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MORPHO-NUTRITIONAL ATTRIBUTES OF TWO VARIETIES OF WATERMELON (*CITRULLUS LANATUS* L.) IN SEMI-ARID ENVIRONMENT OF QUETTA, BALOCHISTAN

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Abstract

The Semi-arid environment is a type of an environment characterized by a scarcity of rainfall and high levels of evaporation, resulting in arid and often unpredictable weather conditions. Semi-arid environments have a significant impact on the morphology, production, and nutrient values of various plants including watermelon varieties. This study conducted to assess the impact of semi-arid climate on a morphological parameter, proximate, and mineral analysis of two varieties of watermelon in a semi-arid environment of Quetta Balochistan. The morphological parameters assessed were main stem length, number of primary branches and its length, number of leaves on the main and secondary branches, number of nodes, fruit weight, and rind thickness. The results were statistically non-significant (p>0.05) foe growth attributes. However, the proximate analysis showed a statistically significant differences (p<0.05) in their crude protein, crude lipid, crude fibre, and carbohydrate content. The mineral analysis also revealed significant differences in their nitrogen, potassium, sodium, manganese, zinc, copper, and iron content. While phosphorus showed non-significant difference. These findings suggest that the two varieties of watermelon have different nutritional compositions and mineral content, which can have implications for their cultivation and consumption. Overall, this study provides valuable insights into the morphological and nutritional characteristics of watermelon varieties grown in a semi-arid environment, which can aid in selecting and breeding varieties suitable for this region.

Keywords: *Cultivation, Mineral analysis, Morphological parameters, Nutritional compositions, Proximate analysis, Semi-arid environment, Watermelon varieties*

INTRODUCTION

The Semi-arid environment is a type of region characterized by a scarcity of rainfall and high levels of evaporation, resulting in arid and often unpredictable weather conditions. This environment covers a significant portion of the globe, including parts of Asia, Africa, Australia, and North America. According to the World Resources institute, more than one-third of the Earth's surface area is classified as semi-arid, making it an essential and complex biome to study and manage (1). These regions are characterized by prolonged drought periods, soil degradation, and restricted water availability, leading to the socioeconomics issues and food insecurity (2). Quetta is the capital of Balochistan province, located in the semi-arid region of Pakistan. Quetta is known for its unique climate, which is characterized by cold winters and hot summers with little rainfall throughout the year (3) (.In general, the area experiences a dry, chilling environment. The most snowfall and rainfall occur in January and February respectively. The summer months are moderate, while June and July experiences temperature of about 20°C to 30 °C. January and February are considered the coldest months having the temperature of -3°C to -11°C respectively (4). Semi-arid environments have a significant impact on the morphology, production, and nutrient values of various plants including watermelon varieties (5). These areas are characterized by low precipitation, high temperature, and high evaporation rates which leads to drought and water scarcity (6). As a result, fruit plants have to overcome these conditions to survive and increase their yield (7).

Watermelon (*Citrullus lanatus* L.) belongs to the Cucurbitaceae family. It is a tendril-bearing, hairy, and spreading, plant. Its stem length reaches several meters. The plant has dark green leaves; leaves are deeply lobed, long-stalked 8 to 20 cm long. It is a self-fertile plant (8). Watermelon can be found in many shapes, sizes, and colors. The shapes of watermelon vary from oblong to round with colors ranging from almost dark black to light green. The skin color of fruit can be striped, solid, or marbled. The consumable portion of watermelon flesh can be red, yellow, and deep red or pink red. Seeded, as well as seedless varieties of watermelon, are available (9) . In warmer parts of the world, watermelon is considered as most extensively grown vegetable crops (10) . Watermelon is basically from Africa and has been cultivated for over 5000 years. The fruits were first introduced in Asia and the Middle East through the Mediterranean between 400 BC and 500 BC (11). Asia produces the world's three-fourth yield of watermelon, among all, china is the leading producer of watermelon in Asia (12).

The growth and development of the watermelon plant can be observed by different growth stages attained by the plant. The main phases of watermelon growth include the initial stage, flowering stage, vegetative stage, yield stage, and ripening stage. The plant growth can be, observed as an increase in width, length, volume, and fresh and dry weight of a plant (13). All the parameters of plant observed at each growth stage, such as its height and leaf size, which tends to increase as the plant increases in size, also for the uptake of nutrients and to anchor plant the roots grow deeper. Although, climate change such as precipitation, relative humidity, evaporation, and solar radiation all such factors influence growth and development of plant (14).

The credibility and quality often come from the food's nutritional composition. Watermelon is a fruit with low calories, providing just 46 calories per cup (152 grams) and approximately 46 calories about 11.6 grams of carbohydrates, making it low calories and low carbohydrates fruit (15). Watermelon is not a good source of fat and protein; it is a significant source of fiber, which can prevent constipation and aid in digestion (16). Watermelon is a rich source of micronutrients and red-carotenoid pigment and lycopene which acts as antioxidant in normal metabolism (17). Watermelon contains a sufficient amount of nutritional agents such as antioxidants beta-carotene and lycopene, and some specific amino acids citrulline, arginine, etc (18). It contains 90 % water and 7.55 carbohydrates. It is a good source of vitamins C and A, which are antioxidants that can help strengthen the immune system and reduce inflammation (19). Vitamins like Niacin, thiamine, and riboflavin are also found in watermelon. Furthermore, it is a good source of iron, magnesium, phosphorus, and potassium (20)(Quek *et al*., 2007). Watermelon extracts such as L-citrulline and L-arginine reduce obesity, Blood pressure, and early hypertension. It also protects from heart diseases and improves the function of arteries (21). Choline an antioxidant also occurs in watermelon which contributes to muscle movement, early brain development, nerve impulse transmission, and maintaining cell membrane structure (22). Moreover, santroza, apple, watermelon and cantaloupe were found with estimated yield of 7.49%, 7.66%, 7.81% and 8.61% nutrients losses respectively (23). Objectives of this study were to compare variation in the growth parameters of two varieties of watermelon (Yellow crimson and crimson sweet) in the semi-arid environment of Quetta, Balochistan and to evaluate nutritional worth by proximate analysis in Red and yellow-fleshed watermelon varieties.

MATERIALS AND METHODS

FILED EXPERIMENT AND LAYOUT

The study was conducted at the Botanical Garden University of Balochistan Quetta from 31st March 2022 till January 2023. The experimental design was completely randomized design (CRD), two plots were selected for the field experiment, and each plot size was approximately 15 feet long and 15 feet wide respectively. Each plot was divided into 3 major rows spaced 4 feet apart per row. The seeds of both varieties of water melon (*Citrullus lanatus* L.) were sown at one-inch depth and the plant-to-plant distance was 1.5 feet.

GROWTH PARAMETERS DETERMINATION

The plant growth data was taken including main stem length, primary branches, numbers of leaves per branch, and the number of nodes per branch. The growth parameters of both varieties were calculated every 10 days (from the day the seeds will sow). The length of main stem was measured in inches and number of primary branches of plant was counted. Number of leaves per branch was counted every 10 days for the observation of plants growth and development process. The number of nodes of each branch was calculated every 10 days for the assessment of plants growth and development process. Fruit weight was noted directly after harvesting using electrical balance. Rind thickness was observed using Electric Vanier clipper.

PROXIMATE ANALYSIS

In this study, standard techniques were employed for proximate analysis to assess the nutritional parameters of two distinct varieties of watermelon (Citrullus lanatus). These methods allowed us to determine the nutrient quantities in the selected plant samples following the guidelines of (24, 25). The analyzed nutritional parameters included moisture content, ash content, crude protein, crude lipid, crude fiber, carbohydrate, and vitamin C.

MOISTURE CONTENT DETERMINATION

The clean Aluminum dish was dried in an oven for one hour the oven temperature was at 105°C. Soon after a desiccator was used for its cooling. After which an empty aluminum dish was weighed (W1). The aluminum-dish was again weighted (W2) by the addition of 2g of sample and it was return to the oven at 105°C to allow them to dry. The dish was removed and reweighted (W3). The moisture content was calculated from the following equation (24).

$$\text{Percentage of Moisture content} = \frac{W2-W1}{W3-W1} \times 100\%$$

ASH CONTENT DETERMINATION

The cleaned crucible container was weighted (W1). Two grams of pretreated watermelon sample powder was transferred and reweighted (W2). The crucible container containing the samples were transferred to a furnace at a temperature of 600 °C and was allowed for a period of ten hours; the sample bacame whitish grey ash subsequently it was allowed to cool, and reweighted (W3). The percentage of ash content was weighted from the following equation (24).

$$\text{Percentage of ash (Dry basis)} = \frac{W3-W1}{W2-W1} \times 100\%$$

Where, W1 = Empty crucible container weight.

W2 = Sample weight before ashing + empty crucible container weight

W3 = crucible container weight in grams.

DETERMINATION OF CRUDE PROTEIN

The Kjeldahl technique was used for the determination of crude protein (24). In this procedure basically, three steps are involved such as Distillation, Digestion, and titration. By the addition of 1g, sulfuric acid digestion was started, for catalysis copper Sulphate tablets were used; approximately 20 to 30ml of sulfuric acid were used in concentrated form). Upon digestion, distillation was performed from the test samples in boric acid 4%, nitrogen was collected. At last, titration was performed with the aid of a titrator by titrating boric acid against sulfuric acid (0, 02 Normal standardized). Eventually, the crude protein (CP) percentage was calculated as:

$$\text{Crude protein \%} = \frac{(\text{ml } H_2SO_4 - \text{Blank}) \times 6.25 \times 14.01}{100 \text{ Weight of the sample}} \times 100$$

CRUDE LIPID

For the Crude lipid analysis, the Soxhlet extractor was used. two grams of prepared sample were weighted and then transferred to a thimble in a round bottom flask 200ml of petroleum were poured and it was heated at 45 °C for three hours. The flask was taken out and allowed to cool for 15 minutes and the percentage% of crude-lipid was analyzed using the following equation (24, 25).

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

CRUDE FIBER

For the analysis of crude fiber AOAC (24) method was utilized in this method the digestion of samples was done using petroleum ether to get a fat free material. The materials were then placed into a container and 200ml of 1.25% pre heated sulphuric acid was added. The material was boiled about 30minutes keeping up a consistent volume of water the water was added. Using the Suction pump through pre heated Buckner flask funnel the filtration was done. The residues were washed with the help of boiled water many times and then transmit into beaker. Then (pre-heated) 200 ml of 1.25% Na2SO4 was mixed and then it was boiled for 30 minutes after that strained and properly washed with ethanol (2 times) and hot water. Then the residue was dried for 24 hours at 650C and weighted down. Using the crucible container the residue was placed in muffle furnace for 4 hours at 400-600 C and for the cooling of resultant ash the desiccator was used and weighted using following formula:

$$\text{Percentage of crude fiber} = \frac{\text{Weight befor ashing} - \text{Weight after ashing}}{\text{Weight of sample}} \times 100$$

CARBOHYDRATE DETERMINATION

Percentage of carbohydrate content of the sample was computed using the following equation: Percentage of carbohydrate = 100 - (% C.lipid % + Ash content % + C.fibre % + C.protein) (24).

VITAMIN C DETERMINATION

Vitamin C determination was done by dissolving 3g of each sample into two Cm^3 10% of glacial acetic acid and blended for ten minutes and with the help of filter paper it was filtered. The residues was washed with 5 cm3 of the portion of 1o% Glacial acetic acid. 60 cm3 of 0.3m H2SO4 was added by the addition of 0.01m Potassium iodate and 2gram of solid potassium iodide followed by 25cm3 of the filtrate was titrated with h0.07m sodium thiosulphate solution (24).

MINERAL ANALYSIS

To conduct mineral analysis of watermelon samples, Kjeldahl method was followed to determine the mineral content in sample. 0.5 grams of dry samples were weighted into a 100ml digestion flask and added 5 ml of concentrated sulfuric acid. Than 0.1 grams of copper sulfate were added as a catalyst and gently heated the flask at moderate temperature 100 – 150 °C until the mixture turned clear and colorless. After cooling, added 2 ml of 30% H_2O_2. The temperature of block disaster was raised to 280°C and heated the tube for 10 minutes at 280C. After cooling 2ml of 30% H_20_2 was added and heated for 10 minutes. This step was repeated for 9 to 10 times until the solution remains clear after the 10 minutes of heat. After cooling the solution, distilled water was added to make up to 100ml volume. To determine the concentration of each mineral in the sample. The standard solution and constructed calibration curves for each element was analyzed using the atomic absorption spectrophotometer instrument (24).

STATISTICAL ANALYSIS

The data was statically analyzed using the "STATISTICX9" and the mean, and standard deviation, using MS Excel the graph was generated.

RESULTS

MORPHOLOGY PARAMETER

Morphological parameters include main stem length, primary branches length, number of leaves on the main branch and secondary branches, number of nodes, fruit weight and rind thickness of two varieties of watermelon. Mean values for each of these variables were recorded at three different time points, namely 10 days, 50 days, and 100 days, for the both plant varieties. The results were statistically non-significant for all morphological attributes (Fig. 1).

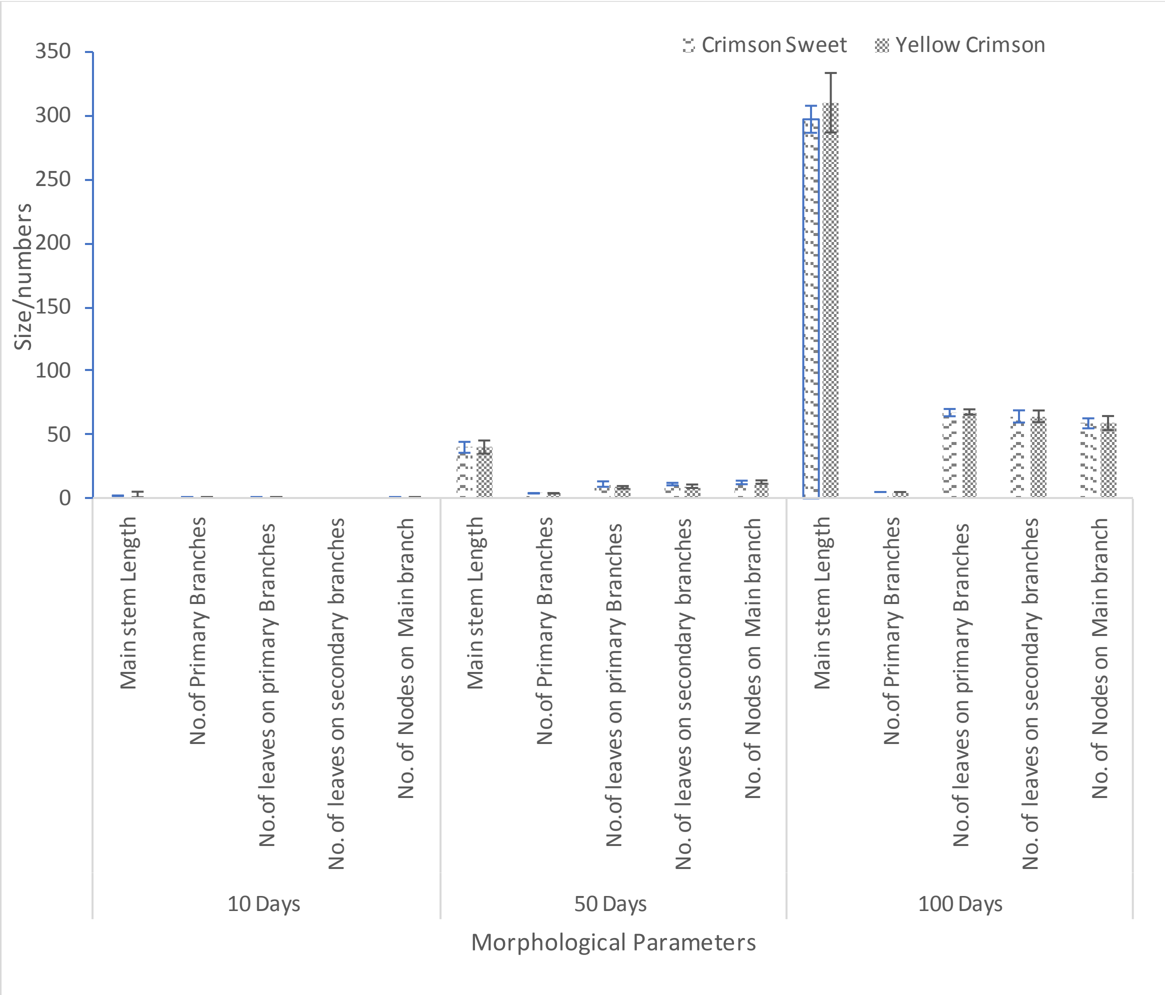

Fig. 1. Morphological attributes of two varieties of watermelon

For the yellow variety, the mean value of the main stem length was 2.8 inches at 10 days, 40 inches at 50 days, and 297 inches at 100 days. The mean value of primary branch length was 2.8 inches at 10 days, 40 inches at 50 days, and 277 inches at 100 days. The mean value of the number of leaves on main branch was 3.16 at 10 days, 11.83 at 50 days, and 67.16 at 100 days, while the mean value of the number of leaves on the secondary branches was 3.33 at 10 days, 13.5 at 40 days, and 64.16 at 100 days. The mean value of the number of the nodes was 2.16 at 10 days, 15.83 at 50 days, and 58.88 at 100 days. Furthermore, the mean value of rind thickness was 19 mm for the yellow variety, and the average weight of fruit was 10.08 kg.

On the other hand, for the red variety, the mean value of the main stem length was 3.8 inches at 10 days, 40.16 inches at 50 days, and 301 inches at 100 days. The mean value of primary branches length was 3.0 inches at 10 days, 40 inches at 50 days, and 301 inches at 100 days. The mean value of the number of leaves on the main branch was 3.08 at 10 days, 40.16 at 50 days, and 301 at 100 days. The mean value of the number of the leaves on the secondary branches was 4.33 at 10 days, 12.16 at 50 days, and 64.33 at 100 days. The mean value of the number of the nodes was 2.83 at 10 days,

15.5 at 50 days, and 59 at 100 days .Lastly, the mean value of the rind thickness was 18.16mm, and the average weight of fruit was 9 kg.

PROXIMATE ANALYSIS

The proximate analysis of the pulp of two varieties of watermelon revealed statistically significant difference ($p<0.05$) in their crude protein, crude lipid, crude fibre, and Carbohydrate, while moisture, ash, and vitamin C content showed non-significant difference ($p>0.05$). The mean moisture content of the yellow variety was 94.72%, which was higher than the mean moisture content of the red-fleshed variety at 92.72%. The Ash content of yellow variety was also higher 1.29%, compared to the red-fleshed variety 1.11%. In terms of protein content, the yellow-fleshed varieties had a mean value of 0.57%, which was lower, the mean value of the red-fleshed variety at 0.79%. Lipid content was not detected in either variety. The mean crude fibre content of the yellow-fleshed variety was 0.38%, while the red variety had a slightly higher mean value of 0.39%. Carbohydrate content was significantly higher in red-fleshed variety 6.15% compared to yellow-fleshed variety at 4.16% (Fig. 2). The mean Vitamin C content of the yellow-fleshed variety was 8.53 mg/20, which was significantly higher than the mean value of the red-fleshed variety at 6.88 mg/20 ml (Fig. 3).

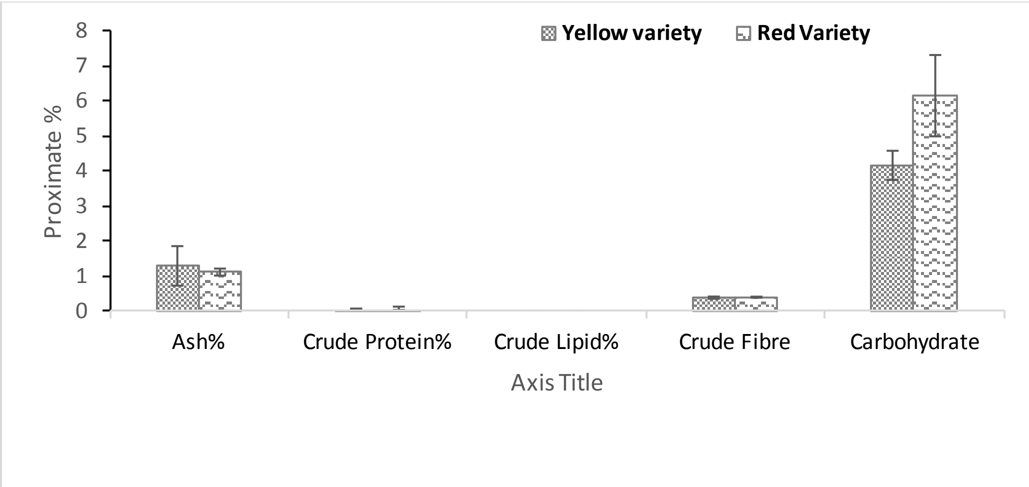

Fig. 2. Proximate analysis of crude protein, crude lipid, crude fiber & carbohydrate of two varieties of watermelon

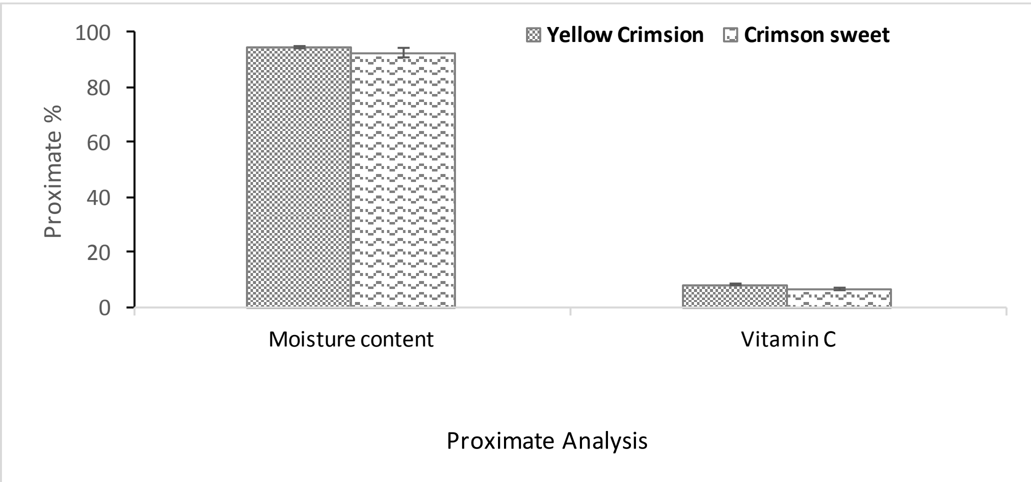

Fig. 3. Proximate analysis of moisture content & vitamin C of two varieties of watermelon

MINERAL ANALYSIS

The mineral analysis of two varieties of watermelon revealed Statistically Significant difference ($p<0.05$) for Nitrogen (N), Potassium (K), Sodium (Na), Manganese (Mn), Zinc (Zn), Copper (Cu) and Iron (Fe) content. In contrast, only phosphorus showed statistically non-significant difference ($p>0.05$). The mean nitrogen content of the yellow-fleshed variety was 0.009%, while the mean nitrogen content of the red-fleshed variety was 0.012%. Potassium content was higher in the yellow variety 2.52% compared to the red-fleshed variety 1.31%. Phosphorus content was also different between the varieties, with the yellow-fleshed variety showing a mean value of 0.32% and the red-fleshed variety showing a mean value of 0.38%. Zinc content was higher in the yellow-variety 0.22% compared to the red-fleshed variety 0.02%. Copper content was also higher in the yellow-fleshed variety 0.05% compared to the red-fleshed variety at 0.01%. Iron content was higher in the red-fleshed variety 4.21% compared to the yellow variety at 2.90%. Sodium content was lower in the yellow-fleshed variety 0.02% compared to the red-variety 0.04%. Manganese content was only detected in the yellow variety, with value of 0.008%, while no manganese was detected in the red-variety (Fig. 4).

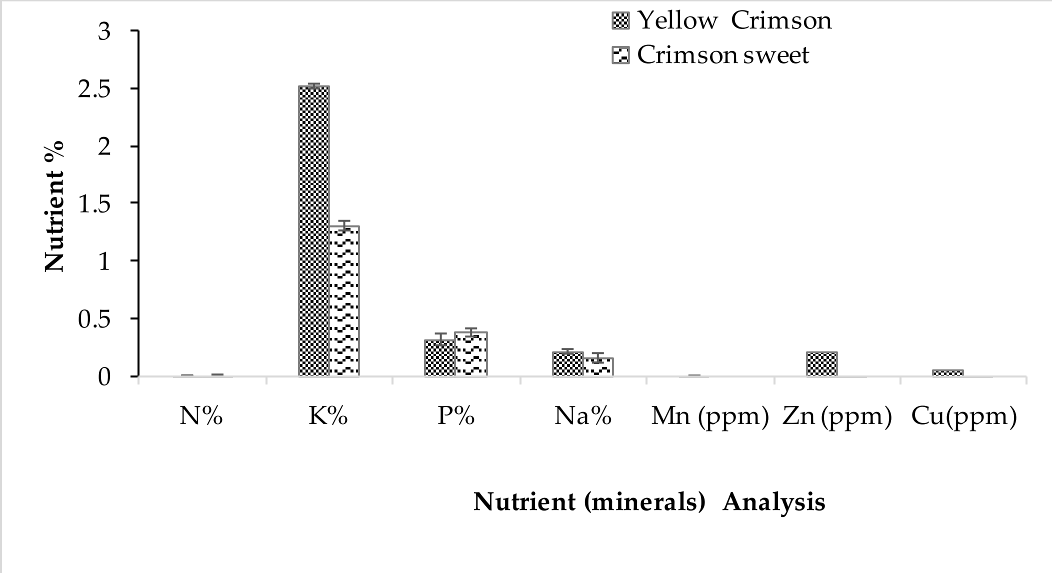

Fig. 4. Minerals analysis of two varieties of watermelon

DISCUSSION

Watermelon is a widely cultivated fruit worldwide, with different varieties and colors, including yellow and red-fleshed varieties. In recent years, studies have focused on the morphological characteristics to enhance the production and quality of watermelon fruit. In this regard, the present study aimed to compare the morphological parameters of the yellow and red-fleshed watermelon varieties.

The results of this study showed that there was no significant difference in the main stem length, number of leaves on the main branch, or number of nodes between the two varieties. This finding indicates that both yellow and red-fleshed watermelon varieties have similar growth patterns and development rates. This result is consistent with previous studies that reported no significant differences in the growth patterns and developmental stages between different watermelon varieties (26).

However, the mean value of fruit weight was higher in the yellow-fleshed watermelon variety than the red-fleshed variety. This finding suggests that yellow-fleshed variety has the potential to produce larger fruits than red-fleshed watermelon. This result is support by previous studies that reported significant difference in the fruit weight between different watermelon varieties (27).In addition, the mean value of rind thickness was higher in the yellow-fleshed variety than the red-fleshed variety. This finding implies that the yellow-fleshed watermelon may have thicker rind, which could potentially protect the fruit from environmental stresses and physical damage. This result is also supported by previous studies that reported significant differences in the rind thickness between watermelon varieties (28).

Overall, the present study provides useful information on the morphological characteristics of yellow-fleshed and red-fleshed watermelon varieties, which could be helpful for growers and breeders to improve the production and quality of watermelon fruits.

Considering the results of the proximate analysis of two varieties of watermelon showed statistically significant differences in their crude protein, crude lipid, crude fibre, and carbohydrate content. This finding is consistent with previous research work that showed variations in the nutrient composition of different watermelon varieties. For instance, a study by (29) found significant difference in the protein, lipid, and fiber content of different watermelon cultivars.

Moreover, the higher moisture and ash content of yellow variety observed in this study are consistent with the findings previous studies. Study by Ayala-zavala *et al.*, (2010) reported that the ash and moisture content of different watermelon cultivars varied significantly (30). Furthermore, the lower protein content of yellow-fleshed variety observed in this study is in agreement with the findings of a study by Tariq *et al.* (2020) that showed variations in the protein content of different watermelon cultivars (31).

In contrast, the higher carbohydrate and vitamin C content of the red-fleshed variety observed in this study are consistent with the findings of previous studies. For instance, a study by Shaheen *et al.* (2022) reported that the red-fleshed watermelon had a higher carbohydrate and vitamin c content compared to the yellow-fleshed variety (32).

In a nut shell, the proximate analysis of two watermelon varieties revealed variations in their nutrient composition. These findings are consistent with previous research work and underscore the importance of the considering the nutrient composition of different watermelon varieties when making dietary choices.

Furthermore, the results of the mineral analysis indicated statistically significant differences for nitrogen, potassium, sodium, manganese, zinc, copper, and iron content. This study confirms that different varieties of watermelon may differ significantly in their mineral content, and the results are consistent with other studies regarding literature.

According to a study conducted by Mani *et al.* (2022), significant variations in mineral content were observed among different watermelon cultivars (33). The study revealed that calcium, magnesium, and iron content differed significantly across various cultivars. Similarly, a separate study by Kang *et al.* (2020) demonstrated significant differences in the mineral content of watermelon grown in different regions of China (34). The levels of potassium, calcium, magnesium, iron, and zinc varied significantly among watermelon samples from distinct regions. These findings highlight the potential implications for the nutritional value and health benefits of consuming different watermelon varieties.

CONCLUSION

Present study was conducted to evaluate and document the impact of semi-arid environment on the morphological parameters, Proximate, and mineral analysis of two varieties of watermelon. The results showed statistically non-significant differences ($P>0.05$) in the morphological parameters. However, the proximate analysis revealed statistically significant difference ($P<0.05$) in crude protein, crude lipid, crude fiber, and carbohydrate content, while mineral analysis showed significant differences ($P<0.05$) in nitrogen, potassium, sodium, manganese, zinc, copper, and iron content. These findings suggest that the two varieties of watermelon have different nutritional compositions and mineral content, which can have implications for their consumption and cultivation. Overall, this study provides valuable insights into the morphological and nutritional characteristics of watermelon varieties grown in a semi-arid environment, which can aid in selecting and breeding varieties suitable for this region.

Conflict of Interest:

Authors have no conflict of interest on this research.

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