanol, methanol and water) for 72 h during which it was intermittently shaken on a shaking orbit machine. The resulting mixture was filtered through a 0.45 µm nylon membrane filter. The extracts were desolventised to dryness under reduced pressure at 40 oC by a rotary evaporator (BUCHI Rotavapor, Model R-124, Germany). The extractive values of the solvent were calculated and the dry extracts were stored in a refrigerator (4 0C) prior to analysis (Arawande et al., 2021; Arawande and Aderibigbe, 2020; Bopitiya and Madhujith, 2014).

Phytochemical screening of solvent-extracts of water melon rinds and seeds

The phytochemicals were qualitatively determined using standard methods described by Trease and Evans, 1989; Evans, 2002 and Sofowora, 2008.

Test for tannin

About 0.2 g of the extract was taken and 2 mL of 10 % ferric chloride was added. Color changes into blue black which indicates the presence of tannin.

Test for alkaloid (Wagner's test)

About 0.2 g of the extract was hydrolyzed by 1% hydrochloric acid; six drops of Wagner's reagent were added. Color changes into brown red/orange precipitate which indicates the presence of alkaloid.

Test for saponin

About 0.2 g of the extract was added with 5 mL of distilled water, it was shaken for 30 seconds and the presence of foam indicates presence of saponin.

Test for terpenoid (Salkowski test)

About 3 mL of chloroform was added to about 0.2 g of the extract and then concentrated sulphuric acid was added from sides of the test tube. The presence of reddish brown color appears at the interface indicates the presence of terpenoids in extract.Test for cardiac glycoside (Keller - Killiani test)

About 0.2 g of the extract was taken and then 1 mL of glacial acetic acid was added and 1 mL of 10% ferric chloride was added, then 1 mL concentrated sulphuric acid was added from the sides of test tube. Formation of green/blue precipitate indicates the presence of cardiac glycoside.

Test for steroid (Lierbermann-Burchardt test)

To about 0.2 g of the extract, 1 mL chloroform was added, 3 mL acetic anhydride was added from sides of the test tube, and then two drops of concentrated sulphuric acid was added. The appearance of dark green color confirms the presence of steroids.

Test for flavonoid

About 0.2 g of the extract was taken; dilute sodium hydroxide was added to create intense yellow color, which on addition of concentrated hydrochloric acid turns into colorless which indicates the presence of flavonoids.

Test for reducing sugars (Fehling's test)

About 0.2 g of the extract was shaken with distilled water and filtered. The filtrate was boiled with drops of Fehling solution A and B for few minutes. An orange red precipitate indicates the presence of reducing sugar.

Test for phlobatannin

About 0.2 g of the extract was added with distilled water then shaken and filtered, then 2 mL of 2% hydrochloric acid was added and boiled. Red colored developed which indicate the presence of phlobatannin.

Test for phenol

2 mL of distill water followed by few drops of 10% ferric chloride was added to about 0.2 g of the extract. Formation of blue or green color occurred which indicates the presence of phenol.

Test for volatile oil

0.1 mL dilute sodium hydroxide and small quantity of dilute hydrochloric acid was added to about 0.5 g of the extract and the solution was shaken. White precipitate was formed which indicates the presence of volatile oil.

Test for quinone

To about 0.2 g of the extract, 1 mL of concentrated sulphuric acid was added. Formation of red color indicates presence of quinone.

Determination of antioxidant properties of water melon rinds and seeds

Total flavonoid

0.1g of extract was weighed into a sample bottle; 10 mL of 80% methanol was added and allowed to soak for 2 hours. 0.4 mL of the solution was measured into a 10 mL volumetric flask, 1.2 mL of 10% sodium hydroxide, 1.2 mL of 0.2 M concentrated sulphuric acid and 3 mL of 3 M sodium nitrate were added. 4.2 mL of distilled water was used to make it up. The absorbance was read using 6850 UV spectrophotometer at wavelength 325 nm (Mahajan and Badujar 2008).

$$\text{Total Flavonoid (mg/100g)} = \frac{\text{Concentration in (mg/l) x volume of sample x DF}}{\text{Sample weight}}$$

0.1g of extract was weighed into a sample bottle; 10 mL of 80% ethanol was added. 2.5 mL sodium phosphate buffer (0.2 M Na2PO3, pH 6.6) and 2.5 mL of 1% potassium ferricyanide were added and incubated at 50˚C for 20 minutes. 2.5 mL of TCA (trichloroacetic acid) was added to stop the reaction. 2.5 mL of the aliquot was taken and diluted with 2.5 mL distilled water and 0.5 mL of 0.1% ferric chloride was added and allowed to stand for 30 minutes in the dark for color development. The absorbance was read using 6850 UV/Visible spectrophotometer at wavelength 700 nm (Alachaher et al. 2018).

$$\text{FRAP (garlic acid equivalent)(GAE)} = \frac{\text{Absorbance} - \textit{Intercept} \text{ x volume of extract x } 100 \times \text{DF}}{\text{Slope of standard} \times \text{sample weight} \times 10\text{^}6}$$

DF: Dilution factor. If not diluted, then DF = 1

Total phenol

0.1 g of extract was weighed into a sample bottle; 10 mL of distilled water was added to dissolve. 1 mL of the solution was pipetted into a test tube and 0.5 mL of 2 N Folin-Ciocalteu reagent and 1.5 mL of 20% sodium carbonate solution was added. The solution was allowed to stand for 2 hours and the absorbance was read using a 6850 UV/Visible spectrophotometer at wavelength 765 nm. Garlic acid solution was used as standard viz 0.5 mg, 1 mg, 2 mg, 4 mg, 6 mg, 8 mg and 10 mg. (Hagerman, et al. 2000).

$$\text{Phenol content mg/100g} = \frac{\text{Concentration in (mg/l)x volume of sample x DF}}{\text{Sample weight}}$$

DF: Dilution factor. If not diluted, then DF = 1

DPPH (2, 2-diphenyl-1-picrylhydrazyl) scavenging

0.1 g of extract was weighed into a sample bottle and 10 mL of ethanol was added, stirred for 15 minutes and allowed to stand for 2 hours. 1.5 mL of the extract was pipetted into a test tube and 1.5 mL of DPPH solution was added. The 6850 UV/Visible spectrophotometer was zeroed with ethanol as the blank solution. The absorbance/ optical density of the control (DPPH solution) was read. The absorbance of the test sample was read at 517 nm (Teraos, et al. 1988).

$$\text{DPPH Scavenged \%} = \frac{\text{Absorbance of control} - \text{Absorbance of test sample}}{\text{Abs of control x sample weight}} \text{ x } 100$$

DF: Dilution factor. If not diluted, then DF = 1

Iron (Fe2+) chelation assay

0.1g of extract was weighed into a sample bottle, 150 µL of 500 µM FeSO4 was added. 168 µL of 0.1M Tris-HCl (pH 7.4) and 218 µL of saline solution was added. 100 µL of the solution was taken and incubated for 5 minutes, before addition of 13 µL of 0.25% 1, 10-phenanthroline. The absorbance was read using 6850 UV/Visible spectrophotometer at wavelength 510 nm (Oboh and Omoregie, 2011).

$$\text{\% inhibition} = \frac{\text{Absorbance of control} - \text{Absorbance of exract}}{\text{Absorbance of exract}} \times 100$$

Statistical analysis

Statistical significance tests were performed using SPSS (v. 20, IBM SPSS Statistics, US) at $p < 0.05$ by means of one-way analysis of variance (ANOVA) followed by LSD post hoc multiple comparison and the experimental results were expressed as mean ± standard mean deviation of three replicates.

Results and discussion

Sample	Solvent					
	Acetone	Chloroform	Ethanol	Ethyl acetate	Methanol	Water
Water melon rinds	5.33^{bc}±0.19	1.51^{c}±0.26	7.34^{b}±0.34	8.70^{b}±0.20	13.56^{a} ±0.20	11.21^{a} ±0.22
Water melon seeds	3.54^{b}±0.16	11.02^{a} ±0.18	3.64^{b}±0.40	5.30^{ab}±0.31	10.17^{a}±0.19	9.59^{a} ±0.35

Note: * = *Result values are expressed as mean value of triplicate determinations ± standard mean deviation Different letter in the same column showed significant difference (p<0.05).*

Table 1: Percentage yield of solvent extracts of water melon rinds and seeds

Percentage yield of solvent extracts of water melon rinds and seeds is presented in Table 1. The percentage yield of watermelon rinds was 13.56±0.20 in methanol, 11.21±0.22 in water, 8.70±0.20 in ethyl acetate, 7.34±0.34 in ethanol, 5.33±0.19 in acetone and 1.51±0.26 in chloroform. The percentage yield of watermelon seeds was 11.02±0.18 in chloroform, 10.17±0.19 in methanol, 9.59±0.35 in water, 5.30±0.31 in ethyl acetate, 3.64±0.40 in ethanol and 3.54±0.16 in acetone. There was no significant difference (P<0.05) in extractive values of methanol and water of watermelon rinds. In similar vein, there was no significant difference (P<0.05) in extractive values of ethanol and ethyl acetate of watermelon rinds. For watermelon seeds, there was no significant difference (P<0.05) in extractive values of methanol, water and chloroform. There was no significant difference (P<0.05) in extractive values of acetone and ethanol. There was high extractive values in methanol and water extracts of watermelon rinds but its chloroform extract had the lowest extractive value. Hence methanol and water were very good solvents in extracting bioactive ingredients from watermelon rinds. There was high extractive values in chloroform, methanol and water extracts of watermelon seeds but its acetone extract had the lowest extractive value. Chloroform, methanol and water were potent solvents for extraction of phytochemicals from watermelon seeds. Extractive value of solvents is an index of the potency of solvents to extract bioactive components of any living

organism either plant or animal. The extractive value of solvent is a measure of the capacity of the solvent to extract bioactive ingredients from a given organic material (Arawande et al., 2018). The solvent ability in obtaining extract from watermelon rinds decreases in order: methanol > water > ethyl acetate > ethanol > acetone > chloroform while that of watermelon seeds decreases in order: chloroform>methanol > water > ethyl acetate > ethanol > acetone. The selection of solvent system for extraction largely depends on the specific nature of the bioactive compound being targeted. Also, different solvent systems are available to extract the bioactive compound from natural products. Extraction efficiency is affected by the chemical nature of phytochemicals, the extraction method used, sample particle size, the solvent used, as well as the presence of interfering substances. Under the same extraction time and temperature, solvent and composition of sample are known as the most important parameters (Arawande et al., 2023; Alachaher, et al. 2018).

	Solvent Extracts					
Phytochemical	Acetone	Chloroform	Ethanol	Ethyl acetate	Methanol	Water
Alkaloid	+	+	+	+	+	+
Flavonoid	+	-	-	+	-	-
Saponin	+	-	-	-	-	+
Cardiac glycoside	-	-	-	-	+	-
Reducing sugar	+	-	-	+	+	+
Tannin	-	-	-	-	+	-
Quinone	-	-	-	-	-	-
Volatile oil	+	+	+	+	-	-
Phenol	-	-	-	-	-	-
Terpenoids	-	-	-	-	+	+
Phlobatannin	-	-	-	-	-	-
Steroid	-	+	-	-	-	-
%Phytochemical extractable	41.67	25.00	16.67	33.33	41.67	33.33

KEY: (+) =Present (-) =Absent

Table 2: Qualitative phytochemical screening of solvent extracts of watermelon rinds

Qualitative phytochemical screening of solvent extracts of watermelon rind was depicted in Table 2. There were twelve phytochemicals screened for in six different solvent extracts. The acetone extracts of the watermelon rinds showed the presence of alkaloid, flavonoids, saponin, reducing sugar and volatile oil. Chloroform extracts of watermelon rinds showed the presence of alkaloid, volatile oil and steroid. It was only alkaloid and volatile oil that were present in ethanol extract of watermelon rinds. Ethyl acetate extract of watermelon rinds contained alkaloids, flavonoid, reducing sugar and volatile oil. Water extract of watermelon rinds had alkaloid, saponin, cardiac glycoside, reducing sugar and terpenoids. For the methanol extracts of watermelon rinds, there were alkaloids, cardiac glycosides, reducing sugar, tannin and terpenoids present. Acetone and methanol extracts had 41.67% phytochemical extractable while ethyl acetate and water had 33.33% phytochemical extractable. Ethanol and chloroform extracts has the lowest phytochemicals extractable among the five solvents used. The percentage phytochemical extractable were 16.67% and 25.00% in ethanol and chloroform respectively.

	Solvent Extracts					
Phytochemical	Acetone	Chloroform	Ethanol	Ethyl acetate	Methanol	Water
Alkaloid	+	+	+	+	+	+
Flavonoid	-	-	-	-	-	-
Saponin	-	-	+	+	+	-
Cardiac glycoside	+	+	+	+	+	-
Reducing sugar	+	+	+	+	+	-
Tannin	-	-	-	-	-	-
Quinone	+	-	+	+	+	-
Volatile oil	-	-	-	-	-	-
Phenol	-	-	-	-	+	-
Terpenoids	+	+	+	+	+	+
Phlobatannin	-	-	-	-	-	-
Steroid	+	+	+	+	+	-
%Phytochemical extractable	50.00	41.67	58.33	58.33	66.67	16.67

KEY: (+) =Present (-) =Absent

Table 3: Qualitative phytochemical screening of solvent extracts of watermelon seeds

Qualitative phytochemical screening of solvent extracts of water melon seeds is presented in Table 3. There were twelve phytochemicals screened for in six different solvent extracts. Acetone extract of watermelon seeds contained alkaloids, cardiac glycosides, reducing sugar, quinone, terpenoids and steroid; this amounted to 50% phytochemical extractable. There were presence of alkaloid, cardiac glycosides, reducing sugar, terpenoids and steroids in chloroform extract of watermelon seeds and this accounted for 41.67% extractable phytochemicals. Ethanol extract of watermelon seeds showed the presence of alkaloids, saponin, cardiac glycoside, reducing sugar, quinone, terpenoids, and steroids. There was 58.33% phytochemical extractable in ethanol extract of watermelon seeds. The ethyl acetate extract of watermelon seeds contained alkaloids, saponin, cardiac glycosides, reducing sugar, quinone, terpenoids, and steroids. There was 58.33% phytochemical extractable in ethyl acetate extract of watermelon seeds. There was presence of alkaloids, saponin, cardiac glycosides, reducing sugar, tannin, quinone, phenol, terpenoids

and steroids in methanol extract of watermelon seeds and this gave 66.67% phytochemical extractable. The water extract of watermelon seeds contained only alkaloids and terpenoids and this amounted to 16.67% phytochemical extractable. It was obvious that methanol, ethanol and ethyl acetate had the highest values of phytochemical extractable while water showed the lowest phytochemical extractable in watermelon seeds.

Antioxidant Properties	Watermelon Rinds *		
	Raw Sample	Methanol extract	Water extract
Total flavonoid (mg/100g)	0.040^{b}±0.002	0.020^{a}±0.001	0.020^{a}±0.001
Total Phenol (mg/100g)	0.060^{b}±0.004	0.110^{a}±0.003	0.180^{a}±0.007
DPPH (%)	79.210^{ab}±0.391	94.950^{b}±0.611	85.730^{a}±0.232
Iron (Fe^{2+}) chelation assay (%)	20.558^{b}±0.109	21.357^{a}±0.190	35.728^{a}±0.228
Ferric reducing antioxidant power (FRAP) (Garlic Acid Equivalent)	0.251^{b}±0.014	0.555^{a}±0.008	0.220^{b}±0.011

NOTE * = *Result values are expressed as mean value of triplicate determinations ± standard mean deviation Different letter in the same row showed significant difference (p<0.05)*

Table 4: Antioxidant properties of watermelon rinds

Antioxidant properties of water melon rinds is shown in Table 4. The table contains the antioxidant properties of raw, methanol extract and water extract of watermelon rinds. The antioxidant properties considered were total flavonoid, total phenol, DPPH, iron (Fe2+) chelation assay, and ferric reducing antioxidant power (FRAP)

The concentration of total flavonoid (mg/100g) ranged between 0.020±0.001 and 0.040±0.002 in the watermelon rinds. The powdered raw sample had total flavonoid of 0.040±0.002 mg/100g and that of methanol and water extracts was 0.020±0.001 mg/100g. The total phenol content (mg/100g) of watermelon rinds was between 0.060±0.004 and 0.180±0.007. The highest value was for water extract while the lowest value was for raw sample of watermelon rinds and that of methanol extract was 0.110±0.003.The radical scavenging activity of watermelon rinds was measured using the DPPH radical assay. 2, 2-diphenyl-1-picrylhydrazyl (DPPH) scavenging (%) of watermelon rinds ranged between 79.210±0.391 and 94.950±0.611. The DPPH value was highest in methanol extract and least in raw sample while it was 85.730±0.232% in water extract of watermelon rinds. The iron chelating power (%) ranged between 20.558±0.109 and 35.728±0.228 with highest value in water extract and the least value in raw sample of watermelon rinds; and it was 21.357±0.190 in methanol extract. The ferric reducing antioxidant power (FRAP) (Garlic Acid Equivalent (GAE)) of watermelon rinds had the highest (0.555±0.008) in methanol extract and lowest value (0.220±0.011) in water extract while it was 0.251±0.014 in raw sample. The reducing capacity of a compound may serve as an important indicator of its potential antioxidant activity (Ho et al., 2012). There was no significant difference (P<0.05) in total flavonoid, total phenol, Iron (Fe2+) chelation assay of methanol and water extracts of watermelon rinds. There was no significant difference (P<0.05) in Ferric reducing antioxidant power (FRAP) (Garlic Acid Equivalent) of raw sample and water extract of watermelon rinds. Water and methanol extracts of watermelon rinds had higher total phenol, DPPH and Iron (Fe2+) chelation assay than raw sample of watermelon rinds

Antioxidant Properties	Watermelon Seeds *		
	Raw Sample	Chloroform extract	Methanol extract
Total flavonoid (mg/100g)	0.130^{b}±0.000	0.030^{a}±0.001	0.430^{a}±0.002
Total Phenol (mg/100g)	0.050^{b}±0.001	0.050^{a}±0.000	0.250^{a}±0.012
DPPH (%)	92.660^{ab}±0.119	92.418^{b}±0.110	96.310^{a}±0.213
Iron (Fe^{2+}) chelation assay (%)	14.571^{b}±0.101	26.946^{ab}±0.119	35.529^{a}±0.221
Ferric reducing antioxidant power (FRAP) (Garlic Acid Equivalent)	0.230^{b}±0.010	0.831^{a}±0.085	1.110^{a}±0.010

NOTE * = *Result values are expressed as mean value of triplicate determinations ± standard mean deviation Different letter in the same row showed significant difference (p<0.05)*

Table 5: Antioxidant properties of watermelon seeds

Antioxidant properties of watermelon seeds is presented in Table 5. The table contains the antioxidant properties of raw, chloroform extract and water extract of watermelon rinds. The antioxidant properties considered were total flavonoid, total phenol, DPPH, iron (Fe2+) chelation assay, and ferric reducing antioxidant power (FRAP). The concentration of total flavonoid (mg/100g) ranged between 0.130±0.000 and 0.430±0.002 in the watermelon seeds. The total flavonoid (mg/100g) of raw sample, chloroform and methanol extracts were 0.130±0.000, 0.030±0.001 and 0.430±0.002 respectively. There was no significant difference (P<0.05) in total flavonoid of chloroform and methanol extracts of watermelon seeds. The total phenol content (mg/100g) of watermelon seeds ranged between 0.050±0.001 and 0.250±0.012. The highest value was for methanol extract while the lowest value was for raw sample and chloroform extract of watermelon seeds. There was no significant difference (P<0.05) in total phenol of raw sample and chloroform extract of watermelon seeds. The radical scavenging activity of watermelon seeds was measured using the DPPH radical assay. 2, 2-diphenyl-1-picrylhydrazyl (DPPH) scavenging (%) of watermelon seeds ranged between 92.418±0.110 and 96.310±0.213. The DPPH value was highest in methanol extract and least in chloroform extract while it was 92.660±0.119% in raw sample of watermelon seeds. There was significant difference (P<0.05) in DPPH of raw sample, chloroform and methanol extracts of watermelon seeds. The iron chelating power (%) ranged between 14.571±0.101 and 35.529±0.221 with higher value in methanol extract and the least value in raw sample of watermelon seeds; and it was 26.946±0.119% in chloroform extract. There was significant difference (P<0.05) in iron chelating power of raw sample, chloroform and methanol extracts of watermelon seeds. The ferric reducing antioxidant power (FRAP) (Garlic Acid Equivalent (GAE)) of watermelon seeds had the lowest value (0.230±0.010) in raw sample and highest (1.110±0.010) in methanol extract while it was 0.831±0.085 in chloroform extract. There was significant difference (P<0.05) in ferric reducing antioxidant power (FRAP) of chloroform and methanol extracts of watermelon seeds. Water and methanol extracts of watermelon rinds

had higher iron (Fe2+) chelation assay and ferric reducing antioxidant power (FRAP) than raw sample of watermelon seeds. Methanol extract of watermelon seeds had higher total flavonoid, total phenol and DPPH than raw sample of watermelon seeds

Conclusion

The watermelon rinds and seeds contained essential phytochemicals. The phytochemicals in watermelon seeds are best extracted using chloroform, methanol and ethyl acetate while that of watermelon rinds are best extracted with methanol and water. Watermelon seeds is richer in phytochemicals than watermelon rinds. Methanol is a very potent solvent in extracting bioactive compounds of high antioxidant properties for both watermelon seeds and rinds. However, further research can be conducted in investigating the antioxidant activity of methanol, water and chloroform extracts of both watermelon seeds and rinds on edible oils in comparison with synthetic antioxidants such as butylated hydroxyl toluene (BHT) and butylated hydroxyl anisole (BHA).

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