Nutritional composition of different varieties of watermelon (*Citrullus lanatus*) fruit at Mille, Northeastern Ethiopia

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**ABSTRACT**

Watermelons belong to the family *Cucurbitaceae*. The plant has fruits and grows on vines and on the ground like cantaloupe, pumpkin. Fruit with good antioxidant properties used to prevent non-communicable diseases (NCDs). However there is knowledge gap in nutritional composition and antioxidant activity of watermelon fruits in our context. Four varieties of watermelon grown in Mille, Ethiopia were studied for their proximate composition, mineral content and total phenolic content (TPC). Results found for proximate composition of varieties watermelon flesh and seed part ranged as follows: Protein; 0.397 – 0.657% (flesh) and 19.87 – 24.60% (seed), Fat; 0.074 – 0.105% (flesh) and 23.35 – 25.25% (seed), Ash; 1.72 – 1.989% (flesh) and 2.4 – 2.6% (seed), Fiber; 0.127 – 0.213 (flesh) and 28.66 – 34.35% (seed), Moisture; 91 – 95% (flesh) and 2.7 – 4.55% (seed), Carbohydrate; 2.122 – 0.016% (flesh) and 10.66 – 20.3% (seed), Kcal; 11.715 – 28.633% (flesh) and 360.55 – 375.21% (seed). The mineral content of *Citrullus lanatus* fruit, for Fe ranged between 0.8 - 3.143 and 2.454 – 4.919 mg/100 gm (in flesh and seed), for Zn 0.057 – 0.144 and 3.223 – 4.476 mg/100 gm (in flesh and seed), for Ca 5.625 – 7.771 and 11.922 – 33.326 mg/100 gm (in flesh and seed), for P 10.826 – 19.037 and 375.90 – 476.96 mg/100 gm (in flesh and seed), for Na 6.15 – 11.58 and 3.87 – 11.96 mg/100 gm (in flesh and seed) and for K 96.55 – 111.01 and 708.66 – 1036.68 mg/100 gm (in flesh and seed) was found. This finding showed that there is significance difference in nutritional composition of fruit, flesh and seed part of watermelon in the sample varieties.

**Key word:** Fruit, mineral content, nutrient, watermelon flesh, watermelon seed, watermelon varieties

**INTRODUCTION**

Watermelon (*Citrullus lanatus* (Thunb) Matsum and Nakai) is a sweet and juicy fruity horticultural crop (Duduyemi et al., 2013). It account for 5.4% of the harvested area devoted to vegetable production in 2008 in Africa and this contributed about 4.6% the world watermelon production 99,194,223 tonnes (Gichimu et al., 2008). Many research reports showed that, watermelon is very rich in micronutrients and lycopene and red carotenoid pigment which acts as antioxidant during normal metabolism (Koocheki et al., 2007). A cup of watermelon provides 24.3% vitamin C and 11.1% vitamin A of the daily requirement (Nagal et al., 2012). Due to its antioxidant properties; lycopene helps cells and other structures in the body to protect from oxygen damage and prevent heart disease (Erukainure et al., 2010). The antioxidant property of watermelon helps in prevention of non-communicable diseases (NCD). According to World Health Organization, 34% of death in Ethiopia is due to cardiovascular disease, cancer and pulmonary disease. The estimated prevalence of disease is 15%, 4%, 4% and 2% for cardiovascular disease, cancer, pulmonary disease and diabetes mellitus respectively (Misganaw et al., 2014).
One of the causes of non-communicable diseases is lack of appropriate dietary intake. Improvement of dietary condition, focusing on use of fruits and vegetables that have good antioxidant properties and nutritional composition is the main strategies in prevention of NCD. There is little information about the nutritional and anti-nutritional composition as well as the antioxidant properties of different varieties fruit of the different varieties of watermelon produced in Ethiopia (Erukainure et al., 2010). Cancer, chronic respiratory diseases and cardiovascular diseases (CVD) are among the major health problem in the world and they are non-communicable diseases (NCDs). The contribution of this disease to mortality and morbidity is projected to increase tremendously by the year 2030. Unhealthy diets, tobacco use, harmful use of alcohol, exposure to environmental carcinogens and physical inactivity are mentioned to be the major causes of NCDs. Incidences of NCD are rising in Ethiopia; this is attributed to regular consumption of processed food, refined food, white sugar, flour and junk food. The objective of this study is to determine the level of nutritional compositions of four varieties of watermelon fruit (Misganaw et al., 2014).

MATERIALS AND METHODS

Description of the study area

The experiment was conducted at Mille Werer Agricultural Technical and Vocational Training College demonstration site, Afar regional state. It is located in Mille district at 10°10' N latitude, 40°32' E longitude, and 356 km North East from Addis Ababa. The altitude of the study area is about 626 meters above sea levels. The experimental area average annual rainfall of about 400 mm and characterized as a semi-arid climatic zone. The mean annual temperature of the experimental site is about 30°C with 39°C maximum and 22.5°C minimum.

Analysis of nutritional composition

Sample preparation

Fruits of different watermelon local varieties were washed and dried in oven at 105°C for one hour and transferred to the desiccator to cool for 30 min. Weights of empty crucible were measured (W1). The samples were mixed and five gram of each sample were transferred to the dried and weighed crucible (W2) and dried at 105°C for 3 hrs. After drying, it is kept in a desiccator to cool to room temperature and it is again weighed (W3). Drying for 30 min of the sample and cooling was repeated for two or more times until a constant weight was obtained.

Moisture content in percent (%) = W2-W3 x 100%
W2-W1

Crude protein analysis

Protein was determined by kjeldhal method. All nitrogen is converted to ammonia by digestion. The ammonia released after alkalization with sodium hydroxide is steam distilled into boric acid and titrated with hydrochloric acid.

Digestion

The samples weigh 0.5 g was taken in flask tube and 6 ml of concentrated sulfuric acid was added and mixed. Then 3.5 ml of 30% hydrogen per oxide were added into digestion flask. The flask was shaken and observing violet reaction. As soon as the violet reaction had ceased, three gram of catalyst (0.5 g) of copper sulfate with 100 g of potassium sulfate) was added into each flask tube. When the temperature of digester reached 370°C, the flask tubes were placed into the digester and the digestion was continued until a clear solution was obtained about 3 to 4 hrs. The flask tubes in the rack were then transferred into hood for cooling. The content in flask tube was diluted with distilled water and shaken to avoid precipitation of sulfate in the solution.

Distillation

A 25 ml of 40% sodium hydroxide solution was added into the solution. A 250 ml conical flask contacting 25 ml of boric acid, 25 ml of distilled water and indicator solution was placed under the condenser of the distiller with its tip immersed into the solution. The distillation was continuing until a total volume become between 200 and 250 ml. The tip also rinsed with a few ml of water before the receiver is removed.

Titration

The distilled solution was then titrated with 0.1N hydrochloric acid to a reddish color.

Nitrogen (%) = VHCl in L × N HCl ×14 ×100
Crude fat content determination

Extraction cylinder were cleaned with hot water, dried in drying oven at 70°C for one hour and cooled in desiccator for 30 min and weighed. The bottom of the extraction thimble was covered with thinly layer of fat free cotton. Two gram of sample were weighed and transferred into extraction thimble and then the thimble was covered with cotton. The thimbles with the samples content were placed into soxhlet extraction chamber. 50 ml of petrolatum ether was added to the extraction flask through condenser. The extraction was conducted for 4 hrs, after that the extraction flask with their content were removed from the extraction chamber and placed in drying oven at 70°C for about 1 hr, and cooled in the desiccator for about 30 min and weighed.

\[
\% \text{ Fat content } = \frac{W_2 - W_3}{W} \\
\]

Where: 
- \( W_1 \) = Weigh of the extraction flask (g)
- \( W_2 \) = weight of the extraction flask plus the dried crude fat (g)
- \( W \) = Weigh of sample (g)

Ash content determination

Porcelain dishes used for the analysis were placed into a muffle furnace for 30 min at 550°C. The dishes were removed and cooled in desiccators for 30 min, and the dished was weighed. Weighed 2.5 g sample was added into each dish. The dishes that contain the sample were placed on a hotplate under a fume hood and the temperature was slowly increased until smoking ceased and the samples become thoroughly charred. Then the dishes were placed inside the muffle furnace at 550°C for 5 hrs. After that it was removed from the muffle furnace and allowed to cool in desiccator and weighed. The amount of total ash was calculated by using the following formula:

\[
\text{Total ash } (\%) = \frac{M_3 - M_1}{M_2 - M_1} \\
\]

Where, 
- \( M_1 \) = Mass of crucible
- \( M_2 \) = Mass of sample with crucible
- \( M_3 \) = Final mass of sample with crucible

Carbohydrate value

The available carbohydrate identify by the difference as

\[
100 - (\text{moisture } + \text{ protein } + \text{ fat } + \text{ ash } + \text{ total dietary fiber}) \\
\] The total energy content in each sample was calculated as follows:

\[
\text{Total energy } (\%) = (9 \times \text{crude fat} + 4 \times \text{crude protein} + 4 \times \text{utilizable carbohydrate}) \\
\]

Mineral analysis

Crucibles and glass wares were washed with 10% nitric acid and placed in oven at 105°C for an hour. Crucibles were cooled in desiccators for 30 min. Each four sample weighing 2.5 g were transferred to the crucible and charred on hot plate until the smoke ceased to appear. The samples were then ashed in muffle furnace which was maintained at 550°C for 5 hrs. The ash was later taken out from the furnace and cooled in desiccators and weighted. Some drops of deionized water were added to the ash and evaporated on hot plate. Some drops of concentrated nitric acid were added and evaporated again using hot plate and ashed once more for 30 min to ensure its complete ashing. The ash was suspended in 7 ml of 6N Hcl and subsequently dried using lower temperature hot plate. Then, 15 ml of 3N Hcl was added into the ash, heated on hot plate until the solution boils, cooled and filtered through filter paper into 50 ml graduated flask. Again, 10 ml of 3N Hcl was transferred to the crucible and heated until the solution boils, cooled and filtered into graduating flask. Crucibles were washed with deionized water three times and the solution was filtered in to a flask. The filter paper was thoroughly washed with deionized water and the solution was collected in to the flask. Lanthanum chloride solution (2.5 ml) was added per 50 ml of solution. Finally, the contents of the flask was diluted and marked to 50 ml with deionized water. The sample solutions were transferred to the urine cap bottle. The blank was prepared by taking the same amount of reagents following the same procedure. Mineral content was determined using the following formula. Finally, Fe, Zn, Ca, P, Na and K content were determined by using this formula:

\[
\text{Metal content in mg/100g of = } \frac{(C_S - C_b) \times V}{(10 \times W)} \\
\]

Where, \( C_S \) = Concentration of sample in ppm
- \( C_b \) = Concentration of blank in ppm
- \( V \) = Volume (ml) of the extract
- \( W \) = Weight (g) of sample

RESULT AND DISCUSSION

Flesh and seed part of four varieties Citrullus lanatus fruit were used for mineral contents and nutrient composition were determined in different methods was used for mineral contents and nutrient composition determination. The findings are presented as follow:
Table 1: Description of four different watermelon varieties.

<table>
<thead>
<tr>
<th>Local Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lahat</td>
<td>Seeded fruit type, open field growing system, grayish with green strips of fruit skin color, deep red flesh color, olong in fruit shape</td>
</tr>
<tr>
<td>Augusta</td>
<td>Seeded fruit type, open field growing system, deep green of fruit skin color, carmine rose or reddish pink flesh color, spherical in fruit shape</td>
</tr>
<tr>
<td>Ria</td>
<td>Seeded fruit type, open field growing system, light green with dark green strips of fruit skin color, red flesh color, oval in fruit shape</td>
</tr>
<tr>
<td>Candy</td>
<td>Seeded fruit type, open field growing system, grayish white of fruit skin color, red flesh color, round in fruit shape</td>
</tr>
</tbody>
</table>

Source: Ministry of Agriculture, Ethiopia (2017)

Table 2: Proximate composition of flesh part of watermelon fruit (%).

<table>
<thead>
<tr>
<th>Sample type</th>
<th>Moisture</th>
<th>Protein</th>
<th>Fat</th>
<th>Ash</th>
<th>Fiber</th>
<th>CHO</th>
<th>Kcal.</th>
</tr>
</thead>
<tbody>
<tr>
<td>CF</td>
<td>92± 0.00a</td>
<td>0.54±0.19b</td>
<td>0.03±0.00a</td>
<td>1.82±0.043b</td>
<td>0.15± 0.007b</td>
<td>5.43±0.062c</td>
<td>24.28±0.175c</td>
</tr>
<tr>
<td>AF</td>
<td>94± 0.01b</td>
<td>0.39±0.10a</td>
<td>0.07±0.00b</td>
<td>1.81±0.036b</td>
<td>0.12± 0.007a</td>
<td>3.58±0.046b</td>
<td>16.60±0.144b</td>
</tr>
<tr>
<td>LF</td>
<td>95± 0.00b</td>
<td>0.57±0.00b</td>
<td>0.10±0.00d</td>
<td>1.98±0.014c</td>
<td>0.21± 0.001d</td>
<td>2.12±0.016a</td>
<td>11.71±0.060a</td>
</tr>
<tr>
<td>RF</td>
<td>91± 0.00a</td>
<td>0.65±0.14c</td>
<td>0.09±0.00c</td>
<td>1.72±0.027a</td>
<td>0.20± 0.001c</td>
<td>6.32±0.019d</td>
<td>28.63±0.961d</td>
</tr>
</tbody>
</table>

CF- Candy flesh, AF-Augusta flesh, LF-Lahat flesh, RF-Ria flesh

Data are average of triplicate ± SE. Mean value with different superscript in the column are significantly different (p<0.005). The result is reported on wet basis.

Ethno botany of watermelon

Four different watermelon varieties were identified in agricultural fields. Name and morphological characters of the four varieties are described in Table 1.

Proximate composition of watermelon fruit (flesh and seed part)

The mean value for moisture, crude protein, crude fat, total ash, carbohydrate and total energy calorie value of flesh and seed part of four local varieties of watermelon are presented in Tables 2 and 3.

Proximate composition of flesh part of watermelon fruit

Moisture content

The mean values moisture content of the four varieties of watermelon is presented in Table 2. It ranged from 91 to 94%. The highest and lowest moisture content was found in flesh of Augusta and Lahat fruit respectively. The moisture content of Candy (92) and Ria (93) were significantly lower than Augusta (94) and Lahat (95) of flesh part watermelon fruit at (p<0.005). Shofian et al. (2011) and Shahzad et al. (2014) indicated that the moisture content of watermelon fruit was 92.47% and 90.95% respectively, which is comparable with this study.

Crude protein content

In Table 2, the protein content of the local four varieties is also presented. The highest and lowest protein content was found in Ria and Augusta respectively. The protein content of watermelon varieties were range from 0.39% to 0.65%. The crude protein content of Augusta was significantly (p<0.005) lower when compared with Ria flesh. However, Candy and Lahat flesh was significantly higher than Augusta flesh but lower than Ria flesh at (p<0.005). These finding are in conformity with the study of Fila et al. (2013) that reported the crude protein content watermelon of fruit as 0.44%.

Crude fat content

The results of crude fat content of watermelon varieties flesh part are presented in Table 2. Crude fat contents of the varieties ranged between 0.038% in Candy to 0.105% of Lahat fruit flesh. There is significant difference in crude fat content among the four varieties. The result of Lahat and Ria flesh has a similarity with the study of Inuwa et al. (2011) which indicated 0.1% to 0.15% fat content of watermelon.

Ash content

The ash content of a biological material is the inorganic residue that remains after organic matter has been burnt.
The ash content of the watermelon fruits flesh ranges from 1.72% in Ria to 1.98% Lahat fruit flesh. There is no significant difference between Candy flesh and Augusta flesh in their ash content, but they have higher significance difference with Lahat flesh but lower significance with Ria flesh. As Sharma et al. (2013) indicated, the ash value of some Nigerian fruit ranges from 0.3%-2.5%, watermelon flesh have the highest ash value (2.5%) than those Nigerian fruit that is related with this study. Fruit with high percentages of ash contents are expected to contain high concentrations of various mineral elements, which are expected to speed up metabolic processes and improve growth and development (Sharma et al., 2013).

Crude fiber content

The results showed the crude fiber content of the four watermelon local varieties. The finding fruit of the varieties contain crude fiber ranging 0.12% in Augusta to 0.21% in Lahat fruit flesh. When comparing the varieties, there is significant difference (p< 0.005) among them. The results are comparable with previous studies Inuwa et al. (2011) indicated that crude fiber content range from 0.3 to 0.4 % and Ramulu and Rao (2003) indicated 0.2%.

Carbohydrate content

The present study showed that there is significant difference (p<0.005) in the level of carbohydrates among fruit flesh of the four local watermelon varieties. The carbohydrate content ranges from 2.12% in Lahat to 6.32% in Ria fruit flesh as shown in Table 3. The result of this study showed that there is significant difference (p<0.005) among the four varieties. The results are relatively similar with 7.19% and 4% to 5% that was reported by Fila et al. (2013) and Inuwa et al. (2011) respectively.

Total energy

The caloric values of the fruit flesh from the four local varieties presented in Table 2. They range from 11.71% in Lahat to 28.63% in Ria fruit flesh. The total energy values are significantly different among each other. The study finding revealed that fruits are poor sources of energy. Significant difference in caloric values of fruit flesh could be attributed to varietal differences. The values of proximate composition of flesh part of Citrullus lanatus, that is moisture, crude fiber, ash, fat and protein agrees with the findings of Potter and Hotchkiss, (1997) and Suchankova et al. (2015) that worked on nutrient components of food, reported a range value of fiber 0.1 g - 6.8 g for fruits. Fruits are not very good sources of fat as reported by Fila et al. (2013). Kyureghian (2010) also reported that nitrogenous content of fruits is low (0.4 g – 0.6 g) as compared to seeds, leaves and some other plants parts. The carbohydrate content of the fruits is low (7.50% to 18.60%) that was reported by Sharma et al. (2013). Fruit with low carbohydrate content might be ideal for diabetic and hypertensive patients who require it for low sugar diets.

Proximate composition of seed part of watermelon fruit

The moisture content of seed of four local varieties of watermelon is presented in Table 3. The value of moisture content of the seed decreased in the order of Ria (4.55)> Augusta (4.20)>Lahat (3.00)> Candy (2.70). There is significant difference (p<0.05) between the varieties of seeds. The moisture content of watermelon seed that was reported by other studies, Lakshmi and Kaul (2011) and Oyeleke et al. (2012) was 4.86% and 6.9% respectively. The protein content of watermelon seed was higher than that found in most legumes as reported by Omobolanle et al. (2014) and the protein quantity meets the daily requirement for adults. The protein content of watermelon seed was indicated (Table 3). Lahat has higher protein than Candy and Augusta but lower than Ria seed. Studies have shown that the fat in watermelon is more of monounsaturated, polyunsaturated and omega-6 fatty acids. The monounsaturated and polyunsaturated fatty acids help reduce blood cholesterol while the omega-6 reduces the risk of heart disease and type 2 diabetes (Gichimu et al., 2008). The fat content obtained in the

<table>
<thead>
<tr>
<th>Sample type</th>
<th>Moisture (%)</th>
<th>Protein (%)</th>
<th>Fat (%)</th>
<th>Ash (%)</th>
<th>Fiber (%)</th>
<th>CHO</th>
<th>Kcal</th>
</tr>
</thead>
<tbody>
<tr>
<td>CS</td>
<td>2.70±0.141a</td>
<td>19.87±0.176a</td>
<td>23.75±0.353a</td>
<td>2.5±0.141a</td>
<td>34.35±0.056d</td>
<td>16.82±0.016c</td>
<td>360.55±0.031a</td>
</tr>
<tr>
<td>AS</td>
<td>4.20±0.000c</td>
<td>21.19±0.000b</td>
<td>23.25±0.353a</td>
<td>2.4±0.000a</td>
<td>38.66±0.042a</td>
<td>20.30±0.031d</td>
<td>375.21±0.019b</td>
</tr>
<tr>
<td>LS</td>
<td>3.00±0.141b</td>
<td>23.60±0.141c</td>
<td>23.75±0.353a</td>
<td>2.6±0.282a</td>
<td>33.45±0.233c</td>
<td>13.59±0.030b</td>
<td>362.53±0.014a</td>
</tr>
<tr>
<td>RS</td>
<td>4.55±0.070d</td>
<td>24.60±0.141d</td>
<td>25.25±0.353b</td>
<td>2.5±0.141a</td>
<td>32.43±0.035b</td>
<td>10.66±0.060a</td>
<td>366.03±0.018a</td>
</tr>
</tbody>
</table>

CS- Candy seed, AS-Augusta seed, LS-Lahat seed, RS-Ria seed.
Data are average of triplicate ± SE. Mean value with different superscript in the column are significantly different (p<0.005).
present study for watermelon seeds are presented in Table 3. In Candy seed (23.75), Augusta seed (23.25) and Lahat seed (23.75) there is no significant difference (P>0.05) seen in fat value but Ria seed has higher fat content than the rest at (p<0.005). The ash value of varieties of watermelon seeds was presented but there is no significant difference between them as given in Table 3. Candy seed (34.35) and Lahat seed (33.45) have higher fiber content than Ria seed (32.43) and Augusta seed (28.66). As shown in Table 4, the carbohydrate content of Ria seed (10.66%) was lower than Lahat (13.59%), Candy (16.82%) and Augusta (20.30%) seeds. The caloric value of Augusta seed (375.21%) was higher than Ria (366.03%), Candy (360.55%) and Lahat (362.53%) seeds. When we compare the result of this study with others, Oyeleke et al. (2012) reported that the protein (27.4%), fat (49.7%), ash (4.1%) and fiber (3.8%), of watermelon seed, Inuwa et al., (2011) reported that protein (38.59%), fat (17.78%), ash (3.17%) and fiber (7.32%) content of watermelon seed. Lakshmi and Kaul (2011) reported that protein (27.59%), fat (46.83%), ash (2.87%) and fiber (4.68%) content of watermelon seed, E-Safy et al. (2012) reported as protein (30.11%), fat (30.73%), ash (3.75%) and fiber (5.19%), Omobolanle et al. (2014) reported as protein (16.3%), fat (12.91%), ash (3.24%), fiber (2.24%) and CHO (58.36%). The results of this study are comparable with some other studies. Generally, the proximate composition of watermelon seed especially the protein and fat content have a good implication for the communities with high protein deficiency and can be used as complement protein with cereals and other plant foods in the diets. The fats are essential because they provide the body with maximum energy and the fat content indicate the importance of the seed for oil extraction that may be used for different food processing.

**Mineral content of watermelon fruit**

The analysis of the mineral constituents for iron, zinc, calcium, phosphorus, sodium and potassium content of watermelon fruit was presented in Table 4 and 5. The previous studies indicated as the mineral content of fruit affected by stage of development and ripening. Soumya and Rao (2014) reported the concentration of mineral contents like Na, Fe and Zn were distinguishably higher in the ripe fruit, whereas the cultivars of watermelon showed their higher mineral concentration (K, Na and Mn) in the early stages of development and ripening. The recent studies of E-Safy et al. (2012) referred the content of mineral elements in plants and fruit depends to a high degree on the soils abundance, including the intensity of fertility.

### Mineral contents of flesh part

#### Iron

According to the results of this study (Table 4), the iron content watermelon flesh varieties have significance difference between them. The Lahat flesh (3.14 mg/100 gm) and Augusta flesh (0.80 mg/100 gm) have highest and lowest iron content respectively, whereas Ria flesh higher than Candy flesh at (p<0.005). The iron content of cultivated watermelon flesh ranged from 0.280 to 0.450 mg/100 g in four different region of Turkey was reported by Otles (1993) that is less than results found in this study.

#### Zinc

There were significance differences in zinc content of watermelon flesh varieties at (p<0.005). Zinc content ranged from 0.057 to 0.144 mg/100 gm, in Augusta and Lahat flesh respectively. Sharma et al. (2013) indicated that the zinc content of *Citrullus lanatus* flesh (7.5 mg/100 g) was higher than nine different Nigerian fruit that also have higher results than this study.

#### Calcium

The calcium content of watermelon flesh part was presented in Table 5. There was significance (p<0.005) difference between Augusta (7.77), Ria (7.05), Lahat (6.50) and Candy (5.62) fruit flesh varieties. Other studies on calcium content of watermelon flesh were reported. Naz et al. (2013) reported that calcium content of 5.6 mg/100 g, whereas Otles (1993) indicated that calcium content of

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**Table 4: Mineral content of flesh part of watermelon.**

<table>
<thead>
<tr>
<th>Sample type</th>
<th>Fe (mg/100g)</th>
<th>Zn (mg/100g)</th>
<th>Ca (mg/100g)</th>
<th>P (mg/100g)</th>
<th>Na (mg/100g)</th>
<th>K (mg/100g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CF</td>
<td>1.51±0.021b</td>
<td>0.06±0.001b</td>
<td>5.62±0.002a</td>
<td>16.56±0.001c</td>
<td>8.31±0.044b</td>
<td>111.01±0.007b</td>
</tr>
<tr>
<td>AF</td>
<td>0.80±0.014a</td>
<td>0.05±0.000a</td>
<td>7.77±0.001d</td>
<td>14.29±0.001b</td>
<td>11.58±0.024c</td>
<td>127.12±0.033c</td>
</tr>
<tr>
<td>LF</td>
<td>3.14±0.01d</td>
<td>0.14±0.002d</td>
<td>6.50±0.001b</td>
<td>19.03±0.002d</td>
<td>10.66±0.043c</td>
<td>96.55±0.024a</td>
</tr>
<tr>
<td>RF</td>
<td>2.31±0.001c</td>
<td>0.12±0.002c</td>
<td>7.05±0.002c</td>
<td>10.82±0.002a</td>
<td>6.15±0.156a</td>
<td>107.42±0.003b</td>
</tr>
</tbody>
</table>

CF- Candy flesh, AF-Augusta flesh, LF-Lahat flesh, RF-Ria flesh

Data are average of triplicate ± SE. Mean value with different superscript in the column are significantly different (p<0.005). The result is reported on wet basis.
Citrus lanatus flesh ranged from 6.17 to 8.33 mg/100 g in agreement with present study.

**Phosphorus**

The phosphorus content of Citrus lanatus flesh in this study is similar to that reported by Otles, (1993) which ranged from 14.82 to 17.95 mg/100 g except for Ria flesh variety. The phosphorous content for four varieties of watermelon flesh was presented in Table 5, have a significantly different from one another (p<0.005). The highest and lowest phosphorous content was found in Lahat flesh (19.03 mg/100 g) and Ria flesh (10.82 mg/100 g) respectively.

**Sodium**

The mean total content of sodium in Candy flesh and Augusta flesh was 8.12 and 11.58 mg/100 g respectively. However, there was significant decrease in sodium content on Lahat flesh and Ria flesh, which were 10.66 and 6.15 mg/100 g respectively. Sodium content of this study was found to be similar to that reported by Otles (1993) that range 3.18 to 9.51 mg/100 g.

**Potassium**

In the present study, the potassium content of watermelon in Candy flesh, Augusta flesh, Lahat flesh and Ria flesh were presented 1036.68, 813.32, 708.66 and 720 mg/100 g respectively. There is significance (p<0.05) difference among the varieties. The Candy flesh and Ria flesh are higher significance difference from Lahat flesh and Augusta flesh. Oyeleke et al. (2012) and Otles (1993) are indicated as potassium content of watermelon flesh 125 mg/100 gm and 98.27 to 156.18 mg/100 gm respectively.

**Mineral content of watermelon seed**

The analysis of the mineral constituents of the watermelon seeds showed a significant concentration of iron, zinc, calcium, phosphorus, sodium and potassium (Table 5). The iron content of seed varieties ranged from 2.454 to 4.919 mg/100 gm. Candy, Augusta and Ria seeds have higher content of iron than Lahat seeds. Zinc content didn't show significance difference among watermelon seed varieties. Concerning calcium content of seeds, Ria and Lahat seeds have higher content than Augusta seed as shown in Table 5. Regarding phosphorus, Ria seeds showed no significance difference from Candy and Augusta seeds but Lahat seed have higher significance difference from the rest at (p<0.005). Only Candy seed (11.96 mg/100 gm) showed higher content than Augusta (3.87 mg/100 g), Lahat (3.94 mg/100 g) and Ria (4.00 mg/100 g) seeds in sodium content. The potassium content of Augusta seed (813.32) was higher than Lahat (708.66) and Ria seeds (720.00) but lower than Candy seeds (1036.68) in mg/100 g. Other studies also reported on mineral content of watermelon seeds, Soumya and Rao (2014) described the sample with the highest ash content had the highest probability of being the one with the highest mineral contents, it contained Fe (2.88), Zn (5.52), Ca (7.37) and Na (11.13) in mg/100 gm. Naz et al. (2013) also reported mineral content of watermelon seed like Zn (9.65), Ca (86.75), P (1073.3), Na (90.35) and K (598.95) in mg/100 gm. Some of the mineral values found in this study have similarities with the two studies.

**CONCLUSION**

The proximate composition in four local varieties of watermelon grown and investigated with respect to the results obtained from this study, the following conclusions are made. The flesh part of watermelon fruit analyzed in this study was found to contain lower level of crude fat, crude fiber, protein and carbohydrate. The study therefore, showed that watermelon fruit flesh is poor source of macronutrients. In contrast, seed of the four local varieties contain appreciable content of protein, crude fat, crude fiber and carbohydrate. This indicates the possibility of using the seed to enhance the nutritional value of processed foods. Studying within the varieties has an implication in watermelon breeding for quality estimation and nutrition breeding. Furthermore, the results of the present study could be used giving information to the farmers to

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**Table 5: Mineral content of seed part of watermelon.**

<table>
<thead>
<tr>
<th>Sample type</th>
<th>Fe (mg/100g)</th>
<th>Zn (mg/100g)</th>
<th>Ca (mg/100g)</th>
<th>P (mg/100g)</th>
<th>Na (mg/100g)</th>
<th>K (mg/100g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CS</td>
<td>4.04±0.311b</td>
<td>3.92±0.105a</td>
<td>20.80±0.866ab</td>
<td>375.90±0.067a</td>
<td>11.96±0.001b</td>
<td>1036.68±0.037c</td>
</tr>
<tr>
<td>AS</td>
<td>4.36±0.480b</td>
<td>3.22±0.108a</td>
<td>11.92±0.287a</td>
<td>415.65±0.013b</td>
<td>3.87±0.026a</td>
<td>813.32±0.220b</td>
</tr>
<tr>
<td>LS</td>
<td>2.45±0.061a</td>
<td>3.41±0.125a</td>
<td>31.14±0.701bc</td>
<td>476.96±0.098c</td>
<td>3.94±0.141a</td>
<td>708.66±0.007a</td>
</tr>
<tr>
<td>RS</td>
<td>4.91±0.210b</td>
<td>4.47±0.061a</td>
<td>33.32±0.073c</td>
<td>403.31±0.099ab</td>
<td>4.00±0.002a</td>
<td>720.00±0.000a</td>
</tr>
</tbody>
</table>

CS- Candy seed, AS-Augusta seed, LS-Lahat seed, RS-Ria seed.

Data are average of triplicate ± SE. Mean value with different superscript in the column are significantly different (p<0.005).
determine best production and by consumers to choose the cultivar with best nutritional quality.

REFERENCES


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