Biological Forum – An International Journal **14(2a): 505-510(2022)**

ISSN No. (Print): 0975-1130
ISSN No. (Online): 2249-3239

Physico-chemical properties and Nutritional Composition of Watermelon (*Citrullus lanatus*) and its Rind Flour

Ashoka S.*, Shamshad Begum S. and K.G. Vijayalaxmi
Department of Food Science and Nutrition, University of Agricultural Sciences,
GKVK Bengaluru (Karnataka), India.

(Corresponding author: Ashoka S.)*
(Received 30 April 2022, Accepted 12 June, 2022)
(Published by Research Trend, Website: www.researchtrend.net)

ABSTRACT: Recently, it has taken a boom the use of fruit and vegetable waste to reduce environmental pollution. Inline, watermelon contains a large amount of polysaccharides, these carbohydrates might play an important role in the health benefits. The aim of this work was to evaluate proximate, chemical and nutritional profiles of freshly procured watermelon and its rind flour. The physical characteristics of the watermelon such as fruit weight, bulk density, length, breadth, TSS and pH were recorded. The watermelon had an average weight (4.49 kg), bulk density (1.03 g/ml), length (31.50 cm), breadth (24.56 cm), TSS (2.0°Brix) and pH (5.36) respectively. The dehydration parameters of the watermelon rind were also studied. The watermelon rind was dried at 60°C, up to 12 hours where the dehydration ratio was 5.6 per cent. The nutrient composition of dehydrated watermelon rind flour indicates that the moisture, carbohydrate, fat, protein, crude fibre and ash were 12.17 per cent, 46.02 g, 2.37 g, 10.18 g, 17.44 g and11.82 g respectively. The mineral composition of the rind flour was 254.25mg of calcium, 268.28mg of phosphorous, 345.48mg of magnesium and 12.76mg of iron respectively. Standardization of different processing methods helps to boost its nutritional value, increase the bioavailability of nutrients and may enhance sensory perception.

Keywords: Watermelon, Physico-chemical Properties, Proximate composition, minerals, rind, pulp, dehydration.

INTRODUCTION

Fruits and vegetables are perishable in nature and incur deterioration at various phases of their harvesting, handling, transit, storage, marketing, processing. The utilization of wastes of fruit and vegetable processing as a source of functional ingredients is a promising field (Schieber *et al*., 2001). The ruined produce is not fit for marketing and are a virtual loss. Some fruits do not find much compatibility for processing and are usually used for direct eating, one such fruit is watermelon (Bhatnagar, 1991).

Watermelon belongs *Cucurbitaceae* family member with a big, oval, round, or oblong shape. Watermelon cultivation has expanded greatly beyond the historically constrained riverbeds of the Yamuna, Ganges, and Narmada in the north, and Godavari, Krishnaand Kaveri in the south, due to inflation of demand for watermelon and its juice in both External (international) and internal (domestic) markets (Aguilo-Aguayo *et al.*, 2010). Half of a watermelon fruit is edible while the other half, consisting of about 35% rind and 15% peel goes to waste (US Department of Agriculture, 2004). Watermelon flesh ranges in colour from pink to red, with some fruits having yellow flesh as well. Sugar Baby, Improved Shipper, Arka Jyoti, Arka Manik, Kiran, Melody, and other varieties of watermelon fruits are primarily found in India. Watermelon is divided into three parts: the flesh, the seed, and the rind. The outer layer of the fruit is smooth and has dark or light green stripes which turns to pale yellowish green when ripe.

Watermelon has been considered favourite among the individuals during the hot, dry summer because of its cool, refreshing taste and appealing red colour. Iron, potassium, magnesium, and phosphorus, as well as other minerals and vitamins, are all abundant in watermelon. Besides vitamins (A, B, C and E), mineral salts (K, Mg, Ca and Fe), and specific amino acids (citrulline and arginine), watermelon provides a wide variety of dietary antioxidants such as carotenoids and phenolics (Perkins-Veazie *et al.*, 2002; 2007). Also, rind of the watermelon possesses a good amount of total phenol contents (0.248 mg/ml) and high free radical scavenging ability (hydroxyl radical scavenger) (Oseni and Okoye 2013). In addition, watermelon contained citrulline compound, which was non-essential amino acid first identified from the juice of watermelon. Citrulline is used in the nitric oxide system in humans and has potential antioxidant and vasodilatation roles (Rimando and Perkins-Veazie, 2005). Even though the watermelon rind is also edible and nutritious, when the juice has been extracted, the remaining rind, seeds, and peel are typically either composted or dumped in open spaces, which causes environmental issues.

Fruit waste, which consists primarily of core, seeds, pomace, and peels, contains a high concentration of water and is in a moist and highly fermentable state. If not further processed, these agrowastes produce odour, soil pollution, insect habitat, and can cause major environmental pollution (Shalini and Gupta 2010).

Physical properties of agricultural commodities are those morphological characteristics that, when studied, are relevant to the design and development of harvesting, handling, processing, and storage equipment for that specific commodity. Mass, size, form, surface area, volume, aspect ratio, sphericity, true density, bulk density, porosity, and angle of repose are among these properties. These characteristics are measurable and characterise the physical state of the materials at any specific point and circumstance. Sorting, grading, and other separation activities require mass, size, and shape. Bulk density, actual density, and porosity are all useful parameters in storage, transportation, and separation systems (Burubai and Amber 2014).

There is dearth of literature availability on physico-chemical properties and nutritional composition of watermelon. In order to explore the physical-chemical characteristics and nutritional composition of watermelon (*Citrullus lanatus*) and its rind flour, the current research was carried out.

MATERIALS AND METHODS

The present study on "Physico-chemical properties and nutritional composition of watermelon *(Citrullus lanatus)* and its rind flour" was carried out at the Department of Food Science and Nutrition, University of Agricultural Sciences, Bangalore during the year 2019.

A. Materials

Selection and Collection of Sample

The watermelon fruits were freshly procured from the neighbourhood market in Bangalore, Karnataka, India, when they were fully grown.

B. Methods

Physico-chemical properties of watermelon. An average of five fruits were chosen at random to represent all the fruits.The mature and ripened fruits of watermelon were used for analysing the physical properties such as weight, volume, length, breadth, width, bulk density, and circumference. The colour and shape of the selected fruitswas observed from its physical/visual appearance.

The digital balance was used to weigh five randomly chosen fruits; the average was then calculated and expressed in kilos (kg). The volume of five fruits was determined by water displacement method and the average was represented in millilitre (mL). Bulk density of the fruits was calculated by the readings of weight and volume of the fruits and the readings expressed in (g/ml). Length, Breadth, and Width of the watermelon were measured by placing fruit at resting position and by using the scale, the above components were estimated using proper methods and expressed in centimetres (cm). Length-wise circumference and width-wise circumference of the watermelon was measured by passing a thread around the lower, middle and upper part of the fruit. The average of the three measurements was then computed and represented in centimetres (cm).

Processing of watermelon. The watermelon melons were cleaned with a clean dry cloth after being thoroughly washed under gently running tap water. All of the watermelons were peeled separately using a peeler, the pulp was extracted from the rind with a knife, and the remaining seeds were separated by cutting the pulp into little cubes. Various sections of the fruit were depicted in (Fig. 1). Following the previous methods, the amounts of pulp, rind, seeds, and peel were recorded with a digital electronic balance and percentages determined.

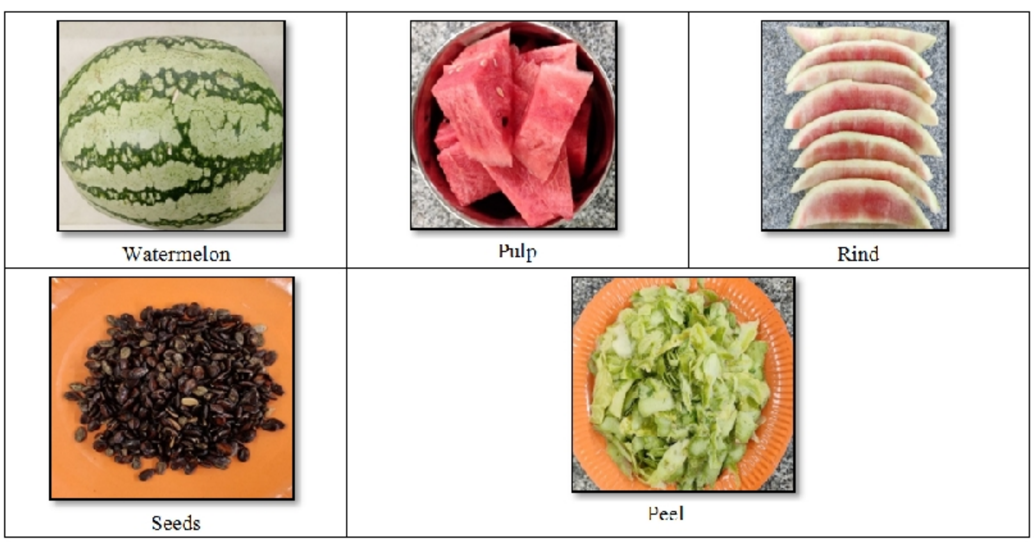

Fig. 1. Watermelon and its parts.

Total edible waste of watermelon. The fruits total edible waste was calculated using the following formula. The percent of edible waste was also calculated.

Total edible waste = Weight of seed + Weight of rind

$$\text{Edible waste generated (\%)} = \frac{\text{Weight of edible waste}}{\text{Weight of whole fruit}} \times 100$$

Total waste generated from watermelon

Total waste generated from watermelon fruits was calculated using the following formula and percentage was calculated.

Total waste generated = Weight of the peel + Seed + Rind

$$\text{Total waste generated (\%)} = \frac{\text{weight of the total waste}}{\text{weight of whole fruit}} \times 100$$

Pulp and rind ratio. The weight of the pulp and rind was taken separately. Then the pulp to rind ratio was calculated by using the following formula.

$$\text{Pulp to rind ratio} = \frac{\text{Weight of the pulp}}{\text{Weight of the rind}}$$

Dehydration of watermelon rind. The watermelon rind was weighed and dried at 60 °C until it dried completely (Fig. 2). Using an electric grinder, the dehydrated rind was ground into powder and sieved using a scientific sieve. The dried flour was then packed and used for another purpose.

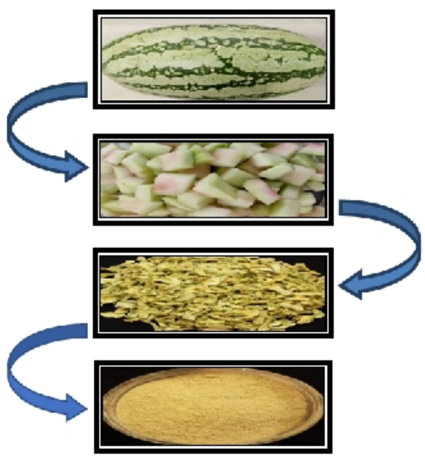

Fig. 2. Processing of watermelon rind flour.

Dehydration Ratio. Dehydrated samples were weighed and per cent dry matter was calculated (Ranganna 1986).

$$\text{Dehydration ratio} = \frac{\text{weight of dehydrated sample}}{\text{Weight of fresh sample}}$$

Chemical Parameters of watermelon rind. By using the oven drying method, the moisture content of fresh watermelon was identified. In order to get a constant weight as well as calculate percentages, the rind was dried in a hot air oven at a temperature of 60 °C. A hand refractometer was used to analyse the watermelon rind's Total Soluble Solids (TSS). A pocket pH metre was used to measure the pH of the watermelon rind (LMPH-10 Upgraded Model).

Proximate and mineral composition. The proximate composition of the watermelon rind flour samples was determined using standard AOAC methods. The watermelon rind flour moisture content was determined using oven drying method. Fat content was determined by Soxhlet extraction method (AOAC 1980). Protein content was determined by the micro Kjeldahl distillation method (AOAC). Crude fibre was analysed by acid and subsequent alkali treatment method (AOAC 1980). Ashing was completed in a muffle furnace (AOAC 1980). Carbohydrate content was calculated by the differential method. Energy also calculated by computation method and all results were expressed as % w/w, based on dry weight basis.

CHO (g/100g) = 100- [Protein(g) + Fat(g) + Fiber(g) + Ash(g) + Moisture(g)]

Energy (kcal) = [Protein (g) × 4] + [Carbohydrate (g) × 4] + [Fat (g) × 9].

Vitamin C (ascorbic acid) estimation was done by a titrimetric method using Iodate Solution (Ranganna, 1996).

The AOAC 1980 method was used to analyse the mineral composition. 5 ml of a 1:1 solution of distilled water and fuming HCl were added to the resulting ash. After drying the mixture over a water bath, another 5 ml of the solution was added. The crucible was removed at this stage and its contents were filtered using Whatman No. 1 filter paper into a ml volumetric flask and diluted. It was then heated further over the water bath until it began to fume. The crucible and filter paper were thoroughly rinsed before the volume was filled with distilled water to the appropriate level. For the estimate of all the minerals in this investigation, aliquots of this mineral solution were obtained.

By titrating against a standard (EDTA) until the colour changes from pink to violet, the calcium was calculated (AOAC 1980). By titrating against a standard (EDTA) until the colour changes from pink to blue, the amount of magnesium was calculated (AOAC 1980). By measuring calorimetrically, the blue colour that results from the ash solution's treatment with ammonium molybdate, which reduces the amount of phosphomolybdate that forms, phosphorus was estimated (AOAC 1980). Using an atomic absorption spectrophotometer, the iron content of the sample was calculated, and the results are given in milligrams per 100 grammes of the sample (AOAC 1980).

RESULTS AND DISCUSSIONS:

A. Physico-chemical Properties of watermelon rind

The physical characteristics of the watermelon such as fruit weight, volume, bulk density, length, breadth, and circumference were recorded and indicated in Table 1. The average weight of the whole watermelon was around 4.49 kg, whereas volume, bulk density, length, and breadth were 4625 ml, 1.03 g/ml, 31.50 cm and 24.56 cm, respectively. The other physical properties like length-wise and width-wise circumference were 71.96 cm and 53.36 cm respectively.

The weight, length, breadth, and length-wise circumference of watermelon in this study indicated that it had higher values than the study reported by

Deepa, (2015) which was 3.34 kg, 23.38 cm, 17.93 cm and 62.02 cm respectively whereas width-wise circumference was about 54.92 cm which is higher than the present study respectively. Similar results are observed for the weight of the fruit reported by El-Badry *et al.* (2014). The pulp, seeds, peel, and rind are the four basic components of a watermelon that make up its biomass. Approximate percentages of the fruit's weight that were made up of the pulp, seeds, peel and rind were 66.16 %, 1.04 %, 3.35 %, and 29.43 percent, respectively (Fig. 3).

It was found that the total amount of waste generated from fresh cut watermelon was around 33.38 percent it includes the weight of the peel, rind, and seeds. Out of this 33.38 per cent of total waste, the edible waste generated was about 30.48 percent it contains the weight of the seeds and weight of the rind (Fig. 4). Similar results are observed by the study El-Badry *et al.* (2014). The pulp to rind ratio was 2.23. Almost similar results were reported by Kumar (1985); Deepa (2015) wherein the weight of the pulp, seeds, and rind and the results revealed that 68 %, 2 %, 30 % and 60.18 %, 2.10 % and 29.94 % of the total weight of the fruit respectively. The seeds and rind weight were lower and rind weight was varying compared to the above-mentioned studies it might be due to different size and variety of the fruit as well.

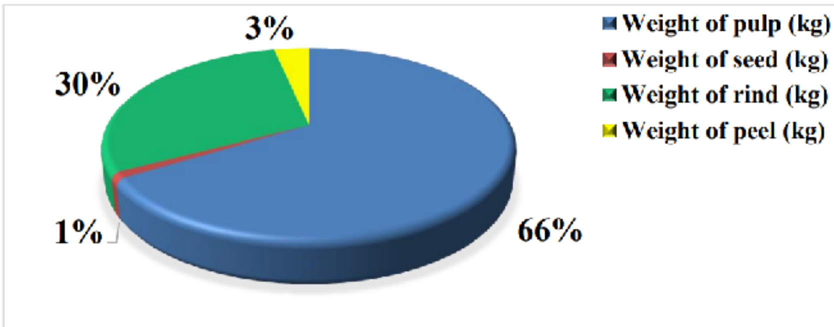

Fig. 3. Per cent composition of parts of watermelon.

Table 1: Physico-chemical properties of watermelon.

Particulars	Mean
Watermelon	
Weight (kg)	4.49
Volume (ml)	4625
Bulk density (g/ml)	1.03
Length (cm)	31.50
Breadth (cm)	24.56
Lengthwise circumference (cm)	71.96
Widthwise circumference (cm)	53.36
Pulp to rind ratio	2.23
Moisture (%)	94.40
Rind	
pH	5.36
TSS (Brix)	2.00

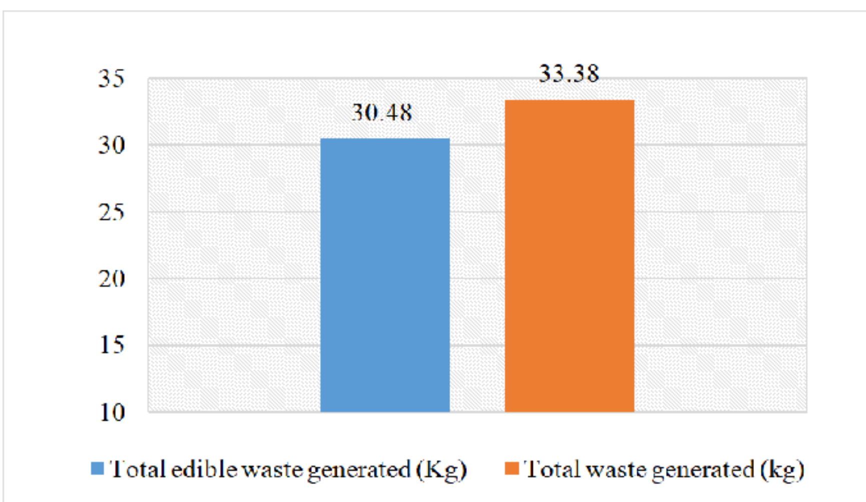

Fig. 4. Per cent of waste generated from watermelon.

It was observed that the chemical properties like moisture, pH, and TSS of the rind were found to be 94.40, 5.36 and 2.00 respectively. The results were on

B. Processing of watermelon

Dehydration

The dehydration parameters of the watermelon rind were indicated in Table 2. The rind was subjected to dehydration in an oven at 60°C up to 12 hours. It was observed that there is high moisture loss and the dehydrated ratio was found to be 5.59.

C. Proximate composition of watermelon rind flour

The proximates like protein, fat, crude fibre, total ash, carbohydrates, ascorbic acid, and minerals were analysed and the results are presented in Table 3.

The nutrient composition of watermelon rind flour has a moisture 12.17 per cent, protein 10.18 g, fat 2.37 g, crude fibre 17.44 g, ash 11.82 g and carbohydrates 46.02 g respectively. Ascorbic acid was found to be 10.25 mg. The mineral composition of the rind flour

par with the study conducted by Deepa (2015) reported that chemical parameters of watermelon rind pH and TSS was 4.71 and 3.02 respectively.

was found to be 254.25 mg of calcium, 268.28 mg of phosphorous, 345.48 mg of magnesium and 12.76 mg of iron respectively. The moisture content of watermelon rind flour of the present study was found higher than the results reported by Hoque and Iqbal (2015) as 10.72 %, the other proximate such as protein, fat, ash and carbohydrates were lower than with values being 11.21 %, 2.38 %, 12.61 %, and 73.18 % respectively. Also, the present results are in line with the study conducted by Badr (2015); Hassan *et al.* (2017).

However, the moisture, ash, fat, protein crude fibre and carbohydrates of watermelon rind flour were 10.61 %, 13.09 %, 2.44 %, 11.17 %, 17.28 %, and 56.02 % as per Al-Sayed and Ahmed, (2013) which is almost similar to the present study.

Table 2: Drying parameters of watermelon rind.

Parameters	Values
Drying duration (hr)	12
Temperature of drying (°C)	60
Weight before drying (g)	100
Weight after drying (g)	5.59
Dehydration ratio	5.59

Table 3: Proximate and mineral composition of watermelon rind flour (Per 100g).

Nutrients	Watermelon rind flour
Moisture (%)	12.17
Protein (g)	10.18
Fat (g)	2.37
Crude fibre (g)	17.44
Ash (g)	11.82
Carbohydrates (g)	46.02
Ascorbic acid (mg)	10.25
Calcium (mg)	254.25
Phosphorus (mg)	268.28
Magnesium (mg)	345.48
Iron (mg)	12.76

El-Badry *et al*. (2014) studied the nutritional composition of watermelon rind flour and the results revealed that it had 11.25 % moisture, 8.70 % protein, 2.21 % fat, 12.93 % ash, 16.8 % crude fibre and 76.16 % carbohydrates, whereas minerals such as calcium, phosphorus, magnesium, and iron which was found to be 276.22 mg, 273.28 mg, 346.61 mg, and 13.5 mg respectively. The observed minerals of this study were slightly lower than El-Badry *et al*. (2014) which might be due to a difference in a variety of fruit, drying condition and climatic conditions.

CONCLUSION

It can be concluded that watermelon rind is a rich source of ascorbic acid and other nutrients like fibre, protein, calcium, iron, phosphorous etc., therefore it can be utilised in the form of value-added products. Also, utilisation of watermelon rind helps in minimizing the environmental pollution.

FUTURE SCOPE

In the present scenario, different approaches are using for the utilization of these wastes because these by-products are an excellent source of various bioactive components such as polyphenols, flavonoids, citrulline, carotenoids, *etc*. Hence, it could be recommended that usage of watermelon rind and its flour in food processing to produce value added food products contained nutritional and bioactive compounds which having a numerous health benefits.

Acknowledgement. The facilities provided by the Dean PGs, UASB, GKVK, Bengaluru, for the conduct of this research program are acknowledged by the authors. Ashoka S, the first author, would like to express my sincere gratitude to my mentor Shamshad Begum S and the members of my advisory

committee for their thorough direction, passionate encouragement, and helpful criticism of this research work.

Conflict of interest. None.

REFERENCES

Aguilo-Aguayo, I., Montero-Calderon, M., Soliva-Fortuny, R. and Martin-Belloso, O. (2010). Changes on flavor compounds throughout cold storage of watermelon juice processed by high-intensity pulsed electric fields or heat. *Journal of Food Engineering*, *100*(1): 43-49.

Al-Sayed, H. M. A. and Ahmed, A. R. (2013). Utilization of watermelon rinds and sharlyn melon peels as a natural source of dietary fiber and antioxidants in cake. *Annals of Agricultural Science*, *58*(1): 83-95.

AOAC (1980). Official methods of analysis. 13th edition. Association of Official Analytical Chemists, Washington DC.

Badr, S. A. (2015). Quality and antioxidant properties of pan bread enriched with watermelon rind powder. *Current Science International*, *4*(1): 117-126.

Bhatnagar, D. K. (1991). Utilization of watermelon rind for jam making. *Indian Food Packer*, *45*(1): 46-48.

Burubai, W. and Amber, B. (2014). Some physical properties and proximate composition of Ipoli fruits. *Journal of Food Processing and Technology*, *5*(7).

Deepa Madalageri, M. (2015). Bio-waste of fruits: a potentialsource of nutraceuticals for health and nutrition security. Ph.D. Thesis. Univ. Agric. Sci., Dharwad.

El-Badry, N., El-Waseif, M. A., Badr, S. A., and Ali, H. E. (2014). Effect of addition watermelon rind powder on the rheological, physiochemical and sensory quality attributes of pan bread. *Middle East Journal of Applied Sciences*, *4*(4): 1051-1046.

Hassan, N. S., Mahmoud, A. H. and El-Kholan, E.A. (2017). Quality enhancing of cake using white watermelon rinds. *Egyptian Journal of Agricultural Research*, *95*(4): 1653-1667.

Hoque, M. M. and Iqbal, A. (2015). Drying of watermelon rind and development of cakes from rind powder. *International journal of novel research in life sciences*, *2*(1): 14-21.

Kumar, P. (1985). Watermelon- utilization of peel waste for pickle processing. *Ind. Food Packer*, *39*(4): 49-52.

Oseni, O. A. and Okoye, V. I. (2013). Studies of Phytochemical and Antioxidant properties of the fruit of watermelon (Citrullus lanatus) (Thunb.). *J. Pharm. Biomed. Sci*, *27*(27): 508-514.

Perkins-Veazie, P., Collins, J. K., Clevidence, B., and Wu, G. (2007). Watermelons and health. *Acta Horticulturae*, *731*, 121.

Perkins-Veazie, P., Maness, N. and Roduner, R. (2002). Composition of orange, yellow, and red-fleshed watermelons. In *Cucurbitaceae* (pp. 436-440). ASHS Press, Alexandria, VA, USA.

Ranganna, S. (1986). Handbook of analysis and quality control for fruits andvegetable products. 2nd Edn. Tata McGraw-Hill, Pub. Co. Ltd., New Delhi, pp.84-86.

Rimando, A. M. and Perkins-Veazie, P. M. (2005). Determination of citrulline in watermelon rind. *Journal of Chromatography A*, *1078*(1-2): 196-200.

Schieber, A., Stintzing, F. C., and Carle, R. (2001). By-products of plant food processing as a source of functional compounds—recent developments. *Trends in Food Science & Technology*, *12*(11): 401-413.

Shalini, R. and Gupta, D. K. (2010). Utilization of pomace from apple processing industries: a review. *Journal of Food Science and Technology*, *47*(4): 365-371.

US Department of Agriculture (2004). Agricultural Research Service, USDA National Nutrient Database for Standard Reference, Release 17, Nutrient Data Laboratory Home Page, http:// www. nal. Usda .gov /fnic /foodcomp.

How to cite this article: Ashoka S., Shamshad Begum S. and K.G. Vijayalaxmi (2022). Physico-chemical properties and Nutritional Composition of Watermelon *(Citrullus lanatus)* and its Rind Flour. *Biological Forum – An International Journal*, *14*(3): 505-510.