

## DIETARY COMPOSITION AND FUNCTIONAL PROPERTIES OF SELECTED WATERMELON SEEDS AVAILABLE IN BANGLADESH

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### ABSTRACT

This study was carried out to investigate the nutritional composition and functional properties of two varieties of watermelon seeds and compare these properties between these seeds for harnessing them for consumption as food. The dried seeds of the two types of watermelon were evaluated by using a standard method for different characteristics such as nutritional, phytochemical and functional properties to perceive the potential benefits of that seed. The result of nutritional composition and phytochemical compound analysis obtained for the two varieties (Crimson red and Charleston gray) of watermelon seed indicated that both varieties of watermelon seed were rich in energy ( $469.60 \pm 0.01$  Kcal/100g,  $408.85 \pm 0.01$  Kcal/100g), crude fat ( $36.61 \pm 0.01\%$ ,  $30.65 \pm 0.01\%$ ), crude protein ( $27.21 \pm 0.01\%$ ,  $22.51 \pm 0.01\%$ ), fiber ( $21.55 \pm 0.01$ ,  $29.85 \pm 0.01\%$ ) and phytochemical compound such as crude alkaloid ( $14.05 \pm 0.006\%$ ,  $10.56 \pm 0.006\%$ ) respectively. The study result showed that, the crude fat, crude protein, energy and crude alkaloid were found to be high in the amount in the Crimson red seed than Charleston gray seed. Whereas the crude fiber was the high amount in the Charleston gray seed compared to the Crimson red seed. Functional properties may impact the behavior of food protein during processing, formulation and storage. The functional properties such as water absorption capacity, oil absorption capacity, emulsion activity, emulsion stability, foam activity, and foam stability were analysed of two varieties of watermelon seeds. The present research study revealed that both the two varieties of watermelon seed are characterized with good functional properties which indicate that the watermelon seeds can be incorporated in the formulation of food for consumption and use for industrial purposes.

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## INTRODUCTION

Bangladesh has a favorable environment to cultivate different types of crops such as paddy, wheat, pea, soybean, sunflower, mustard, etc., and also several kinds of fruits such as olive, jackfruit, mango, watermelon etc. (Hoque et al., 2015). Watermelon (*Citrullus lanatus*) is a very common tasty and juicy fruit in Bangladesh that belongs to the family of Cucurbitaceae. It is an important crop during the hot season to meet the demand for water as it contains 90 percent of water. It also contains vitamins (A, B, C) and minerals. Watermelon is produced in different areas of Bangladesh. There are cultivated different indigenous varieties of watermelon such as sugar baby, Charleston gray, Crimson red etc. in our country (Rabbany et al., 2013). The seed of watermelon is considered as highly nutritious. It is an excellent source of fat, protein, minerals such as Mg, K, P, Fe, Zn, Na, Ca, Cu, vitamins (A, B) and other phytochemical compounds (Braide et al., 2012). The watermelon seed has an economic advantage. The seeds are ground into flour and used in the preparation of sauces and snacks. The oil obtains from watermelon seed is used in cooking food and manufacture of cosmetics products (Jensen et al., 2011). Watermelon seed is rich in protein; it constitutes nine essential amino acids along with glutamic acid, lysine and tryptophan. The seed of watermelon contains a low amount of carbohydrates but a high amount of calories. For the athlete, roasted watermelon seed can be a best choice as a supplement. The seed is also a good source of different types of fats like monounsaturated fat, polyunsaturated fat and omega-6 fatty acid which assist in the retrenchment of high blood pressure. Polyunsaturated fat help in reducing blood cholesterol level and cut down the risk of heart disease and type 2 diabetes. The seeds are very useful to cure illness, restoration of health and improve our memory. Protein-energy malnutrition is one of the leading nutritional health problems among children. So for removing malnutrition and mineral deficiency, it is the best option that increases the use of unconventional seeds and cereals like grains as a good source of protein and minerals (Virginia and Ajit, 2014). Functional properties such as water absorption capacity, oil absorption capacity, emulsion activity, emulsion stability, foam stability, foam capacity, bulk density are the idiosyncratic physiochemical properties that affect the protein content of food products during manufacturing and storage of food. Fruit and fruit seed are excellent natural sources of nutritional elements. These natural elements are plant origins and play a vital role in maintaining human health, especially in the prevention of disease, growth and development of our bodies. In the modern era, the demand for phyto-nutrients which are found in the seed of fruits and vegetables is increasing due to public awareness regarding their health (Naz et al., 2013).

Considering the health and economic benefits of unutilized watermelon seed, present research work was aimed to evaluate the chemical composition and functional

properties of two varieties of locally grown watermelon seed available in Bangladesh.

## MATERIALS AND METHODS

### Sample collection

Two varieties of watermelon seed such as Crimson red (black color ) and Charleston gray (brown color ) were collected from the local seed supplier of Chattogram, Bangladesh. Each type of variety was collected from the same lot of seed supplier.

### Processing of watermelon seed

The collected watermelon seed was taken in a dry and clean steel tray. The dirt, foreign materials, immature seed were removed from the fresh matured seed and thoroughly cleaned. The watermelon seed was placed on a cabinet dryer for drying at 60°C for 24 h. Then the dried seed was ground by using an electrical grinder to convert the seeds into powder form. The husk was separated from seed powder. The seed powder was packed in polyethylene bags and stored in a vacuum plastic container.

### Determination of proximate composition

The proximate composition of watermelon seed powder such as moisture, ash, protein, fat, fiber was determined in triplicate by following the AOAC method (AOAC, 2005). The total carbohydrate was estimated by subtracting method (Pearson, 1976). The energy value of the seed was calculated according to the formula as reported earlier (Nile and Khobragade, 2009). All proximate contents were expressed in percentage.

### Carbohydrate content

Carbohydrate was estimated by subtracting the percentage amount of moisture, ash, protein, ash and crude fiber from 100 according to subtracting method. Carbohydrate was calculated by the following formula (Pearson, 1976).

% Carbohydrate = 100 – (% Moisture + % Ash + % Protein + % Fat + % Crude fiber)

### Energy value

Energy value was calculated by the following formula:

Energy value (Kcal/ 100g) = (4× % Carbohydrate) + (9 × % Fat) + (4× % Protein)

### Determination of phytochemical compounds

Crude alkaloid was determined according to the method as described earlier (Harborne, 1998). Saponin was estimated by following the standard protocol (Obadoni and Ochuko, 2002).

### ***Crude alkaloids content***

Approximately 2.5 g of watermelon seed powder was mixed with 100 ml of 10% acetic acid in ethanol. The mixture was incubated at 25°C for 4 h and then percolated the solution. The filtrate was placed in a hot water bath to thicken it up to one-fourth of the actual amount. Then the concentrated NH<sub>4</sub>OH was added drop by drop for precipitation. The precipitates were collected and rinsed with NH<sub>4</sub>OH. Then it was allowed to filtration. Finally, the weight of dried alkaloid was taken and estimated by the following formula.

$$\% \text{ Crude Alkaloid} = \frac{\text{Weight of Crude Alkaloid}}{\text{Weight of sample}} \times 100$$

### **Saponin content**

About 5g of watermelon seed powder was added with 50 mL of 20% aqueous ethanol. The mixture was placed in a hot water bath for heating at 55°C for 4 h and filtrate the solution. The residual was turning out with 50 ml 20% ethanol solution. The concentration of extracts was decreased to about 10 ml by heating on hot water bath at 90°C. Then it takes into a separating funnel and mixed with 20 ml of diethyl ether and agitated the solution. The hydrous was restored when the ether layer was substituted. The clarification system was resolved by adding 15 ml of n-butanol and washed the n- butanol extracts were rinsed two times with 10 ml 5% NaCl. The residual mixture was placed on a water bath and allowed to dry to obtain a constant weight. Then, the saponin content was estimated as a percentage by using the following formula.

$$\% \text{ Saponin} = \frac{\text{Weight of Saponin}}{\text{Weight of sample}} \times 100$$

### **Determination of functional properties**

The water absorption capacity of the watermelon seed powder was determined (Phillips et al., 1988). The oil absorption capacity was evaluated according to the standard method (Sosulski, 1962; Njintang et al., 2001). The emulsion activity and stability were estimated (Naczka et al., 1985). The foam capacity and foam stability were determined by following the standard protocol (Coffmann and Garciaj, 1977).

#### **Water absorption capacity (WAC)**

Approximately 2g of seed powder (M<sub>0</sub>) was taken in Sorvall ST 8R centrifuge machine (Thermo Fisher Scientific, Germany) tube and added 20 mL distilled water and agitated for 30 min. Then the solution was placed on a hot water-bath at 37 °C for 30 minutes and it was centrifuged at 5000 rpm at 10 minutes. Then the obtained sediment (M<sub>2</sub>) was weighed, and it was allowed to dry at 105°C to constant weight (M<sub>1</sub>). The water absorption capacity was estimated by the following formula.

$$\% \text{ WAC} = \frac{M_2 - M_1}{M_1} \times 100$$

#### **Oil absorption capacity (OAC)**

About 1g of sample ( $M_0$ ) was mixed with 10 ml of soybean oil and agitated the mixture for 30 min., then centrifuged the mixture for 10 min at 4500 rpm and taken the weight of obtaining sediment ( $M_1$ ). The oil absorption capacity was determined by following formula.

$$\% \text{ OAC} = \frac{M_1 - M_0}{M_0} \times 100$$

#### **Emulsion activity (EA)**

About 3g of seed powder was mixed with 25 mL distilled water and blended for 30 s. Then 50 mL oil were added to it and allowed for homogenization. Then centrifuged the emulsion at 1500 rpm for 5 minutes and determined the emulsion layer. The emulsion activity was determined by the following formula.

$$\% \text{ EA} = \frac{\text{Height of emulsified layer}}{\text{Height of whole layer in centrifuge tube}} \times 100$$

#### **Emulsion stability (ES)**

The emulsion stability was determined after heating the emulsion contained in the calibrated centrifuged tube at 85 °C for 15 minutes in a water-bath, allowed to cool for few minutes and again centrifuged at 1500 rpm for 5 minutes. Emulsion activity was determined by the following formula.

$$\% \text{ ES} = \frac{\text{Height of remaining emulsified layer}}{\text{Original emulsion height}} \times 100$$

#### **Foam capacity and foam stability (FC and FS)**

Around 5g of seed powder sample was taken in a 250 mL cylinder. The volume of seed powder was recorded, and 100 ml of distilled water was mixed with the sample. Then, the mixture was shaken few minutes to obtain foam and recorded the foam volume and foam stability was estimated by recording the foam capacity at 10, 30 and 60 minutes intervals. The foam capacity and stability were evaluated by the following formula.

$$\% \text{ FC} = \frac{\text{Volume after homogenization} - \text{Volume before homogenization}}{\text{Volume before homogenization}} \times 100$$

$$\% \text{ FS} = \frac{\text{Volume after time (t)}}{\text{Initial foam volume}} \times 100$$

### Statistical analysis

All data obtained from the estimation of proximate composition, phytochemical compound and functional properties of watermelon seed powder were imported in Microsoft Excel 2007 spreadsheet for statistical analysis. Statistical data analysis was carried out by using IBM SPSS STATISTICS 25. Data were estimated for statistical significance by using the independent sample 't' test for the comparison of mean values, where n = 3 obtained from the triplicate test for each sample. The statistical data analysis was conducted at a 5% level of significance. All results were expressed as a mean  $\pm$  SD (Standard deviation).

## RESULTS AND DISCUSSION

### Proximate composition

The present research study evaluated the nutritional composition and functional properties of the Crimson red and Charleston gray varieties watermelon seed to attain a scientific basis for the potential use of watermelon seed in the formulation of food products, manufacturing of medicine and industrial purpose. In this study, the moisture content was found for the two varieties of watermelon seed as 3.65 % for Charleston gray and 3.71% for Crimson red (Table 1). The difference in moisture content between the two varieties was significant ( $p < 0.05$ ). This result was similar to that of studies reported by Mehra et al. (2015) and Egbunu (2015). This moisture content was lower than that reported by Akusu and Kiin-Kabari (2015); Tabiri et al. (2016); Hannah and Krishnakumari (2015) and Jacob et al. (2015) who found the moisture content range of 7.1 to 9.59%. The disparity observed in the result might be due to differences in varieties, drying process, and methods of analysis etc. Moisture content is considered an important factor for storage quality of product because high moisture facilitates the rapid growth of microorganism which ultimately spoils the product.

Table 1. Proximate composition of watermelon seed

Proximate Parameters (%)	Sample (Watermelon Seed)		P value
	Charleston gray	Crimson red	
Moisture	3.65 $\pm$ 0.01	3.71 $\pm$ 0.01	>0.05
Ash	2.61 $\pm$ 0.01	3.11 $\pm$ 0.01**	< 0.001
Crude Protein	22.51 $\pm$ 0.01	27.21 $\pm$ 0.01**	< 0.001
Crude Fat	30.65 $\pm$ 0.01	36.61 $\pm$ 0.01**	< 0.001
Fiber	29.85 $\pm$ 0.01	21.55 $\pm$ 0.01**	< 0.001
Carbohydrate	10.75 $\pm$ 0.01	7.85 $\pm$ 0.01**	< 0.001

\*\*P< 0.01

The ash contents were 2.61% for Charleston gray and 3.11 % for Crimson red (Table 1). This result showed that the ash content of the seed of Crimson red variety was found higher than the seed of Charleston gray. The result for ash content was consistent with the result reported by Egbuonu (2015); Tabiri et al. (2016); Jacob et al. (2015) and Akusu and Kiin-Kabari (2015) who found the moisture content range of 2.48 to 3.63% respectively.

The percentage of protein found in this analysis for the two varieties of watermelon seed was 22.51% for Charleston gray variety and 27.21% for the Crimson red variety. This analysis revealed that the Crimson red variety of watermelon seed contained a higher amount of protein than that of the Charleston gray variety. The protein percentage found in this study was compatible with that study reported by Akusu and Kiin-Kabari (2015) and Egbuonu (2015) who showed the protein percentage range of 21.46 to 25.33% and higher than that reported by Tabiri et al. (2016) and Mogotlane et al. (2018) who found the protein content range of 14.90 to 17.75% and lower than the result (34.22%) reported by Mehra et al. (2015). The distinction observed might be due to differences in variety, geographical location, method of analysis, etc.

The fat content of two varieties of watermelon seed was found 30.65% for the Charleston gray variety and 36.61% for the Crimson red variety. The result showed that both varieties of watermelon seed contained a high amount of fat or lipid but the fat content of the seed of crimson red variety was higher than Charleston gray variety. This result is consistent with Mogotlane et al. (2018) and Mehra et al. (2015). According to Mogotlane et al. (2018) and Mehra et al. (2015) the range fat content was 31.6 to 34.4% which was lower than the study result (45.66%) reported by Akusu and Kiin-Kabari (2015) and higher than the study result conducted by Tabiri et al. (2016) and Hannah and Krishnakumari (2015).

The fiber and carbohydrate contents were found in this analytical study for two varieties of watermelon seed were 29.85% of fiber and 10.75% of carbohydrate for Charleston gray variety and 21.55% of fiber and 7.85% of carbohydrate Crimson red variety. This study revealed that the seed of Charleston gray variety contained a higher amount of fiber and carbohydrate than the Crimson red variety. The result found for carbohydrate content is similar to that study reported by Akusu and Kiin-Kabari (2015), higher than that reported by Mogotlane et al. (2018) who showed the carbohydrate content range of 3.16 to 5.26% and lower than that studies reported by Mehra et al. (2015) and Egbuonu (2015) who revealed a range of 26.57 to 28.07 % of the carbohydrate content in watermelon seed flour. The fiber content obtained in this study was higher than that of analysed by Jacob et al. (2015); Akusu and Kiin-Kabari (2015) and Mehra et al. (2015) who reported a range of 0.1 to 6.4% of fiber content in watermelon seed.

The energy value found for the two varieties of watermelon seed as  $408.85 \pm 0.01$  Kcal/100g for the Charleston gray variety and  $469.60 \pm 0.01$  Kcal/100g for the

Crimson red variety (Figure 1). The result showed that the seed of the Crimson red variety contained a higher amount of energy than the seed of the Charleston gray variety. The energy value obtained in the present study was consistent with that study conducted by Hannah and Krishnakumari (2015) who found 465.68 Kcal /100 g for watermelon seed extract, lower than that analytical study reported by Egbuonu (2015); Mehra et al. (2015) who showed that a range of 531.15 to 574.58 kcal/ 100g energy value for watermelon seed and higher than the result reported by Tabiri et al. (2016) who found a range of 354.05 to 369.11 Kcal/ 100g. The disparity observed in the energy value of watermelon seed among the studies might be due to differences in varieties, geographical location, soil, method of analysis etc.

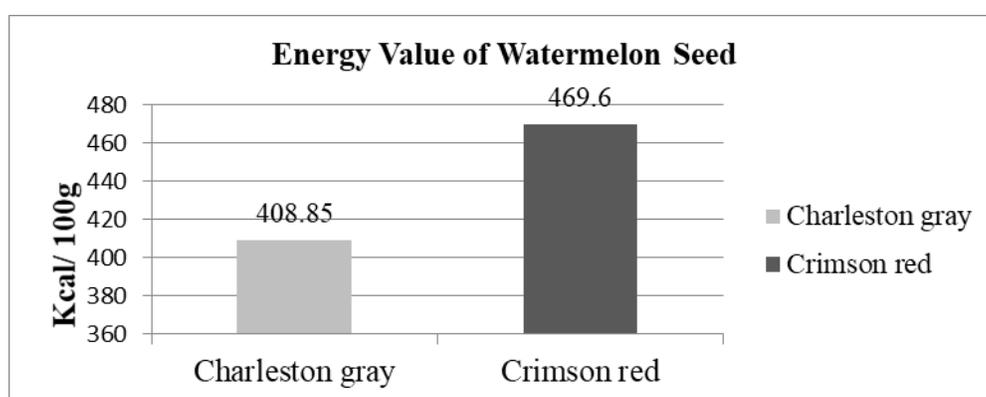


Figure 1. Comparison of energy value between seeds of two watermelon genotypes

#### Phytochemical compound

The crude alkaloid content in the seed of Crimson red variety was found higher ( $14.05 \pm 0.006$  %) than the seed of Charleston gray ( $10.56 \pm 0.006$  %) (Table 2). The saponin content (0.04%) was found the same in two varieties of watermelon seed. The difference in the value of the crude alkaloid content for the two varieties of seed was significant ( $p < 0.05$ ) and the value of saponin content was not significant ( $p > 0.05$ ). The result of this study was consistent with that study conducted by Mehra et al. (2015).

Table 2. Phytochemical compounds of watermelon seeds

Phytochemical compound (%)	Sample (Watermelon Seed)		P value
	Charleston gray	Crimson red	
Crude Alkaloid	10.56±0.006	14.05±0.006**	<0.001
Saponin	0.04±0.006	0.04±0.006	1.000

\*\* P&lt; 0.05

Table 3. Functional properties of two watermelon genotypes

Functional Parameter (%)	Sample (Watermelon Seed)		P value
	Charleston gray	Crimson red	
Water absorption capacity	133.33±0.01	120.33±0.01**	< 0.001
Oil absorption capacity	118.51±0.01	122.51±0.01**	< 0.001
Emulsion activity	23.31±0.01	21.41±0.01**	< 0.001
Emulsion stability	11.51±0.01	11.50±0.01	1.000
Foam capacity	4.61±0.01	6.31±0.01**	< 0.001
Foam stability	45.21±0.01	39.61±0.01**	< 0.001

\*\* P&lt; 0.05

### Functional properties

In the case of the Charleston gray seed the water absorption capacity (133.33±0.006 %), emulsion activity (23.31±0.006 %) and foaming stability (45.21±.006 %) were found higher than the Crimson red seed (Table 3). On the other hand, the oil absorption capacity (122.51±0.006 %) and foam capacity (6.31±0.006 %) were higher in Crimson red seed than Charleston gray seed variety (Table 3). The difference in the value of the functional properties for the two varieties of seed, aside emulsion stability was significant (p <0.05). The functional properties are the intrinsic factors that are important for food processing and storage. The result for functional properties was in contrast to the study reported by Egbunu (2015) and corresponded to that reported by Marie et al. (2015). The distinction observed might be due to differences in varieties of watermelon, agro-ecological condition, geographical location, climate, propagation method, method of analysis etc.

## CONCLUSION

The present study evaluated the nutritional, phytochemical and functional properties of two varieties of watermelon seed. The phytochemical compound analysis of the watermelon seed indicated that both varieties of seed contained a good amount of valuable phytochemical compounds such as crude alkaloid. The study result revealed that the two varieties of watermelon seed had good functional characteristics. This research study is an indication that the great potential opportunities for the utilization of the unutilized watermelon seed to develop as medicine, cosmetics, value-added product and dietary supplement instead of throwing them away as waste after consuming the fruit pulp.

## CONFLICT OF INTEREST

The authors have declared no conflict of interest.

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