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Watermelon White Rind as a Natural Valuable Source of Phytochemicals and Multinutrients

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Abstract

Watermelon white rind as agriculture waste posed potential pollution and ecological problems. Rind constitutes 30% of the weight of whole watermelon fruit. The present study focused on determining the antioxidant activity, fatty acid composition, mineral content, vitamins and amino acid profile of the white rind. The results revealed that the rind had total antioxidant activity of 2974±11.31 mg AAE/100g, total phenols content of 139.6±2.54 mg GAE/100g and total flavonoids of 40.4 ±0.92 mg QE/100g. Ferric reducing antioxidant power (FRAP) assay indicated the high reducing ability of the rind. Crude protein content amounted to 13.3%, crude fiber (14.7%) and fat (2.11%). Moreover, mineral analysis ensured that the rind is a source of iron (30.4 mg/kg), potassium (6.95%), copper (9.4 mg/kg), chromium (85µg/100g) and selenium (542µg/100g). Unsaturated fatty acids amounted to 81.2%. Glutamic acid and lysine were the most predominant amino acid found in the rind. Vitamins A and E valued 383.44 µg/100g and 3.72 mg/100g, respectively. As a conclusion, watermelon white rind can be regarded as a potential source of phytochemicals and other nutrients.

Introduction

Agricultural by-products such as fruit and vegetable wastes are posing an environmental problem and are considered of the main sources of municipal solid wastes. Thus, utilization these wastes as sources of bioactive compounds may be of considerable economic benefits and has become increasingly attractive ***(Deng et al., 2012)***. There is a potential for conversion of agriculture wastes into useful products or even as raw material for other industries ***(El-Badry et al., 2014)***. These wastes can represent an important source of sugars, minerals, organic acids, dietary fiber, and bioactive compounds ***(Djilas et al., 2009).***

Watermelon *Citrullus lanatus* (Thunb.), from the family of cucumber (*Cucurbitacea*), is a large, oval, round or oblong tropical fruit. It is a very rich source of vitamins and also serves as a good source of phytochemicals ***(Al-Sayed and Ahmed, 2013).*** The therapeutic effect of watermelon has been reported and has been ascribed to antioxidant compounds. The citrulline in watermelon rinds gives it antioxidant effects that protect from free-radical damage. Additionally, citrulline converts to arginine, an amino acid vital to the heart, circulatory system and immune system ***(El-Badry et al., 2014).***

Watermelon biomass is categorized into three main components which are the flesh (68% of the total weight), the rind (30%), and the seeds (2%). The red colored flesh of watermelon is only edible and the remaining white part with skin is considered as waste ***(Reddy et al., 2008).***

Although several studies have reported the nutritional and phytochemical evaluation of watermelon, yet no much attention was paid for the evaluation of its white rind. Thus the aim of the present work was focused on determining the antioxidant activity, fatty acid composition, mineral content, vitamins, proximate analysis and amino acid profile of watermelon white rind.

Materials and Methods

Watermelon white rind

The watermelon white rind was collected from restaurants in Cairo and Giza governorates. It was cut into small pieces, dried to constant weight at 40˚C and pulverized into fine powder.

Chemical analysis

Protein, crude fiber and fat were determined using the procedures described by ***AOAC (2012),*** vitamins E and A using HPLC, according to ***Danish Official (1996).***

Fatty acid composition

Fatty acid composition of dried white watermelon rind was determined by gas chromatography according to ***AOAC (2012).***

Amino acid content of the rind

Analysis of amino acid was conducted using HPLC according to the method described by ***AOAC (2012).***

Minerals analysis of the rind

Calcium, phosphorous, copper and manganese were determined according to ***AOAC (2012).***

Evaluation of total antioxidant capacity, flavonoids, total phenols and FRAP

The antioxidant activity of the extract was evaluated using the phosphomolebdenum assay described by ***Prieto et al (1999).*** Total flavonoids content was determined as described by the method of ***Willet (2002)***. The concentration of total phenol was determined using spectrophotometric method described by ***Singleton et al. (1999).*** Ferric Reducing Antioxidant Power was performed according to ***Ammar et al., (2015).***

Results

Proximate analysis and vitamin content of the rind are shown in (Table 1). Results ascertained that the rind had high protein, fiber and vitamin contents.

Fatty acid composition

Fatty acid composition of the rind is shown in table (2). Saturated and unsaturated fatty acids valued 17.68, 81.2%, respectively.

Amino acid content of the rind

Seventeen amino acids were identified in the rind, nine of which were essential that cannot be synthesized by the body and obtained from the diet.

The highest percentage was for glutamic acid (0.76), followed by lysine (0.70) and the lowest was methionine (0.04%).

Elemental analysis of the rind

The minerals content of watermelon rind is summarized in Table 4. The results showed that watermelon white rind contained valuable amounts of calcium, phosphorus, magnesium, chrome, selenium, potassium and copper.

Quantitative phytochemical evaluation of watermelon rind

Table (5) presented the results of the antioxidant properties of watermelon rind. Results showed that watermelon rind contained high amount of phenolic and flavonoids compounds.

Ferric Reducing Antioxidant Power (FRAP) of watermelon rind (Fig. 1) reflected the electron donation ability of antioxidants present in watermelon rind to convert Fe^{3+} into Fe^{2+}. The amount of the Fe^{2+} complex was followed by measuring the formation of Perls' Prussian blue at the absorbance of 700 nm**.** The results showed an increase in the absorbance proportional to the increase in watermelon concentration. This result indicated an increase in the reducing power activity and that watermelon rind was an electron donor capable of reducing Fe^{3+} ions in a linear concentration-dependent manner.

Discussion

Phenolic compounds are widely distributed and are found in large quantity in the plant kingdom. They have been shown to comprise multiple biological functions including antioxidant activity ***(Subhadradevi et al., 2010).***

Flavonoids are naturally occurring in plants and are thought to have positive effects on human health. Flavonoids have been shown to be highly effective scavengers of most oxidizing molecules, including single oxygen, and various free radicals implicated in several diseases ***(Saeed et al., 2012).*** The antioxidants act as a protector from free radicals and their role is the prevention of several diseases which is mainly attributed to the prevention of LDL oxidation through a scavenging activity against peroxyl and hydroxyl radicals ***(Chatterjee, 2014).***According to ***Kenari et al. (2014),*** Ferric Reducing Antioxidant Power (FRAP) is often used as an indicator of electron donation which is the important mechanism to determine antioxidative activity. Presence of reductants like antioxidants in tested sample will reduce Fe^{3+}, so reducing capacity of antioxidant is an indicator of its antioxidative activity.

The proximate composition results of water melon rind were comparable to those reported by ***Al-Sayed and Ahmed, (2013)*** which found that watermelon rind powder had moisture, fat and protein carbohydrates (10.61%, 2.44% and 11.17%, respectively).

The white watermelon rind contained nine essential amino acids that cannot be synthesized by the body and are supplied from the diet. These results are in agreement with the results previously reported by ***Al-Sayed and Ahmed, (2013).*** Also, rind can be considered as a source of polyunsaturated fatty acid.

Minerals have several health benefits to the human body. Calcium, phosphorus and magnesium provide structures for human bones. Sodium and potassium help in the maintenance of normal blood pressure. Iron is a part of haemoglobin and myoglobin. Copper plays an important role in the breakdown of carbohydrates, fats and proteins into digestible forms and convert them into energy ***(Mehra et al., 2015).***

Selenium is an essential nutrient, works as antioxidant in combination with vitamin E. Selenium, vitamin E and beta-carotene may lower LDL cholesterol ***(Faghihi et al., 2014).*** Selenium deficiency resulted in disease conditions in human ***(Levander, 1986).***Chromium enhances the action of insulin ***(Mertz, 1993)*** and is directly involved in carbohydrate, fat and protein metabolism ***(lukaski, 1999).***

Conclusion

Selenium, chromium, vitamins, amino acids and unsaturated fatty acids content' had paid attention to watermelon white rind as a source of various nutraceuticals. Further studies will be conducted to highlight its therapeutic effects as fruit residues directed to maximize the utilization of waste.

Table (1): Chemical composition and vitamins analysis of dried watermelon white rind

Test	Protein (%)	Moisture (%)	Fiber (%)	Fat (%)	Vitamin E mg/100g	Vitamin A µg/100g
result	13.3	16.8	14.7	2.11	3.72	383.44

Table (2): Fatty acid composition of dried white watermelon rind % of fat

Name \ Compound	Structure	Distribution	Classification
Palmitic acid	C16:0	11.8%	Saturated Fatty Acid
Stearic acid	C18:0	5.23%	Saturated Fatty Acid
Arachidic acid	C20:0	0.44%	Saturated Fatty Acid
Total saturated fatty acids (%) 17.47			
Oleic acid	C18:1n-9	22.2%	Monounsaturated Fat
Myristic acid	C14:0	0.21%	Saturated Fatty Acid
Linoleic acid	C18:2n-6	49.7%	Polyunsaturated Fatty Acid
Linolenic acid	C18:3 n-3	6.20%	Polyunsaturated Fatty Acid
Gadoleic acid	C20:1 n-9	0.32%	unsaturated Fat
Behenic acid	C22:0	0.44%	polyunsaturated Fatty Acid
Palmitoleic acid	C16:1n-7	0.21%	omega 7 monounsaturated fatty acid
Vaccinic acid	C18:1n-7	1.80%	omega-7 monounsaturated fatty acid
Erucic acid	C22:1 n-9	0.33%	monounsaturated omega-9 fatty acid
Non identified fatty acid		0.50%	
Total unsaturated fatty acids (%) 81.91			

Table (3): Amino acid profile of rind (on dry basis)

Amino acid	Percentage
Leucine	0.21
Valine	0.29
Lysine	0.70
Phenylalanine	0.20
Therionine	0.12
Isoleucine	0.14
Histidine	0.09
Aspartic acid	0.34
Argenine	0.27
Alanine	0.25
Proline	0.21
Glutamic acid	0.76
Glycine	0.16
Serine	0.09
Histidine	0.09
Cystine	0.12
Methionine	0.04

Table (4): Minerals content of dried watermelon white rind

Element (Unit)	Result
Calcium %	0.29
Phosphorus %	0.35
Magnesium %	0.25
Sodium %	0.4
Potassium %	6.95
Copper mg/kg	9.4
Iron mg/kg	30.4
Chrome µg/100g	85
Selenium µg/100g	542

Table (5): Antioxidant properties of watermelon rind

Total antioxidant capacity (mgAAE/100g)	2974±11.31
Total phenolics content (mg GAE/100g)	139.6 ±2.54
Total flavonoids content (mg QE/100g)	40.4±0.92

Results were expressed as mean± SD
AAE: ascorbic acid equivalent, GAE: gallic acid equivalent and QE: quercetin equivalent.

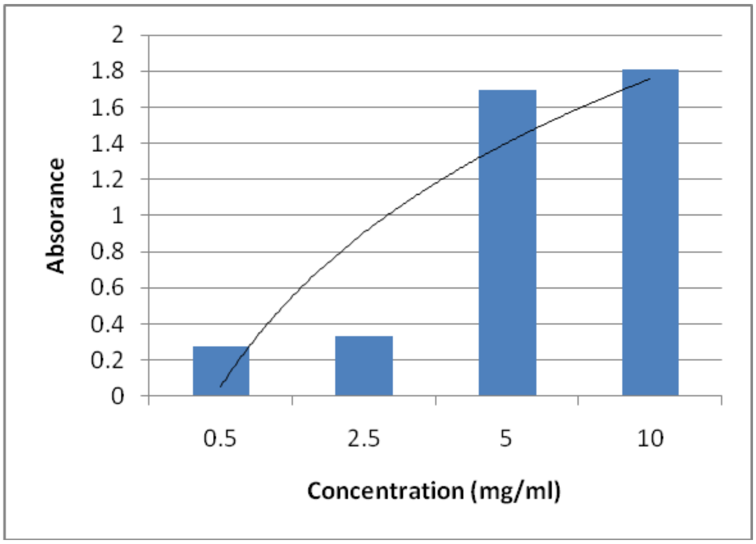

Fig. (1): Ferric Reducing Antioxidant Power (FRAP) of watermelon white rind

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قشرة البطيخ البيضاء كمصدر طبيعى للعديد من للمواد الفعالة و المغذية

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الملخص العربي

تعتبر قشرة البطيخ البيضاء من المخلفات الزراعية التي تسبب مشاكل بيئية و تمثل٣٠٪ من الوزن الكلي لثمرة البطيخ. تم التحليل الكيميائى للقشرة البيضاء و بلغت نسبة البروتين13,3 ٪ والألياف14,7 ٪ والدهون2.21 ٪ .

ركزت هذه الدراسة على تقدير النشاط المضاد للأكسدة و الأحماض الدهنية، العناصر المعدنيه، الفيتامينات، والأحماض الأمينية لقشرة البطيخ البيضاء. وقد اظهرت النتائج أن النشاط الكلي المضاد للأكسدة للقشرة هو ٢٩٧٤ مللجم / ١٠٠ جم مكافئ لحمض الاسكوربيك، اما المحتوى الكلي للفينولات فقد كان 139,6 مللجم / ١٠٠ جم مكافئ لحمض الجاليك كما وجدت الفلافونيدات الكليه بنسبة 40,4 مللجم / ١٠٠ جم مكافئ للكويرسيتين. تم عمل إختبار القدرة على إختزال أيونات الحديديك و أشارت نتائج الاختبار إلى قدرة القشره البيضاء للبطيخ على اختزال ايونات الحديديك بصوره تتناسب طردياً مع التركيز.
اظهر تحليل العناصر المعدنيه ان القشرة مصدر للحديد (٤, ٣٠ ملجم/كجم) والبوتاسيوم (6,95٪)، والنحاس (٤, ٩ ملجم/كجم) والكروم (٨٥ ميكروجرام /١٠٠ جرام) والسيلينيوم (٥٤٢ ميكروجرام /١٠٠ جرام).

أوضحت النتائج ان القشرة البيضاء مصدر لتسع احماض أمينية اساسية و كان محتوى الاحماض الدهنية الغير مشبعة يصل الى ٢, ٨١%. من النتائج السلبقة يتضح أن قشرة البطيخ البيضاء تعتبرمصدرا للعديد من للمواد الفعالة و المغذية.