SCAP
SOCIEDADE DE CIÊNCIAS AGRÁRIAS DE PORTUGAL

Fruit quality of watermelon germplasm grown in agroecological production system in the Submiddle of the San Francisco Valley, Brazil

Qualidade de frutos de germoplasma de melancia produzidos em sistema agroecológico no Vale do Submédio São Francisco, Brasil

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https://doi.org/10.19084/RCA18235
Received/recebido: 2018.08.01
Received in revisedform/recebido em versão revista: 2018.10.03
Accepted/aceite: 2018.10.16

ABSTRACT

We evaluated watermelon germplasm from traditional agriculture on the nutritional quality of fruits in an agroecological system of production for to identify promising genotypes for a pre-breeding program of the species in the Submiddle of the San Francisco Valley. We used 23 watermelon accessions of the Vegetable Germplasm Bank of the Federal University of Valley of the San Francisco (BGH/UNIVASF) and four commercial cultivars were used in a randomized block design, with three replicates. The management was based on agroecological techniques. We harvested the most developed fruit of each plant and from them we took samples of the pulp to form composite samples for quality assessment. We evaluated the content of soluble solids, total titratable acidity, vitamin C, lycopene and total soluble solids/total titratable acidity ratio. Uniformity was observed for vitamin C content. However, there was variability for soluble solids, soluble solids/titratable total acidity ratio and lycopene. The accessions BGH/UNIVASF 67 and 121 are promising because they have good fruit quality and large genetic dissimilarity. In order to maximize the chances of genetic gains we cancross the commercial cultivar "Perola" or Sugar Baby with accessions that presented good means and genetic divergence, such as BGH/UNIVASF 67, 91 and 121.

Keywords: *Citrullus lanatus*, agroecology, genetic diversity.

RESUMO

Avaliou-se germoplasma de melancia oriundo da agricultura tradicional do semiárido de Pernambuco, quanto à qualidade nutricional, em sistema agroecológico de produção para identificar genótipos promissores para programa de pré-melhoramento da espécie no Vale do Submédio São Francisco. Foram utilizados 23 acessos de melancia do Banco de Germoplasma de Hortaliças da Universidade Federal do Vale do São Francisco (BGH/UNIVASF) e quatro cultivares comerciais no delineamento de blocos ao acaso, com três repetições. O manejo adotado foi com base em técnicas agroecológicas. Colheu-se o fruto mais desenvolvido de cada planta e deles foram obtidas subamostras da polpa para compor a amostra composta, empregada na análise de qualidade. Avaliou-se o teor de sólidos solúveis, acidez total titulável, vitamina C, licopeno e a relação teor de sólidos solúveis/acidez total titulável. Observou-se uniformidade para o teor de vitamina C. Contudo, houve variabilidade para sólidos solúveis, relação sólidos solúveis/acidez total titulável e licopeno. Os acessos BGH/UNIVASF 67 e 121 são promissores por apresentarem boa qualidade de fruto e ampla dissimilaridade genética. Para maximizar as chances de ganhos genéticos pode-se cruzar a cultivar comercial Pérola ou "Sugar Baby" com acessos que também apresentaram boas médias e divergência genética, como o BGH/UNIVASF 67, 91 e 121.

Palavras-chave*:* *Citrullus lanatus*, agroecologia, diversidade genética.

INTRODUCTION

Watermelon [*Citrullus lanatus* (Thunb.) Matsum & Nakai] is an oleraceous belonging to the family Cucurbitaceae, original from Africa and plays important economic and social roles in the generation of jobs in Brazil, mainly in Northeast, Southeast, South and Central West Brazil (Souza *et al*., 2004).

Due to the sweet and refreshing taste, watermelon is highly appreciated during the hottest hours of the day (Dias *et al*., 2006). Its pulp consists of a natural source of carotenoids, especially lycopene that is responsible for the reddish color, or beta-carotene, which are considered powerful antioxidants and fight free radicals that alter cells' DNA and trigger the carcinogenic process (Leão *et al*., 2006). It is also a good source of vitamin C, which plays an important part as an enzymatic cofactor in several physiological processes whose lack causes a disease known as scurvy. In addition, it contains many other vitamins and minerals, mainly potassium, magnesium, calcium and iron (Phillips *et al*., 2010; Tlili*et al*., 2011).

The evaluation of watermelon quality is performed by analyzing variables related to the appearance of the fruit and its acceptance by the consumer. The quality factor is what most influences consumer behavior and induce recurring shopping habits and brand loyalty at a reasonable cost. Sweetness is the most critical quality characteristic of watermelon, along with the color of the pulp, which depends on the accumulation of carotenoids, which may be red, salmon, yellow, orange or canary yellow (Kyriacou *et al*., 2018). The physicochemical and chemical characteristics most commonly used in fruit and vegetable quality evaluation are: pH, titratable acidity, soluble solids, soluble solids/titratable acidity ratio, total sugars, reducing and non-reducing sugars, volatile compounds, pectic substances, vitamin C, pigments (chlorophyll, carotenoids, flavonoids), phenolic compounds, respiration and ethylene production (Chitarra & Chitarra, 2005).

However, few studies in literature deal with the nutritional quality of this oleraceous. The studies comparing nutritional quality of different watermelon cultivars were generally developed by evaluating commercial cultivars in a conventional production system (Lima Neto *et al*., 2010; Leão *et al*., 2006) and does not include traditional cultivars with great genetic variability for plant and fruit characteristics (Queiróz, 1999).

In Northeastern Brazil, specifically in the semiarid region of the Pernambuco state, there are many watermelon accessions grown by family farmers, and part of that germplasm was rescued and is stored in the Germplasm Active Bank of Cucurbits of Embrapa Tropical SemiArid (Queiróz, 2011) and the Vegetable Germplasm Bank of the Federal University of the San Francisco Valley (BGH/UNIVASF). The characterization of these approaches to nutritional quality is an important strategy to assess the potentiality and possibility of inclusion of this material in watermelon breeding programs.

As the phenotypic expression of the characters can be influenced by the production system in which the genotypes are evaluated and considering the growing demand for quality food free from agrochemical residues, an alternative for the cultivation of watermelon is the agroecological system. An agroecological production system seeks to eliminate the use of industrialized agrochemicals, valuing the use of organic sources and integrated pest management (Altieri, 2012). In addition, it reduces the impacts on the environment and also the costs of production, making it possible to select materials more adapted to such system, a research exercise that has been little explored.

Due to the lack of studies comparing the nutritional quality of watermelon accessions in an agroecological system under the edaphoclimatic conditions of the San Francisco Valley it is necessary to study the potential of traditional cultivars due to the socioeconomic importance of the species to the region, especially to family farming.

Therefore, the objective of this study was to evaluate nutritional quality of watermelon accessions originated from traditional agriculture in an agroecological system in order to identify promising genotypes for pre-breeding programs of the species in the Submiddle of the San Francisco Valley.

MATERIAL AND METHODS

The experiment was performed at the Olericulture and Agroecology sector of the Federal University of San Francisco Valley (UNIVASF), at 9°31′ S and 40°54′ W, on the Agricultural Sciences campus, in Petrolina-PE, from August 2015 to September 2016. The municipality presents an altitude of 376 m, average annual temperature of 26°C and annual rainfall of less than 500 mm (Beltrão *et al.*, 2005). The soil of the area is classified as Ortic Quartzarenic Neosol, whose chemical analysis showed the following characteristics: pH (water): 6.5; P: 56 mg/dm^3 (Mehlich: HCl + H_2SO_4); K: 0.48 cmol$_c$/dm^3; Ca: 2.8 cmol$_c$/dm^3; Mg: 1.2 cmol$_c$/dm^3; Al: 0.00; V: 88%; Cu: 0.1 mg/dm^3; Fe: 39.0 mg/dm^3; Mn: 28.4 mg/dm^3; Zn: 700 mg/dm^3 and B: 0.45 mg/dm^3.

We used 23 watermelon accessions from the BGH/UNIVASF: 41, 60, 62, 63, 67, 91, 116, 121, 144, 147, 177, 189, 190, 210, 218, 237, 239, 258, 312, 321, 355, 356 and 389. Four commercial cultivars were used as control: Crimson Sweet, Charleston Gray, "Perola" and Sugar Baby. Genotypes were allocated in a randomized complete block design, with three replicates, totaling 81 plots. Five plants were distributed per plot and lateral borders.

The seedlings production occurred in a protected environment using plastic trays filled with commercial substrate (Bio-Kompound), with transplanting at 24 days after sowing, when they presented two definitive leaves. The soil was plowed, scoured, harrowed, and furrowed. We adopted a drip irrigation system, with lateral lines of 15 m in length, emitters spaced at 0.30 m and average flow of 1.62 L h^{-1}. In addition, to a cocktail of green manure, aiming to improve physical, chemical and biological properties of the soil. An organic fertilizer was applied 60 m^3/ha organic compound. The chemical analysis of the organic compound presented the following characteristics (g/kg): N: 5.8; P: 2.05; K: 9.00; Ca: 0.1; Mg: 2.0; S: 1.1; C: 171; C/N: 29/1; pH (water): 7.7; B: 0.019; Cu: 0.002; Fe: 7.81; Mn: 0.26; Zn: 0.040 and Na: 0.66.

In May 2016, we set the crop at a spacing of 3.0 m between rows and 0.90 m between plants and in an agroecological system of production. Cultural practices and phytosanitary treatments were carried out using alternative treatments in phytosanitary management and the use of mulch for the control of spontaneous herbs. Two hours long daily irrigations were performed, distributed throughout the day according to the weather conditions.

Harvest started on 08/01/2016 and lasted until 08/27/2016, cycling from 78 to 104 days, depending on the genotype. The most developed fruit of each plant was harvested, totaling five fruits per plot. A composite sample of pulp was made by collecting samples of approximately 35 grams from the central region of each of the five fruits that composed the plot, 175 grams total. Analyzes were performed at the university Olericulture laboratory by using the juice obtained from the composite samples after being ground. The following physico-chemical variables were evaluated: vitamin C (VC), total titratable acidity (TTA), soluble solids (SS) and lycopene.

Vitamin C

Determined by titration with potassium iodate solution (0.002 M) and an aliquot of 5 mL of the obtained composite samples juice plus 50 mL of distilled water, 10 mL of sulfuric acid (20%), 1 mL of iodide potassium (1%) and 1 mL of starch (1%), according to the Adolfo Lutz Institute (Ial, 1985). The final titration occurred when the natural color of the pulp changed to a brownish color. The vitamin C content was found by equation 1, where V1 was the volume of the titration and V2 was the volume of the sample. The result was expressed as mg of ascorbic acid/100 mL of juice.

Equation 1:

$$VC = \frac{100 \text{ x } V1 \text{ x } 0.0886}{V2}$$

Total titratable acidity

Determined by titration using standard sodium hydroxide solution (0.003 M) and an aliquot of 1 mL of the sample plus 100 mL of distilled water. Phenolphthalein (1%) to indicate the change that occurred when it changed from a light pink color to a more intense pink color, persisting for at least 30 seconds (IAL, 1985). The value of TTA was found by equation 2, where V is the titrant volume spent in the titration; f corresponds to the correction factor of the titrant solution; M represents the molarity of the titrant solution; and P is the volume of sample used.

Equation 2:

$$\text{TTA (\%)} = \frac{\text{V (mL) x f x M x 100}}{\text{P (mL)}}$$

It is worth mentioning that vitamin C and total titratable acidity were analyzed in duplicate.

Lycopene

Determined by spectrophotometry, according to Rodriguez-Amaya (2001). Pigment extraction was performed by employing approximately five grams of the sample plus 30 mL of acetone over a period of 15 minutes. Subsequently, the vacuum filtration of the extract into a kitassate was carried out so as not to lose the residue of the pulp. This residue was macerated in a crucible with 15 mL of acetone for three minutes and again filtered. This process was repeated three times for each sample. The extract was transferred to a separatory funnel with 25 mL of petroleum ether, which was washed to remove acetone. Afterwards, it was transferred to a 25 mL volumetric flask for reading in the spectrophotometer (model IL-592) at the wavelength of 470 nm. The lycopene content was found by equation 3, being expressed in microgram of lycopene per gram of pulp.

Equation 3:

$$\text{Lycopene } (\mu\text{g/g}) = \frac{\text{sample volume (mL) x absorbance x } 10^4 \text{ x dilution}}{\text{sample weight (g) x 3,450}}$$

For the accessions, a duplicate analysis was performed in cases where the standard deviation among the blocks was higher than 5.0 μg/g. This criterion was extended to 8.0 μg/g for commercial cultivars, due to the magnitude of the values presented by them.

Soluble solids

Determined using a LED analog refractometer (model ZGRB-32ATC) during collection of pulp samples, expressed in °Brix (AOAC, 1992). The SS/TTA ratio was determined by the ratio between the two variables.

Statistical analysis

Data was submitted to analysis of the assumptions of the analysis of variance, with transformation ($X = \sqrt{Y}$) for those who did not attend them. The analysis of variance and comparison of the means by the Scott-Knott test, at 5% of significance, were performed. The genetic distance between the genotypes was estimated by the "Standard Euclidean Mean Distance", whose generated matrix was used to obtain the similarity matrix, which was used in the cluster analysis by the Inverted Tocher Optimization Method, as recommended by Oliveira (2007). All analyzes were performed in the Genes Program (Cruz, 2013).

We estimated the sum of "Ranks" (Mulamba & Mock, 1978), adapted by Souza (2017), to help select the most promising genotypes for several characteristics simultaneously. For this, the means-grouping test (Scott-Knott, at 5% of significance) was used, assigning grades to the genotypes according to the group of means to which they belonged. The genotypes of the group of means with the most interesting values for each fruit quality variable received a grade of "1" and the other genotypes were assigned increasing grades according to the respective groups of means. The scores obtained by each genotype were summed in the different variables and those that obtained lower values for this sum of "Ranks" were considered as of better performance for fruit quality.

RESULTS AND DISCUSSION

The mean values of soluble solids, titratable total acidity and the ratio of these variables, as well as the vitamin C and lycopene content are shown in Table 1. There was a significant difference for all variables except for vitamin C. The soluble solids in the pulp ranged from 5.97 to 9.01 °Brix. The commercial variety "Perola" presented the highest mean value of soluble solids differing statistically from the evaluated genotypes, except for the cultivars Sugar Baby (8.65 °Brix) and Crimson Sweet (8.53 °Brix) and the accessions BGH/UNIVASF 60 (7.86 °Brix), 67 (8.08 °Brix), 91 (8.17 °Brix), 121 (8.03 °Brix), 177 (8.15 °Brix), 189 (8.32 °Brix), 190 (7.63 °Brix), 210 (7.67 °Brix), 258 (8.37 °Brix) and 312 (7.59 °Brix). Generally, in the Cucurbitaceae family the main sugars responsible for the sweetness of the pulp are glucose, fructose and sucrose (Barros *et al*., 2012). This is the most critical quality characteristic for watermelon, with the majority of open field cultivars in full maturity reaching between 10 and 13 °Brix (Kyriacou *et al*., 2018). The value recommended in the literature as minimum content to obtain the acceptable flavor in watermelon is 10 °Brix (Leão *et al*., 2006; Lima Neto *et al*., 2010; Barros *et al*., 2012). By international standards, the fruit can be classified according to the refractometric index when measured at the midpoint of the fruit in the equatorial section. For values ≥ 8 °Brix or ≥ 10 °Brix, the fruit is of "good internal quality" and "very good internal quality", respectively (Kyriacou *et al*., 2018).

The similarity in soluble solids content between traditional and commercial cultivars may be related to the "art enhancement" that the farmer practices by removing seeds from the tastiest fruits to cultivate later cycles. It is noteworthy that commercial cultivars were developed for conventional cultivation conditions with the application of highly soluble fertilizers. However, agroecological farming does not employ chemical fertilizers and the availability of nutrients does not occur with the same intensity compared to the conventional system. Thus, the soluble solids content obtained by commercial cultivars in agroecological systems was satisfactory compared to the results found by Lima Neto *et al*. (2010), who evaluated the quality of different varieties of watermelon in a conventional system, including Crimson Sweet and Sugar Baby varieties, which presented soluble solids content of 8.7 and 8.3 °Brix, respectively.

The titratable acidity variable did not meet the assumptions of the analysis of variance, even after data transformation. In quantitative terms, there was a variation in the acidity of the pulp of the watermelon fruits from 0.74 to 1.59. The acidic characteristic is derived from the presence of organic acids, such as malate (75%), citrate (> 20%) and other acids present at minimum concentrations (Kyriacou *et al*., 2018). This acidity reduces gradually during the maturation process, equilibrating with the soluble solids of the pulp, giving the sensation of freshness and improving the flavor and post-harvest performance of the watermelon (Kyriacou *et al*., 2018; Chitarra & Chitarra, 2005).

The relationship between soluble solids content and total titratable acidity (SS/TTA) is an important index to evaluate fruit flavor in preference to the isolated use of these variables (Chitarra & Chitarra, 2005). However, there are no available values in the literature of the SS/TTA ratio considered acceptable for watermelon. Chitarra and Chitarra (2005) establish for watermelon the minimum value of 10 °Brix for soluble solids, but do not define the minimum value of total titratable acidity for a balanced ratio. Thus, the values of this relation are very variable. For the evaluated genotypes there was a significant difference at 1% for SS/TTA (Table 1). The accessions BGH/UNIVASF 41 and 67 presented the highest mean values, being 10.34 and 10.85, respectively. However, these values did not differ from each other and were statistically the same as that of access 91 (8.41) and the commercial varieties Charleston Gray (9.21), "Perola" (9.17) and Sugar Baby (9.00). This fact stems from the low total titratable acidity obtained by the genotypes, making the fruits attractive to the consumer's taste. In general, the performance of commercial varieties in agroecological cultivation was similar to the results found by Lima Neto *et al*. (2010) in conventional cultivation, for the variable at stake.

Regarding the vitamin C content, there was no significant difference between the evaluated genotypes (Table 1). Uniformity for this characteristic reduces the chances of genetic gains. In absolute values, Crimson Sweet showed higher vitamin C content (5.41 mg/100 mL of juice) than the other evaluated treatments. The mean values found by Lima Neto *et al*. (2010) for commercial varieties of watermelon in conventional system of cultivation were slightly higher than those observed in this study, but also did not differ statistically. It is worth noting that the amount of vitamin C and other antioxidant compounds in fruits and vegetables is strongly influenced by genotypic differences and external factors such as agrotechnical processes, conditions, degree of maturation at harvest and post-harvest handling (Tlili *et al*., 2011).

Another antioxidant compound that plays an important role in the quality of watermelon is the lycopene content. For the evaluated genotypes there was a significant difference at 1% for the lycopene variable (Table 1), which was expressed as a fresh mass basis. The commercial varieties "Perola" and Sugar Baby obtained the highest mean values of lycopene, being 58.02 and 58.49 μg/g of pulp, respectively, not differing from each other. However, these values differed statistically from Crimson Sweet (38.60 μg/g) and Charleston Gray (38.67 μg/g) and BGH/UNIVASF 121 (32.34 μg/g). Approximately 70% of the evaluated genotypes presented average lycopene content ranging from 15.19 to 27.87 μg/g of pulp, the lowest values being found below 15.19 μg/g of pulp. The performance of commercial varieties in agroecological cultivation, especially Crimson Sweet and Charleston Gray cultivars, was satisfactory when compared to the results found by Leão *et al*. (2006), when evaluating eight commercial cultivars in a conventional system with average lycopene contents of 22.64 and 22.28 μg/g of pulp for Crimson Sweet and Charleston Gray varieties, respectively.

Nevertheless, it is important to highlight the influence of the genetic factor and also the conditions of cultivation and laboratory analytical gait in the quantification of lycopene. Thus, there is great variation in lycopene contents available in the literature for watermelon. In a study with open-pollinated cultivars and seedless watermelon hybrids, Fish *et al*. (2002) observed a variation in lycopene content between 39.1 and 63.0 μg/g of pulp. Setiawan *et al*. (2001) studied the quality of 18 fruit species produced in Indonesia and observed variation in lycopene content from 87.31 to 135.23 μg/g of watermelon pulp. Carotenoid composition of 50 watermelon cultivars was studied by Perkins-Veazie *et al*. (2006) and found a high variability of lycopene content between cultivars in the range of 35.2 to 112.4 μg/g of pulp.

For the sum of "Ranks" index (Figure 1), the commercial cultivars "Perola" (PER) and Sugar Baby (SG) obtained index 5, showing a better performance for the variables analyzed. The BGH/UNIVASF accessions 67, 91 and 121 displayed good performance for the quality characteristics with index 7 which is the same value obtained by commercial cultivars Crimson Sweet (CS) and Charleston Gray (CG).

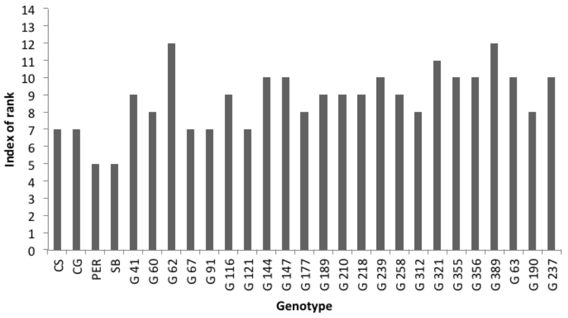

Figure 1 - Sum of "Ranks" index for 23 accessions and four commercial varieties of watermelon grown in agroecological system.

The study of genetic diversity using the criterion of similarity for the variables analyzed allowed to separate the most similar genotypes in different groups, while those more genetically distant were allocated in the same group. Thus, 18 different genetic groups were formed (Table 2). Group I was the most numerous, with seven accessions and three commercial cultivars, indicating that these are the most genetically divergent genotypes for fruit quality. The other 17 genotypes were allocated in separate groups, evidencing similarity and, consequently, narrowing of the genetic base, fact that reduces the chances of gains for the studied characteristics.

In the field of plant breeding, hybridization between divergent parents is basic in order to

Table 1 - Mean values of soluble solids (SS), total titratable acidity (TTA), soluble solids/titratable acidity ratio (SS/ATT), vitamin C (VC) and lycopene for 23 accessions of watermelon and four commercial varieties cultivated in agroecological system

Geno-type	SS** (°Brix)		TTA[5] (%)		SS/TTA**		VC^{ns} (mg/100 mL of juice)		Lycopene** (µg/g)[6]	
CS[1]	8.53	± 0.5 a	1.29	± 0.4	6.93	± 1.8 b	5.41	± 1.7	38.60	± 2.1 b
CG[2]	7.23	± 0.5 b	0.94	± 0.5	9.21	± 4.5 a	3.89	± 0.9	38.67	± 3.5 b
PER[3]	9.01	± 0.2 a	1.00	± 0.2	9.17	± 1.3 a	5.02	± 1.9	58.49	± 3.9 a
SB[4]	8.65	± 0.5 a	0.96	± 0.1	9.00	± 0.2 a	4.48	± 1.2	58.02	± 7.9 a
41	7.41	± 0.1 b	0.74	± 0.1	10.34	± 1.9 a	3.94	± 0.5	20.13	± 1.5 c
60	7.86	±.03 a	1.04	± 0.2	7.74	± 1.6 b	3.73	± 0.7	27.87	± 3.0 c
62	6.51	± 0.1b	1.04	± 0.1	6.36	± 0.9 b	2.97	± 0.2	4.01	± 0.7 d
63	7.26	± 0.4 b	1.14	± 0.2	6.47	± 0.8 b	3.35	± 0.7	19.78	± 3.4 c
67	8.08	± 0.6 a	0.78	± 0.2	10.85	± 2.5 a	4.12	± 0.8	24.70	± 3.6 c
91	8.17	± 0.2 a	1.04	± 0.3	8.41	± 2.7 a	4.24	± 1.2	24.51	± 4.4 c
116	6.34	± 0.6 b	1.21	± 0.4	5.84	± 2.7 b	3.53	± 0.3	23.59	± 3.0 c
121	8.03	± 0.4 a	1.59	± 0.1	5.08	± 0.5 b	3.00	± 0.5	32.34	± 1.0 b
144	6.60	± 0.4 b	1.01	± 0.3	6.73	± 1.4 b	3.38	± 0.3	16.04	± 1.3 c
147	6.54	± 1.0 b	0.98	± 0.04	6.66	± 0.9 b	3.72	± 0.3	15.19	± 6.1 c
177	8.15	± 0.2 a	1.16	± 0.3	7.46	± 2.3 b	4.06	± 0.4	22.44	± 0.6 c
189	8.32	± 0.3 a	1.23	± 0.1	6.81	± 0.8 b	3.24	± 0.6	19.05	± 2.3 c
190	7.63	± 0.5 a	1.11	± 0.3	7.03	± 1.1 b	4.44	± 1.1	22.72	± 3.7 c
210	7.67	± 0.6 a	1.18	± 0.2	6.64	± 1.2 b	3.53	± 0.6	19.62	± 2.5 c
218	6.90	± 0.3 b	1.08	± 0.3	6.83	± 2.3 b	3.90	± 0.2	23.41	± 4.4 c
237	6.65	± 1.0 b	1.22	± 0.4	5.85	± 2.1 b	3.90	± 0.5	15.85	± 1.8 c
239	5.97	± 0.9 b	0.98	± 0.2	6.14	± 0.4 b	2.96	± 0.8	17.78	± 2.4 c
258	8.37	± 0.6 a	1.34	± 0.4	6.60	± 1.8 b	4.58	± 1.2	19.16	± 1.3 c
312	7.59	± 0.7 a	1.24	± 0.1	6.14	± 0.6 b	3.48	± 0.9	22.27	± 3.7 c
321	6.50	± 0.7 b	1.12	± 0.1	5.87	± 1.2 b	3.90	± 1.7	9.72	± 3.2 d
355	6.62	± 0.3 b	1.25	± 0.05	5.30	± 0.2 b	4.50	± 1.9	17.03	± 2.5 c
356	7.07	± 0.7 b	1.12	± 0.1	6.35	± 1.1 b	4.31	± 0.6	19.17	± 5.4 c
389	6.62	± 0.4 b	1.09	± 0.05	6.10	± 0.2 b	3.84	± 1.0	3.71	± 0.7 d
Min.	5.97		0.74		5.08		2.96		3.71	
Max.	9.01		1.59		10.85		5.41		58.49	
Avarege	7.42		1.11		7.11		3.90		23.48	
C.V(%)	11.20		15.54		20.74		15.46		54.74	

CS[1]: Crimson Sweet. CG[2]: Charleston Gray; PER[3]: "Perola"; SG[4]: Sugar Baby; TTA[5]: Standard deviation of total titratable acidity: 0.17; Lycopene[6]: variable transformed by the square root method (X = √Y); **groups of means followed by the same letter in the column do not differ between each other by the Scott-Knott test at 1% significance; ns: not significant.

have in their segregating generations a greater possibility of recovering transgressive genotypes (Falconer, 1987). However, it is important that genetically divergent parents are selected from a group of promising genotypes. In this context, accessions BGH/UNIVASF 67, 91 and 121 performed well considering all quality variables studied (G 67, G 91 and G 121, respectively - Figure 1) and two of these accessions (BGH/UNIVASF 67 and 121) were allocated in the group of the greatest dissimilarity (Group I - Table 2). Thus, the accessions BGH/UNIVASF 67 and 121 have the potential to be inserted in a hybridization program because they present good means and belong in the group with the greatest genetic divergence.

Although the performance of commercial varieties was satisfactory in terms of fruit quality, when cultivated in an agroecological system these same varieties showed high susceptibility to powdery mildew (Santos, 2016) and low productivity (Souza, 2017), which limits their indication to be interbreeding in breeding programs geared towards more sustainable systems. However, another possibility to maximize the chances of genetic gains is to insert the cultivars "Perola"

Table 2 - Grouping established by the Inverted Tocher Optimization Method among 23 accessions and four commercial varieties of watermelon on fruit quality

Group	Genotype (BGH/UNIVASF)									
I	Perola	62	121	67	Crimson Sweet	239	41	355	Sugar Baby	389
II	258									
III	189									
IV	116									
V	321									
VI	Charleston Gray									
VII	237									
VIII	312									
IX	144									
X	147									
XI	63									
XII	210									
XIII	91									
XIV	177									
XV	356									
XVI	190									
XVII	60									
XVIII	218									

and/or Sugar Baby in the breeding program, since these presented good performance among the commercial varieties and crossed them with genotypes that also presented good performance for the quality variables, especially the accessions BGH/UNIVASF 67, 91 and 121.

CONCLUSIONS

There was genetic variability for all fruit quality variables evaluated, except for vitamin C content. Among the genotypes studied, the BGH/ UNIVASF 67 and 121 accessions are promising due to good fruit quality and broad genetic dissimilarity. The cultivars "Perola" and Sugar Baby stood out as to the quality of fruit among the commercial varieties, which could be crossed with genotypes that also presented good performance, especially the accessions BGH/UNIVASF 67, 91 and 121.

ACKNOWLEDGEMENTS

Research developed with financial support received from the National Council for Scientific and Technological Development - CNPq - Brazil (Case Nº: 462355 / 2014-4).

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