Nutrient and Dietary Fibre Profile Of Dehulled and Undehulled Seeds of Sweet Princess Watermelon (*Citrullus lanatus*) Consumed in Nigeria

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***Abstract*-- Background: Plant foods are important dietary sources in the developing countries because of their availability and low cost. The seeds of many tropical fruits which are discarded maybe rich in nutrients and dietary fibre.**
Objective: This study examined the nutrient and dietary fibre contents of dehulled and undehulled seeds of sweet princess specie of watermelon consumed in Nigeria.
Methods: Small tan coloured seeds of the watermelon were manually separated from the pulp, washed and shade dried until the seed coats were easy to remove. The seeds were divided into two portions; one was dehulled manually and milled into flour and the other was milled without dehulling. Proximate, vitamins, minerals and dietary fibre composition of the samples were determined using standard procedures. The data were statistically analyzed and compared on dry weight basis at $p < 0.05$ significant level.
Results: The results showed that on dry weight basis, the undehulled sample had more carbohydrate (48.35g) than the dehulled (33.08g) sample. Protein (38.59g), fat (17.78g), retinol (56.47µg), potassium (717mg) and insoluble non-starchy polysaccharide (10.28%) in the dehulled seeds differed on dry weight basis from those of the undehulled sample (28.50g, 10.65g, 17.21µg and 474mg, respectively). The differences were statistically significant ($p>0.05$). The iron content of the two samples was generally low (1.94mg for dehulled and 4.81mg for undehulled). The undehulled sample had higher (57.56%) total soluble non-starch polysaccharide (NSP) than the dehulled sample (34.66%).
Conclusion: Sweet princess watermelon seeds contain appreciable amount of nutrients and dietary fibre, their consumption with the fruit pulp or alone could be one of the ways of increasing dietary fibre intake in particular.

***Index Item*-- watermelon seeds, dehulled, undehulled and chemical composition**

I. INTRODUCTION

One possible way of achieving nutrition security in developing countries is through exploitation and utilization of available foods sources and resources ([1]). In such countries, plant foods are the most important dietary sources to satisfy individuals' nutrient requirements due to their availability and low cost. Many of tropical plants yield edible fruits whose seeds are often not consumed. A specie of watermelon (*Citrullus lanatus*) known as the sweet princess is one of such fruits whose seeds are not routinely eaten with the pulp. The seeds of watermelon in general belong to a class of minor legumes. Legumes are still relatively under exploited and utilized throughout the developing world despite their roles as a source of protein and oil in human diet. There is consistent evidence from epidemiological studies that consumption of legumes play a role in preventing chronic diseases like diabetes, cardiovascular diseases and overweight as well as improving gut health ([2]). This is attributed to their low glycemic index which means that carbohydrate in leguminous seeds have slower rates of digestion and absorption and therefore, low insulin demand. This quality is beneficial in long term high blood glucose control ([3]). Chronically elevated blood glucose level and excessive insulin secretion are thought to play important role in development of type 2 diabetes mellitus ([4]).

The increase in the incidence of chronic non-communicable diseases (NCD) in most developing countries is attributed to urbanization which results in changes in dietary pattern and sedentary life-style. This leads to nutrition transition ([5]) – a shift from the consumption of traditional foods high in complex carbohydrate/dietary fibre to high consumption of energy dense modified and processed foods. This injudicious food habit may predispose an individual to diseases such as obesity, diabetes mellitus, cardiovascular diseases ([6]) and certain cancers. Diabetes mellitus has recently emerged as one of the major health problems in Africa including Nigeria ([5]). In 2000, WHO ([7]) reported that about 171 million people globally suffer from diabetes out of which 90% are non-insulin dependent ([8]). This figure according to the report will double by 2030. This is because the risk factors of diabetes are increase with age and as the elderly population increases so will the incidence and prevalence. The estimated population of diabetes in Nigeria is about six million ([9]).

Non-communicable diseases are linked with low dietary fibre diets. Chemically, dietary fibre consists of non-starch polysaccharides ([10]). Essentially dietary fibre or non-starch polysaccharide (NSP) is the indigestible portion of plant foods which is composed of soluble and insoluble fibre. Soluble dietary fibre or soluble non starch polysaccharide (s-NSP) when consumed in large amounts is linked with slow glucose absorption from the small intestine and reduced insulin release ([11]). This effect is helpful in the treatment of type 2 diabetes. Foods rich in soluble fibre are low in glycemic index making them excellent sources of

carbohydrates in the diet of those affected by diabetes ([12]). Soluble dietary fibre is in addition implicated with reduced synthesis of cholesterol in the liver and low blood cholesterol level ([11]). The insoluble part of the dietary fibre or insoluble NSP increases fecal bulk, softens stool and shortens transit time of food through the intestinal tract.

The objective of this study was to determine the nutrient and dietary fibre composition of dehulled and undehulled sweet princess watermelon seeds.

II. MATERIALS AND METHODS

The specie of watermelon (*Citrullus lanatus)* fruits used for this study was the sweet princess which has round shape, light green in colour with soft sweet deep red flesh or pulp and small tan coloured seeds. The seeds were manually separated from the pulp, washed and shade dried until the seed coats were easy to remove. The seeds were divided into two portions; one portion was dehulled manually before being milled into flour and the second portion was milled into flour without dehulling. The samples were analyzed for proximate, vitamins and minerals content using standard methods described by the Association of Official Analytical Chemist ([13]). All the analyses were performed in triplicate. The two samples were converted to the same moisture level and the values statistically analyzed using mean, standard deviation, T-Test and Least of Significant Difference (LSD) for separation of means.

RESULTS

The nutrient and dietary fibre composition of sweet princess watermelon seed as consumed (wet weight basis) is shown in Table I. The protein (37.82g), potassium (705.37mg) and dietary fibre (33.99%) were high in the dehulled samples while the undehulled sample was high in carbohydrate (43.30g), ascorbic acid (62.54) magnesium (594.11mg) and dietary fibre 51.37%).

TABLE I
NUTRIENT AND DIETARY FIBRE CONTENT OF WATERMELON SEEDS AS CONSUMED PER 100G

Nutrient	Dehulled seed	Undehulled seed
Moisture	2.06±0.06	10.14±0.13
Protein (g)	37.82±0.02	25.60±0.02
Fat (g)	17.43±0.04	9.61±0.02
Carbohydrate (g)	32.42±0.01	43.30±0.14
Retinol (µg)	55.31±0.01	15.30±0.01
Ascorbic acid (mg)	40.51±0.03	62.54±0.03
Thiamin (mg)	0.22±0.01	0.17±0.03
Niacin (mg)	2.76±0.57	2.20±0.08
Potassium (mg)	705.37±5.28	421.86±1.70
Magnesium (mg)	526.58±2.26	594.11±3.61
Iron (mg)	1.94±0.03	4.27±0.05
Zinc (mg)	19.55±0.03	18.62±0.03
Dietary fibre (%)	33.99±0.37	51.37±0.36

Mean ± SD of 3 determinations

The comparative proximate composition (on dry weight basis) of the dehulled and undehulled watermelon seeds outlined in Table II shows that the protein content of the dehulled seeds was significantly higher (38.59%) than the undehulled seeds (28.50%). The undehulled sample contained more carbohydrate (48.35%) and dietary fibre (10%.30) than the dehulled (33.08% and 7.32%, respectively).

TABLE II
COMPARATIVE PROXIMATE COMPOSITION OF DEHULLED AND UNDEHULLED WATERMELON SEEDS (DRY-WEIGHT BASIS) PER 100G

Nutrients (%)	Dehulled Watermelon seeds	Undehulled seeds
Protein	38.59±0.04^{b}	28.50±0.01^{a}
Fat	17.78±0.01^{a}	10.65±0.01^{a}
Carbohydrate	33.08±0.03^{b}	48.35±0.01^{a}
Ash	3.17±0,02^{a}	2.23±0.02^{a}
Crude fibre	7.32±0.01^{a}	10.30±0.01^{a}

Mean ± SD of 3 determinations

Means with different superscript along the same vertical line are significantly different from each other ($p < 0.05$)

The retinol (56.47µg), thiamin (0.23mg), niacin (2.83mg), potassium (717mg) in the dehulled seeds differed from those of the undehulled sample. The differences were not statistically significant ($p > 0.05$) for the undehulled thiamin (0.19mg) and niacin (2.49mg) as delineated in Table III. Ascorbic acid (70.09mg), magnesium (667.35mg), iron (4.81mg) and zinc (20.72mg) were found to be more in the undehulled sample than the dehulled.

TABLE III
COMPARATIVE MICRONUTRIENT COMPOSITION OF DEHULLED AND UNDEHULLED WATERMELON SEEDS (DRY-WEIGHT BASIS) PER 100G

Nutrients	Dehulled seeds	Undehulled seeds
Retinol (µg)	56.47±0.11[a]	17.21±0.13[b]
Ascorbic acid (mg)	41.38±0.08[b]	70.09±0.08[a]
Thiamin (mg)	0.23±0.01[a]	0.19±0.01[a]
Niacin (mg)	2.83±0.02[a]	2.49±0.04[a]
Magnesium (mg)	537.68±0.81[b]	667.35±2.81[a]
Potassium (mg)	717±2.16[a]	474±2.15[b]
Iron (mg)	1.94±0.01[b]	4.81±0.04[a]
Zinc (mg)	19.96±0.02[a]	20.72±0.18[a]

Mean ± SD of 3 determinations . Means with different superscript along the same vertical line are significantly different from each other ($p< 0.05$)

Table IV shows the dietary fibre composition of dehulled and undehulled watermelon seeds. The undehulled watermelon seeds had more soluble fibre (53.45%) and total NSP (57.56%) than the dehulled sample while the insoluble NSP was higher in the dehulled seeds. The differences were significant ($p<0.05$).

TABLE IV
COMPARATIVE DIETARY FIBRE COMPOSITION OF DEHULLED AND UNDEHULLED WATERMELON SEEDS (DRY-WEIGHT BASIS) PER 100G

Nutrients (%)	Dehulled seeds	Undehulled seeds
Soluble NSP	23.81±0.08[b]	53.45±0.04[a]
Insoluble NSP	10.28±0.01[a]	5.25±0.03[b]
Total NSP	34.66±0.01[a]	57.56±0.04[b]

Mean ± SD of 3 determinations
Means with different superscript along the same vertical line are significantly different from each other ($p< 0.05$)

III. DISCUSSION

The result of this study showed that, the dehulled and undehulled seeds of sweet princess watermelon were relatively high in some nutrients and dietary fibre. On wet weight basis (as consumed), the protein content of both samples (37.82g for dehulled and 25.60g for undehulled) were higher than that found in most legumes and the quantity met more than half of the FAO/WHO/UNU ([14]) recommended daily requirement for adults ([15]). This result supports the work of Adegboye ([5]). On dry weight basis, the protein content of the dehulled and undehulled samples (38.59g and 28.50g, respectively) was comparable to the 30% reported by USDA ([15]) in a similar study. Dry pumpkin seed kernel has about the same amount of protein but dry roasted sunflower seed has less ([16])

The carbohydrate content of both samples was significant and was found to be more in the undehulled than the dehulled seeds (48.35g and 33.08g, respectively). This amount could satisfy ⅓ of the daily caloric intake of a healthy adult. This quantity is beneficial because it spares protein as an energy source and acts as mild natural laxatives for human beings by adding bulk to the diet ([17]).

The low fat content of both samples on wet weight basis (17.43g for dehulled and 9.61g for undehulled) contradicts the reports of Adegboye and Adesanya ([5]) and Solanki ([18]) which showed that the fat content of watermelon seed varied from 20% to 50%. This disparity could be attributed to varietal differences; there are about 100 varieties of watermelon. In addition, it suggested that the sweet princess watermelon seed is not oily seed. However, studies have shown that the fat in watermelon is more of monounsaturated, polyunsaturated and omega-6 fatty acids than the saturated fatty acids. The monounsaturated and polyunsaturated fatty acids help reduce blood cholesterol ([19]) while the omega-6 reduces the risk of heart disease and type2 diabetes ([20]).

Micronutrients (retinol, ascorbic acid, thiamin, niacin, potassium, magnesium, iron and zinc) profile of dehulled and undehulled sweet princess watermelon seeds as consumed were appreciable when compared with their levels in the pulp. These nutrients are important in maintaining good health. For instance, retinol (55.31µg for dehulled seed and 15 30µg for undehulled seed) and ascorbic acid (40.51mg for dehulled and 62.54mg for undehulled) are powerful antioxidants which have been found prevent cancer causing cellular damage in experimental animals ([21]). In addition, retinol prevents cardiovascular diseases, eye problems and diabetes ([22]) while ascorbic acid performs a variety of important cell functions ([5]). Niacin which was reported in an earlier study as the most prevalent (3.8mg/100g) of all the B complex vitamins in watermelon seed ([19]) is important for cellular respiration.

The magnesium content of the samples was high and comparable with earlier result ([19]). The quantity also met the Recommended Daily Allowance of adults ([14]). Magnesium improves insulin sensitivity and may delay the onset of type 2 diabetes in individuals with high risk factors. The potassium values for the dehulled seed and the undehulled seeds were high, this is beneficial in the management of diabetes because potassium helps to control blood pressure and possibly prevents stroke, one of complications of the disease ([23]). The watermelon seeds studied were not a good source of iron because the iron values were lower than 7.28mg/100g reported in an earlier study ([16]). The zinc values of the samples (19.96mg for the dehulled seeds and 20.72mg for the undehulled seeds) were higher than

10.24mg/100g in watermelon kernel reported in a previous study ([16]) as well as the Recommended Daily Intake for adult men (11mg) and adult women (8mg). The presence of this mineral would help to support many body functions such as protein metabolism, wound healing and growth ([11]) necessary in the management of diabetes

The soluble NSP or soluble dietary fibre composition varied from 23.81% in the dehulled sample to 53.45% in the undehulled sample. Soluble NSP in the diet of diabetics is important because it increases intestinal transit time, delays gastric emptying, slows glucose absorption and alters nutrient utilization due to the thickening of the unstirred water layer ([24]). It also reduces cholesterol synthesis in the liver ([11]) and lowers serum cholesterol ([25]).The insoluble NSP values were 10.28% for the dehulled seeds and 5.25% for the undehulled seeds. Srilashmi ([25]) reported that insoluble fibre decreases intestinal transit time, increase fecal bulk, delay glucose absorption and slow starch hydrolysis. The total NSP content of the undehulled watermelon seeds was higher (57.56%) than dehulled watermelon seeds (34.16%). This is expected as plant fibre is found more on seed coat.

IV. CONCLUSION AND RECOMMENDATION

The dehulled and undehulled sweet princess watermelon seeds contained significant quantities of macro and micro nutrients. The seeds especially the undehulled seeds were high in soluble dietary fibre suggesting that they can serve as snacks for people living with type2 diabetes. In conclusion, watermelon seeds are good for the body and should be consumed alone or with the pulp. Anti-nutrient and phytochemical content of the seeds can be investigated as well as a biological study to determine the bioavailability of the nutrients in humans. More work can also be done on the possibility of using the flour from the seed to produce snacks for diabetics.

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