

Growth, yield and phytochemical characterization of small watermelon varieties in hydroponics

ABSTRACT

The objective of this study was to characterize four small watermelon varieties (Extasy Hazeera®, Ki Kodama, Beni Kodama and Tayo Sakama®) grown in hydroponic system regarding plant growth, fruit yield, basic composition and content of main phytochemical elements. Varieties presented similar dry matter production and partitioning. The highest fruit yields were achieved by 'Extasy' and 'Ki Kodama' (17.02 and 16.07 kg m⁻²). The varieties did not differ with regard the fruit basic composition. There was negative emphasis on pulp of variety 'Ki Kodama' (yellowish color), in which was detected the lowest levels of: ascorbic acid (AA=48.0 µg g⁻¹), folic acid (FA=0.025 µg g⁻¹), total lycopene (TL =8.0 µg g⁻¹) and total carotenoids (TC=43.0 µg g⁻¹); besides the lowest antioxidant activity (20.23%). By the other side, 'Ki Kodama' was higher regarding the content of β-carotene (31.0 µg g⁻¹). Varieties of reddish pulp ('Beni Kodama', 'Extasy' and 'Taiyo') did not showed significant difference concerning the studied phytochemicals levels, with average of: AA content (from 70.7 to 80.0 µg g⁻¹), FA content (from 0.046 to 0.054 µg g⁻¹), TL (from 56.4 to 65.7 µg g⁻¹), for TC (from 70.0 to 80.0 µg g⁻¹) and for β-carotene (from 9.7 to 11.0 µg g⁻¹). The obtained results allow concluding that although varieties present similar plant growth and basic composition of fruits, 'Extasy' and 'Ki Kodama' demonstrate larger fruit yield potential. However, except for the high content of β-carotene, 'Ki Kodama' presents fruits with low levels of phytochemicals and reduced antioxidant activity. Varieties with reddish color pulp have presented proper levels of phytochemicals in fruits.

Keywords: *Citrullus lanatus*, soilless cultivation, post harvest, quality, lycopene, dry matter partitioning.

1. INTRODUCTION

Although there is virtual consensus about the importance of eating fruits and vegetables for the prevention of chronic diseases [1], the consumption of these foods has not increased in Brazil [2]. The causes of this situation are several, but include cultural, socio-educational and economic features besides factors intrinsic to the product itself [3]. In the last case, the appearance and practicality have been named as fundamental to the intention to purchase and consumption of fruits and vegetables [4]. In this sense, watermelon [*Citrullus lanatus* L.(Thunb.) Matsum & Nakai] is a widely accepted fruit vegetable by appearance, crunchiness, flavor and freshness it provides, but has the limitation of being a product "impractical", especially by its excessive size. The cultivation of the small watermelons may be an interesting alternative, since maximizing convenience of the product reduces the intensity of the negative attributes named.

In addition to fruits of smaller size, it is expected that the cultivation of small watermelon plants creates good-looking fruits and present high agronomic yield. In this case, one of the proposals is the protected cultivation with the use of closed soilless growing systems, such as the hydroponic system NFT (Nutrient Film Technique), which shows itself promising and has enabled increased yield and quality of vegetables [5]. In addition, there are reduced waste of water and nutrients in this production system. But it is widely known that the cultivation systems should be tested for each species and variety [6, 7]. That is why in this work there will be evaluated agronomic (fruit yield and basic composition and growth components) and phytochemical variables [Total Content of Soluble Solids (TSS), pH, total titratable acidity (TTA), Ascorbic Acid Content (AA), Folic Acid (FA), Total Lycopene (TL), Beta Carotene (β-carotene), Total Carotenoids (TC) and Antioxidant Activity].

The NFT system is well established for some species, as is the case of leafy vegetables and some fruit vegetables such as tomato, and has been shown to be capable of providing high yield and quality [8, 9]. However, for small watermelon varieties included in this work, there is no information that supports the estimate of plant growth, fruit yield and quality. The hypothesis is that the small watermelon grown in protected environments and NFT system can generate high fruit yield with consistent quality to consumer demands, all with reduced environmental impact, especially in relation to the consumption of water, fertilizers and pesticides.

Regarding the actual intrinsic quality itself, watermelon is an important source of carotenoids, phenolic compounds and organic acids, which gives antioxidant potential [6, 1, 10, 11]. However, these groups of compounds, commonly called as resulting molecules of secondary metabolism, have their synthesis and accumulation strongly associated with genotypic characteristics and cultivation conditions in order to act as a defense mechanism to biotic and abiotic stressors agents [12]. Therefore, the characterization of the varieties in each cultivation condition is very important in order to quantify the presence of these compounds widely named as promoters of functional properties in vitro and in vivo.

Thus, this work aimed to characterize different varieties of small watermelon with regard to the dry matter production and partitioning and fruit yield and quality in hydroponics.

2. MATERIAL AND METHODS

The experiment was conducted at the Didactic and Experimental Field of the Department of Plant Science of the Federal University of Pelotas, located in the city of Capão do Leão, RS, Brazil. The climate of this region is characterized by being tempered, well distributed rainfall and hot summer, and according to Köppen classification, of Cfa type. The plants were grown inside a symmetric roof structure greenhouse (10.0 m x 21.0 m and 5.0 m maximum height), covered with polyethylene plastic film thickness of 150 μm , arranged in north-south direction. The experiment was conducted from October 30th, 2011 (sowing) to February 14th, 2012 (final harvest).

Four small watermelon varieties were studied: 'Beni Kodama' (Sakama®), 'Extasy' (Hazera®), 'Ki Kodama' (Sakama®) and 'Taiyo' (Sakama®). Seeds were sown in phenolic foam cubes (2.5cm x 2.5cm x 3.8cm). Ten days later, when seedlings presented completely open cotyledons, irrigation with nutrient solution at 50% of the original concentration started, keeping it until seedlings reached from three to four true leaves. Twenty-nine days after sowing, the plants were transplanted to the hydroponic NFT cultivation channels. Randomized blocks experimental design was used with four treatments (varieties) and three biological replications.

The greenhouse contained 12 wood-made gullies (0.30 m wide and 7.50 m long) internally recovered by double face (black-white) plastic channels. Gullies were arranged in pairs sloping 2%. The gullies were connected to a nutrient solution catchment tank of 1000 liters. The pairs of double rows were 1.20 m apart with 0.50 m between-row distance. Spacing plants 0.37 m within-row distance imposed plant density at 3.1 plants m^2 . Using a 3/4 HP motor pump unit, fixed to the catchment tank, the nutrient solution was supplied to the NFT gullies by a PVC pipe for 30 minutes every 1 hour during the period from 8 a.m. to 19 p.m.

The nutrient solution employed by Marques et al. (2014) for watermelon crop was used, with electrical conductivity of 1.8 dS m^{-1} and the following macronutrients composition (mmol L^{-1}): 12.8 NO_3^- 1.4 $\text{H}_2\text{PO}_4^{2-}$; 2.0 SO_4^{2-} ; 0.8 NH_4^+ ; 6.0 K^+ ; 4.0 Ca^{2+} ; 1.7 Mg^{2+} ; and micronutrients (mg L^{-1}): 4.00 Fe; 0.56 Mn; 0.26 Zn; 0.22 B; 0.03 Cu; 0.05 Mo.

Nutrient solution supplied to the crop was monitored daily by measuring electrical conductivity (EC) and pH. The adjustment of the EC was realized by water or stock concentrated nutrient solution addition when EC showed variation of 10% above or below the value of 1.8 dS m^{-1} , respectively. The pH was maintained in a range of 6.0 ± 0.5 by addition of correction solution based on potassium hydroxide (1N KOH) or sulfuric acid (1N H_2SO_4).

Plant training was done through plastic stake nets. All side shoots were removed until 8th leaf axil. Fruits were allowed to grow only from the 12th leaf axil side shoots, removing all hermaphrodite flowers of the main stem. Fruits were sustained through plastic nets bags fixed in stake nets.

All plants were harvested 78 days after setting (107 days after sowing) in order to evaluated plant growth and photoassimilate partitioning. The fresh and dry weights (after drying at 650 C in a forced air oven until constant matter) of roots, leaves (including petioles), stem and fruits (including peduncles) of 4 plants per replication (12 plants per treatment) were measured. At the end of the experiment cumulative weights including all previous harvests were calculated. The cumulative leaf area were also measured by leaf area integrator equipment (LI-COR, model 3100).

The evaluation of fruits composition were performed employing three technical analysis of each biological replication, considering the eatable pulp of the small watermelons as working sample. Besides the color, total soluble solids (TSS), pH, total treatable acidity (TTA), ascorbic acid content (AA), folic acid content (FA), total carotenoids (TC) and individual [β -carotene and lycopene (TL)] and antioxidant activity in vitro were determined. These methods are detailed by Tiecher et al. (2013), who have optimized the conditions for tomatoes. These were considered suitable for small watermelons, which was evidenced by preliminary tests showing that the methodological procedures were efficient and effective for this pattern.

The data were analysed by analysis of variance and means were compared according to Tukey test (P= .05).

3. RESULTS AND DISCUSSION

The varieties plant growth was similar (Table 1). There were not observed statistical differences related to the following variables: total dry matter (TDM), fruit dry matter (FDM) production and dry matter partitioning among the plant organs (root, stem, leaves and fruits). The accumulated TDM was 341.72; 397.14; 375.81 and 331.61 g plant⁻¹, respectively, for 'Beni Kodama', 'Extasy', 'Ki Kodama' and 'Taiyo'. According to DM partitioning data (Table 1), the general behavior of varieties shows that at the end of the experiment, on average, 72.2% of TDM was allocated to the fruits. Leaves represented the vegetative organs which most accumulated DM (14.8% of plant TDM), followed by stems (10.4% of plant TDM) and the roots (2.5% of plant TDM).

Table 1. Total dry matter (TDM), leaf area index (LAI), dry matter partitioning, fruit dry matter (FDM) and fruit dry matter content (FDMC) of small watermelon varieties in hydroponics

Varieties	TDM (g plant ⁻¹)	LAI	Dry matter partitioning (%)				FDM (g plant ⁻¹)	FDMC (%)
			Root	Stem	Leaves	Fruits		
Beni Kodama	341.72 a*	2.23 ab	2.6 a	11.0 a	15.4 a	71.0 a	242.32 a	6.84 a
Extasy	397.14 a	2.85 a	2.6 a	10.1 a	15.7 a	71.6 a	285.92 a	5.31 b
Ki Kodama	375.81 a	1.97 b	2.0 a	9.0 a	12.8 a	76.2 a	287.63 a	5.66 ab
Taiyo	331.61 a	1.86 b	2.8 a	11.5 a	15.5 a	70.2 a	233.18 a	6.34 ab
CV (%)	10.47	11.80	22.5	13.0	9.7	4.3	13.53	8.45

* Means followed by the same letter in the column do not differ at 5 % probability by the Tukey test.

Studies about DM production and partitioning among the plant organs, as well as the relationships that rule these dynamics, is an important tool for characterizing growth. Differences in DM partitioning are commonly attributed to genetic factors (variety), such as in this research and environmental conditions (cultivation system) [14].

In this study high values for TDM production (Table 1), achieving overall average of 361.57 g plant⁻¹ (equivalent to 1120.86 g m⁻²) were obtained. Working with the 'Smile' variety in soil grown, Aumonde et al. (2011a) demonstrated lower TDM (200.62 g plant⁻¹ representing 321.0 g m⁻²). This outstanding difference on total accumulation of DM can be explained by the high availability of water and nutrients offered to the plant associated with the intrinsic characteristics of the varieties used in the study.

Regarding DM allocated to the roots, usually they represent a small fraction of the total DM of plant [14]. In hydroponics, a high growth of shoots with a reduced root system are usually founded [9], as

observed in this study (Table 1). This fact is explained by the frequent supply of water and mineral nutrients to the plant which reduces the need for the roots develop.

The average value of 72.2% of DM allocated to fruits fraction was higher than the result observed with the small watermelon 'Smile' (42% DM for fruits) by Aumonde et al. (2011a) in soil cultivation and greenhouse condition. Researches on conventional watermelons grown in soil indicate that fruits represent from 63.9% [7] to 69% [16] of the plant DM. Thus, a tendency of small watermelons varieties to present higher capacity to destine photoassimilates for the generative fraction when produced in hydroponic systems can be inferred.

'Extasy' showed leaf area index (LAI) of 2.85, statistically similar to the value of 'Beni Kodama' (2.23) and higher than 'Ki Kodama' (1.97) and 'Taiyo' (1.86) (Table 1). The study of morphological and physiological variables such as the LAI constitutes an important parameter to be considered in growth analysis and development of photosynthetic organs, and the interception of solar radiation by the crop [14]. In this sense, 'Extasy' stood out for its high LAI.

On the other hand, fruits of 'Extasy' (5.31%) had lower dry matter content than 'Beni Kodama' fruits (6.84%), both of which did not differ from 'Taiyo' (6.34 %) and 'Ki Kodama' (5.66 %) in this feature (Table 1). The greatest dry matter content of 'Beni Kodama' fruits shows greater DM accumulation per unit of fruit fresh matter. So, this result reinforces the idea that the accumulation of water in fruits occurs at a different rate from the DM accumulation since the small watermelon 'Extasy', whose results showed the lowest fruit dry matter content, was statistically higher than 'Beni Kodama' relative to fruit yield (Table 2).

Table 2. External and internal image, color pulp (CP), fruit number (FN), average fruit weight (AFW) and fruit yield of small watermelon varieties in hydroponics

Varieties	External image	Internal image	CP		FN (Fruit Plant ⁻¹)	AFW (Kg)	Fruit yield (Kg m ⁻²)
			°Hue	C			
Beni Kodama			32.69 c*	25.58 a	2.50 a	1.42 a	11.01 b
Extasy			27.47 c	29.09 a	3.00 a	1.83 a	17.02 a
Ki Kodama			100.67 a	30.63 a	3.20 a	1.62 a	16.07 a
Taiyo			39.57 b	27.02 a	2.80 a	1.29 a	11.20 b
CV (%)	-	-	4.37	16.37	13.90	16.29	9.28

* Means followed by the same letter in the column do not differ at 5 % probability by the Tukey test.

As expected, there was a great difference regarding to fruit appearance (Table 2). Externally, except the fruits of variety 'Taiyo', whose peel color is yellow, all other studied varieties showed light green peel coloring with dark green rifling in greater or lesser rate. Except 'Ki Kodama', which has yellow

pulp, the other varieties presented a tendency to reddish color pulp, varying only on tone. Considering that the Hue angle is a variable that considers the value 0° to the red color and 90° to the yellow color, the pulp of the fruits 'Ki Kodama' appears as yellow (Hue angle = 100.67°), and varieties 'Taiyo' (Hue angle = 39.57°), 'Beni Kodama' (Hue angle = 32.69°) and 'Extasy' (Hue angle = 27.47°) appear as reddish, being the more intense red 'Extasy' and 'Beni Kodama'. Furthermore, fruits of small watermelon triploid hybrid 'Extasy' differ by the absence of seeds (Table 2).

In reference to yield components, significant differences were not evident for fruit number (FN) and average fruit weight (AW) (Table 2). FN oscillated from 2.5 to 3.2 fruits plant⁻¹ and AW varied from 1.29 to 1.83 kg fruit⁻¹. Despite the absence of differences regarding the both previous variables, the combination of the higher FN and AW values led to 'Extasy' and 'Ki Kodama' presented higher fruit yield, respectively, 17.02 and 16.07 kg m⁻².

Regarding FN and AW, Marques et al. (2014) accounted for 2.2 and 1.7 fruits plant⁻¹ and 1.8 and 1.7 kg fruit⁻¹, respectively, for 'Rapid Fire' and 'Smile'. In an evaluation study of the physical characteristics of different varieties of watermelon in the region of Mossoró (RN), Neto et al. (2010) found high fruit AW for small watermelon 'Sugar Baby' (4.2 kg fruit⁻¹). AW values of small watermelon fruits suitable for market oscillate in the range from 1 - 3 kg fruit⁻¹ [17], and these figures were reached in this study (Table 2).

The obtained fruit yields ranged from 11.0 to 17.0 kg m⁻², respectively, for 'Beni Kodama' and 'Extasy' (Table 2), representing 110 t ha⁻¹ to 166 t ha⁻¹. The average yield was 109% higher than those obtained in the open field small watermelon production system [18], 142% higher than those referenced on soil greenhouse cultivation [19] and 126% higher than the obtained yield in hydroponics previous work [5].

Regarding the basic composition, varieties were very similar. They have presented values that did not differ statistically referring to TSS, pH and TTA, with average values of 9.8°Brix for TSS, pH 5.7 and TTA 0.13% of citric acid (Table 3). The main phytochemical compounds analysis emphasized the negative aspects of the pulp of 'Ki Kodama', in which were detected the lowest levels of AA (48.0 µg g⁻¹), FA (0.025 µg g⁻¹), TL (8.0 µg g⁻¹), TC (43.0 µg g⁻¹) as well as the lowest antioxidant activity (20.23%) (Table 3). Moreover, 'Ki Kodama' was higher in relation to β-carotene content (31.0 µg g⁻¹ of pulp), which is consistent with the yellow pulp color (Hue angle = 100.67°) (Table 2). Among varieties 'Beni Kodama', 'Extasy' and 'Taiyo' there were no significant differences on studied levels of phytochemicals, averaging: AA content (70.7 to 80.0 µg g⁻¹ of pulp); FA content (from 0.046 to 0.054 µg g⁻¹ of pulp); TL (from 56.4 to 65.7 µg g⁻¹ of pulp); TC (from 70.0 to 80.0 µg g⁻¹ of pulp) and β-carotene (from 9.7 to 11.0 µg g⁻¹ of pulp).

Table 3. Physical-chemical characteristics and the content of the main phytochemicals present in fruits of four small watermelon varieties in hydroponics

Varieties	TSS (°Brix)	pH	TTA (%)	AA (µg g ⁻¹)	FA (µg g ⁻¹)	TL (µg g ⁻¹)	β-carotene (µg g ⁻¹)	TC (µg g ⁻¹)	Antioxidant Activity (%)
Beni Kodama	10.27 a*	5.60 a	0.14 a	80.0 a	0.054 a	56.4 a	10.3 b	72.3 a	33.77 ab
Extasy	9.57 a	5.73 a	0.15 a	76.0 a	0.049 a	65.7 a	11.0 b	80.0 a	38.77 a
Ki Kodama	10.23 a	5.85 a	0.11 a	48.0 b	0.025 b	8.0 b	31.0 a	43.0 b	20.23 c
Taiyo	9.23 a	5.68 a	0.12 a	70.7 a	0.046 a	58.6 a	9.7 b	70.0 a	32.53 b
CV (%)	6.55	2.06	14.3	5.37	15.82	10.25	13.39	7.49	6.35

* Means followed by the same letter in the column do not differ at 5 % probability by the Tukey test. CV= coefficient of variation; TSS= Total Soluble Solids; pH= hydrogen potential; TTA= total treatable acidity; AA= Ascorbic Acid; FA= Folic Acid; TL= Total Lycopene; TC= Total Carotenoids; AA= Antioxidant Activity (% of inhibition).

In this work, the TSS content ranged from 9.23 to 10.27°Brix (Table 3). These values can be considered adequate, based on consumer markets requirement of watermelons with minimum TSS of 9°Brix [17]. Despite the marked phenotypic differences observed (color of skin and pulp, presence or absence of seeds), the TSS, as well as pH and TTA were similar. As the cultivation conditions were

the same for all varieties, this indicates that these materials have similarity in photosynthetic potential, considering that the main components of the TSS (sugars and organic acids) are products of photosynthesis [20]. The similarity of the photosynthetic potential is corroborated by similar DM production presented by the varieties (Table 1).

Several studies [18, 10, 6, 21] showed that the TSS values can vary depending on environmental conditions, cultivation systems, as well as used watermelon varieties. For example, Marques et al. (2014), working with small watermelons 'Rapid Fire' and 'Smile', obtained, respectively, 10.3 and 9.4°Brix, while Rodrigues et al. (2014), studying variety 'Rapid Fire', detected only 8.8°Brix in fruits. These studies with 'Rapid Fire' took place in the same location, in a protected environment, in the same growing season, but in different years, which means different environmental conditions and can explain the differences for the same variety.

Regarding AA content in the fruits, 'Ki Kodama' was lower than other analyzed varieties ($48.0 \mu\text{g g}^{-1}$), ['Beni Kodama' ($80.0 \mu\text{g g}^{-1}$), 'Extasy' ($76.0 \mu\text{g g}^{-1}$) and 'Taiyo' ($70.7 \mu\text{g g}^{-1}$)]. These values are close to those obtained by Neto et al. (2010) (from 60.7 to $87.8 \mu\text{g g}^{-1}$) and lower of those detected by Campagnol et al. (2012) (from 109.3 to $120.3 \mu\text{g g}^{-1}$). In general, watermelons are not rich source of AA, containing from 10 to $80 \mu\text{g g}^{-1}$ [11, 22]. Exceptionally, there is reference of higher levels [19]. The levels observed ranged from 48.0 to $80.0 \mu\text{g g}^{-1}$, indicating moderately fruits rich in AA. Among the studied varieties, 'Ki Kodama' was the poorest in this vitamin C source which can be ascribed to the genetic factor, given that cultivation conditions was the same for all varieties.

Similar to what happened with the AA content, FA content was also lower in 'Ki Kodama' (Table 3). Although FA values are relatively low, this is an important molecule, because contributes to functional properties and highlight relevance of the effect of folic acid in the prevention and cancer therapy [23]. The dark green leafy vegetables, asparagus, corn, peanuts, yeast, citrus fruits as well as whole grains, which have levels between 0.2 and $1.6 \mu\text{g g}^{-1}$ [24] are considered the main natural sources of the phytochemical. However, despite reduced amount, the presence of FA in the chemical constitution of small watermelon was identified.

In watermelons, the red color is due to the lycopene accumulation [6, 10, 25]. Thus, it was expected that red pulp varieties had more lycopene, which effectively occurred: 'Beni Kodama' ($56.4 \mu\text{g g}^{-1}$), 'Extasy' ($65.7 \mu\text{g g}^{-1}$) and 'Taiyo' ($58.6 \mu\text{g g}^{-1}$). Compared TL concentrations found in other varieties, these figures, especially relating to varieties of red pulp, can be considered good, considering that Leão et al. (2006) detected levels of 22.64 , 29.90 and $30.14 \mu\text{g g}^{-1}$ for varieties 'Crimson Sweet', 'Rubi' and 'Smile', respectively. Besides, Aumonde et al. (2011 b) detected the value of $12.72 \mu\text{g g}^{-1}$ for variety 'Smile', and Choo and Sin (2012) observed only $9.5 \mu\text{g g}^{-1}$ in red pulp watermelon varieties. On the other hand, Perkins-Veazie et al. (2006) found TL content of $93.0 \mu\text{g g}^{-1}$ in seedless watermelon variety 'Extasy'.

Another component of carotenoids in fruits and vegetables is β -carotene [23]. This phytochemical compound, vitamin A precursor, was detected at higher levels in the yellow variety ('Ki Kodama' = $31.0 \mu\text{g g}^{-1}$). This value is three times higher than those of red pulp varieties on average (9.7 to $11.0 \mu\text{g g}^{-1}$; Table 3). This result was similar to that obtained by Perkins-Veazie et al. (2006), whereby, among 50 watermelon varieties with red colored pulp, the maximum value of β -carotene was $10.2 \mu\text{g g}^{-1}$. Aumonde et al. (2011 b) obtained only $0.39 \mu\text{g g}^{-1}$ for small watermelon 'Smile', whose pulp is red. Thus, in general, the varieties studied in this work are good sources of provitamin A, even those of red pulp.

Total carotenoids (TC) of the studied small watermelons are represented, mostly, by lycopene and by beta carotene, which represent, on average, from 78 to 83.7% of TC. The lowest TC values were found in 'Ki Kodama' fruits ($43.0 \mu\text{g g}^{-1}$), while the varieties 'Beni Kodama', 'Extasy' and 'Taiyo', with 72.3 , 80.0 and $70.0 \mu\text{g g}^{-1}$, respectively, presented higher TCs (Table 3). In 'Ki Kodama' fruits (yellow pulp), lycopene corresponds to only 18.6% of TC content, while β -carotene represents 72.1% of TC. Oppositely, in the red pulp varieties, β -carotene is equivalent to a small fraction of TC content ($13.7 - 14.2\%$), whereas lycopene is around 80% of TC. These results indicate that in addition to this qualitative difference, small watermelons can be considered a good source of TC, based on levels commonly found in other foods cited as sources of those compounds [28].

Regarding antioxidant activity determined in vitro, there was emphasis on varieties 'Beni Kodama' and 'Extasy', followed by 'Taiyo' and 'Ki Kodama' (Table 3), what is consistent with the composition of phytochemicals. 'Ki Kodama' fruits presented low AA, FA and TL contents and, consequently, the lowest antioxidant activity (20.23%; table 3). The other three studied varieties, which were richer in AA, FA and TL, presented 35.02% of antioxidant activity on average (Table 3).

4. CONCLUSION

Although varieties presented similar plant growth and basic composition of fruits (TSS, pH and TTA), 'Extasy' and 'Ki Kodama' demonstrated larger fruit yield potential. However, except for the high content of β -carotene, 'Ki Kodama' presents fruits with low levels of phytochemicals and reduced antioxidant activity. Varieties with reddish color pulp have presented proper levels of phytochemicals in fruits.

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