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Nutritional Composition and Antioxidant Capacity of Four Tomato Varieties (*Lycopersicon esculentum* Mill) Cultivated in Cote d'Ivoire

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Authors' contributions

This work was carried out in collaboration among all authors. Author SD designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors ENK, IC, AAA, KY and AAAL managed the analyses of the study. All authors read and approved the final manuscript.

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ABSTRACT

Aims: This study is to ascertain nutrient content and antioxidant compounds of four varieties of *Lycopersicon esculentum* Mill. (UC82b, Amiral F1, Local cotelette and Local cerise) grown in Cote d'Ivoire.
Study Design: This study is to assess the nutritional and antioxidant value of tomatoes (*Lycopersicon esculentum* Mill.) grown in Cote d'Ivoire in order to know if they can help to prevent against oxidative stress.

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Place and duration of Study: Four ripe tomato varieties were collected from different tomato fields in Yamoussoukro district (Cote d'Ivoire) during season from December 2016 to January 2017. The determination of nutrient content and antioxidant compounds were ascertained at the LAPISEN of INPHB (Yamoussoukro).
Methodology: Macronutrient and micronutrient of the four tomato varieties collected were determinate. Then, lycopene, polyphenol and flavonoid contents were assessed. The antioxidant capacity of tomato extracts was evaluated using DPPH method.
Results: Among the varieties studied, Amiral F1 has the highest antioxidant capacity with an EC50 of 3.47 mg/mL and the highest total polyphenol content (17.5 mg/100 g EAG of fw). Local cotelette variety is the richest in lycopene (2.9 mg/100 g of fw) and vitamin C (35.4 mg/100 g of fw). In addition, this variety also has the highest levels of calcium (31 mg/100 g of fw), magnesium (21 mg/100 g of fw) and potassium (333 mg/100 g of fw). UC82b is the best source of iron (0.065 mg/100 g of fw), phosphorus (23 mg/100 g of fw), manganese (0.086 mg /100 g of fw) and zinc (0 11 mg/100 g of fw).
Conclusion: This investigation showed that the different studied varieties of tomato possessed high antioxidant capacities. As a result, they could be used to fight against oxidative stress.

Keywords: Antioxydant activity; lycopene; total polyphenols; tomato varieties.

1. INTRODUCTION

Lycopersicon esculentum Mill commonly known as tomato is from Northwestern of South America. It has been considered a long time like an ornamental plant. Today, tomatoes are among fruit-vegetables which are most consumed in the world. It is the third most cultivated species in the world after potatoes and sweet potatoes [1]. In addition, it is the second most consumed fruit-vegetable in the world after potatoes [2].

Tomatoes present different colors depending on their stage of maturity (green, yellow, orange or red). Their red color indicates the full maturity stage. This coloring is due to carotenoids synthesized during its maturation [3]. The main carotenoid responsible for this coloring is lycopene, which contents a very powerful antioxidant [4]. Lycopene is only brought to body by food [5].

According to Giovannucci [6], the high consumption of lycopene or tomato products protect people against prostate cancer. Also, there are a correlation between tomatoes consumption or tomato-based foods and diseases reduction such as cardiovascular diseases, gastrointestinal infections and epithelial cell infections [7,8]. This would be due to antioxidant compounds found in tomatoes such as vitamins C and E, flavonoids and other phenolic compounds [9]. Other studies have highlighted nutritional and antioxidant properties of tomatoes [10,11,12]. However, little scientific data are available for tomatoes from Cote d'Ivoire. So, various conditions such as the climate, soil type, variety and maturity stage can influence the physicochemical, antioxidant and nutritional composition of plant's fruits [13,14]. Thus, the present study focused about determination of the nutritional value and antioxidant capacity of four varieties of tomato grown in Cote d'Ivoire. They will determine macronutrient (carbohydrates, lipids and proteins), micronutrient, oligo nutrient contents, antioxidant compounds and evaluate the antioxidant activity of these varieties.

2. MATERIALS AND METHODS

2.1 Material

2.1.1 Plant material

Three local varieties of tomato (*UC82b, Locale cerise* and *Locale cotelette*) and one hybrid variety of tomato called *Amiral F1* were used for this study (Fig. 1). These different varieties were harvested from three different farmers in Yamoussoukro district, namely N'gattakro, Zatta and Lolobo, from the Central of Cote d'Ivoire.

2.1.2 Chemicals

All chemicals used were analytical quality. Methanol (Carlo Erba, Spain), Folin-Ciocalteu reagent (Panreac quimica, Spain), sodium nitrite (Merck, Germany), calcium carbonate (Merck, Germany), aluminum chloride (Merck, Germany), sodium hydroxide (Scharlau, Spain), citric acid (Riedel-of-Haën, Germany), ethanol (Carlo Erba, Spain), acetone (Carlo Erba, Spain), hydrochloric acid (Pancreac quimica, Spain), sulfuric acid 96% (Carlo Erba, Spain). Standards used for polyphenols quantification were gallic acid (Sigma Aldrich, Germany) for total polyphenols and quercetin (Sigma-Aldrich, Germany) for total flavonoids. Standard multi element solution was used to characterize trace elements (Tecknolab AB, Sweden). DPPH (1,1-diphenyl-2-picryl-hydrazyl) for antioxidant activity assessment and β-carotene for carotenoids characterization were from Fluka (USA).

2.2 Methods

2.2.1 Sampling

Samples were performed during the period from December 2016 to January 2017. They concerned firm fruits at commercial maturity stage (red color). The fruits were kept in coolers containing ice and then sent to the laboratory. Then, the collected samples were gathered by variety and divided into two parts. The first part was dried at 60°C for 48 hours and then milled and the second part refrigerated at 4°C.

2.2.2 Preparation of ethanolic extract

Dried sample was ground and then 10 g of the ground material were homogenized in 100 mL of 70% (V / V) ethanol for 24 hours. The mixture was centrifuged at 1000 rpm for 10 min. The supernatant was recovered and dried at 60°C for 48 hours. After, extracts were used to determinate total polyphenols, total flavonoids and antioxidant activity of various tomatoes.

2.2.3 Determination of physicochemical parameters

Moisture content, ash content, dry matter, titratable acidity and pH were determined according to AOAC method [15].

2.2.4 Determination of macronutrient content

Crude fiber and total protein measurements extracted by Kjeldahl were determined using AOAC method [15]. In addition, total lipid content extracted by Soxhlet was determined according to AFNOR method [16]. Finally, total carbohydrate content was determined according to FAO method [17] using following formula:

Total Carbohydrates (%) = 100 - [(% Protein) + (% Lipid) + (% Water) + (% Ashes)]

2.2.5 Determination of energy value

Total energy value was determined according to FAO method [17] using following formula. Energy Value (Kcal / 100 g fw) = (% protein x 4) + (% lipid x 9) + (% carbohydrate x4)

2.2.6 Determination of mineral content

Minerals such as calcium, iron, magnesium, phosphorus, potassium, manganese and zinc were assayed by an atomic absorption flame spectrophotometer (Varian AA Spectrometer, Australia). Mineral contents of the different varieties of tomatoes were determined according to AOAC method by the calibration line of each desired mineral.

2.2.7 Determination of vitamin C content

Vitamin C content was determined according to Pelletier et al. [18] method. 10 grams of fresh cut tomatoes were crushed and solubilized in 40 mL of meta phosphoric acid (2%). The whole was then subjected to centrifugation at 3000 rpm for 20 minutes. The supernatant obtained was adjusted with distilled water to 50 mL. 10 mL of this solution was titrated with a solution of 2.6 DCPIP at 0.5 g / L until turning pink (pink champagne). Vitamin C content was determined as follow:

$$Vitamin\ C\ (\%) = \frac{(0{,}5 \text{ x v x } 10^3 \text{ x } 500)}{m_e}$$

With:

v: 2,6 DCPIP volume poured in equivalence
m_e: the test sample

2.2.8 Determination of total carotenoid content

Carotenoid content was determined according to FAO method [17]. 2 g of fresh tomatoes were crushed and homogenized in 50 mL of acetone until complete decolorization of the residue. The filtrates were introduced into a separating funnel and 100 mL of petroleum ether were added. The mixture was stirred slightly and then leaving at rest. The ether phase (phase containing carotenoids) was recovered in another bulb, washed with 50 mL of distilled water and then dried with 10 g of anhydrous sodium sulphate. Absorbance of this solution was read spectrophotometer at 450 nm against petroleum ether. Carotenoid content was determined according to a calibration line in β-carotene equivalent per gram of fresh crude.

2.2.9 Determination of lycopene content

Lycopene was measured in tomatoes according to method described by Benakmoom et al. [19]. 0.1 g of tomato powder was dissolved in 10 mL of solvent mixture (hexane / acetone / ethanol,

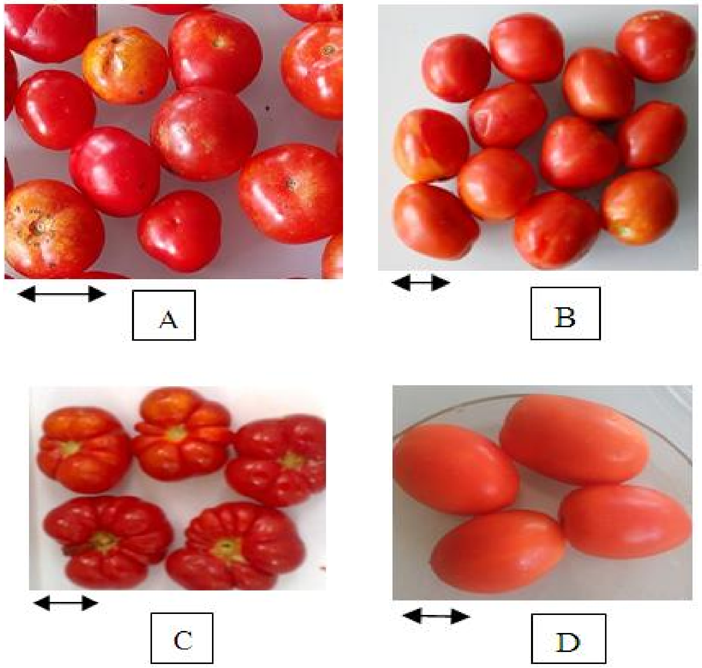

Fig. 1. Different varieties of tomato *Lycopersicon esculentum* Mill

A: Local cerise, B: UC82b, C: Local cotelette, D: Amiral F1 (hybrid)

50/50/1, V / V / V) and then stirred for 10 min. The whole was centrifuged at 5000 rpm for 15 minutes. Then, 1 mL of the organic phase was recovered and diluted in 10 mL of hexane. Absorbance of this solution was measured at 472 nm using hexane as blank. Lycopene content was determined according to the following formula:

$$Lycopene\ content\ (\%) = \frac{(\text{Abs}_{472} \text{ x Fd x } 10^5 \text{ x V})}{3450 \text{ x } 100 \text{ x m}}$$

Fd: Dilution factor
V: Volume of extraction solvent,
3450: Extinguishing coefficient of hexane,
m: Weight of the test sample.

2.2.10 Determination of total polyphenols in tomatoes

To 2.5 mL of Folin-Ciocalteu reagent diluted 1/10 were added 30 µL of diluted extract of tomato. The mixture was kept for 2 min in dark at room temperature (30 ± 2°C). 2 mL of Na_2CO_3 (75 gL^{-1}) was added. The resulting mixture was incubated at 50°C in a water bath during 15 minutes in order to allow total development of the blue color. The absorbance was read to UV-visible spectrophotometer at wavelength λ = 760 nm. Polyphenols assayed was expressed as mg EAG (Equivalent Gallic Acid) per g of dry plant extracted according to Singleton and Wood method [20,21]. Assays were performed in triplicate.

2.2.11 Determination of total flavonoids in tomatoes

Total flavonoid assay was performed according to the method described by Marinova et al. [22]. 2.5 mL of diluted extract was mixed with 0.75 mL of 5% (w/v) $NaNO_2$ and 0.75 mL of 10% (w/v) $AlCl_3$. After 6 min of reaction in dark at room temperature (30 ± 2°C), 5 mL of NaOH (1 M) were added to the mixture. The volume of the mixture was adjusted to 25 mL with distilled water and it was agitated vigorously. Absorbance of the solution was measured with spectro-photometric at λ = 510 nm. Total flavonoid assayed was expressed as mg QE (Equivalent Quercetin) per g of dried plant extract. All assays were performed in triplicate.

2.2.12 Determination of the antioxidant activity of tomatoes by the DPPH method

The antioxidant activity of tomatoes was determined according to the method described by Von gadow [23]. The inhibition percentage of DPPH by tomato extracts and their efficacy concentration at 50% (EC_{50}) were performed. 50 µL of ethanolic extract from different concentrations (1 to 10 $mg.mL^{-1}$), 5 mL of methanolic DPPH at 25 mg.L^{-1} were added. The mixture was incubated at room temperature without light for 30 minutes. Absorbance was read at 515 nm relative to methanol. About the control, 50 µL of of ethanolic extract was replaced by 50 µL of methanol. Inhibition percentage (% inh) of ethanolic extracts of tomato was determined as follows:

$$\%\,Inhibition = \frac{(A_0 - A_{30}) \times 100}{A_0}$$

With:

A_0: absorbance of control after 30 min of incubation,
A_{30}: absorbance of sample after 30 min of incubation.

The efficient concentration at 50% DPPH of the different extracts was determined according to the line f (C) = % inhibition. It has been determinate as follows:

$$EC_{50} = \frac{(50 - b)}{\mathrm{a}}$$

a: directing coefficient of the line, f (C) : % inhibition, b : y-intercept

2.3 Statistical Analysis

Statistical analysis was carried out by performing a one-way variances analysis (1-factor ANOVA) for all data (mean of each metered parameter). This analysis was performed using Statistica 7.1 software. Mean comparisons were made by the Newman-Keuls test at $p<0.05$.

3 RESULTS

3.1 Physicochemical Parameters of Tomatoes

Table 1 shows physicochemical parameter of four varieties of tomato (*UC82b*, *Amiral F1*, *Local cotelette* and *Local cerise*) grown in Cote d'Ivoire. Water contents of studied tomatoes are all greater than 91%. Ash levels determined for these tomatoes vary between 0.5 and 0.8%. In ascending order, ash rate of variety *UC82b* < *Amiral F1* < *local cerise* < *Local cotelette*. pH of these tomatoes varies from 3.6 to 4.1. *Local cerise* variety has the lowest pH (pH = 3.6) while *Amiral F1* variety has the highest pH (pH = 4.1). In ascending order of pH: pH (*local cerise*) < pH (*local cotelette*) < pH (*UC82b*) < pH (*Amiral F1*).

3.2 Nutritional Composition

3.2.1 Macronutrient content and energy value

Table 2 shows total protein, total carbohydrate, total lipid, fiber and energy value of four varieties of tomato (UC82b, Amiral F1, Local cotelette and Local cerise) grown in Cote d'Ivoire. Total protein content of the four tomatoes varieties ranges from 0.74 to 1.46 g per 100 g of fresh tomatoes. Among studied tomatoes, Local cotelette variety has the highest protein content. In contrast, UC82b variety contains the small amount of protein. However, statistical analyzes showed that there is no significant ($p > 0.05$) difference between protein content of Amiral F1 and *UC82b* varieties.

Total lipid content of these tomatoes ranges from 0.05 to 0.79 g per 100 g of fresh tomatoes. Results analysis showed that Local cerise variety is the richest in lipid and variety UC82b, the least rich in lipid. The results also indicate that Local cerise variety is the richest carbohydrate (5.58 g/100 g of fresh tomato). In contrast, Amiral F1 variety has the lowest carbohydrate content (3.48 g/100 g fresh tomato). Carbohydrate content of Local cerise is higher than that of Amiral F1, but this difference is not significative at ($p > 0.05$).

Fiber content of the four varieties of tomato is ranging between 0.7 and 2 g per 100 g of fresh tomatoes. *Local cotelette* variety has the highest fiber content and *Amiral F1* variety has the lowest fiber content.

Energy value of these four varieties of tomato ranges from 18 to 32 kilocalories per 100 g fresh tomatoes. *Local cotelette* variety has the highest energy value. *Amiral F1* variety has the lowestenergy value. In ascending order of energy value, we have energy value (*Amiral F1*)

Table 1. Physicochemical parameter of four tomato varieties per 100 g of fresh tomato

	pH	Moisture (g)	Dry matter (g)	Titrable acidity (meq)	Ash (g)
UC82b	4.10 ± 0.01 ^{c}	94.30 ± 0.10 ^{b}	5.69 ± 0.10 ^{b}	9.33 ± 0.57 ^{a}	0.51 ± 0.01 ^{a}
Amiral F1	4.00 ± 0.01 ^{d}	95.05 ± 0.01 ^{c}	4.95 ± 0.01 ^{a}	8.65 ± 0.56 ^{a}	0.59 ± 0.00 ^{a,b}
Local cotelette	3.90 ± 0.01 ^{b}	91.76 ± 0.04 ^{a}	8.24 ± 0.04 ^{c}	18.26 ± 1.12 ^{b}	0.77 ± 0.05 ^{c}
Local cerise	3.60 ± 0.05 ^{a}	93.99 ± 0.34 ^{b}	6.01 ± 0.34 ^{b}	26.00 ± 2.00 ^{c}	0.71 ± 0.08 ^{b,c}

These values are mean value ± standard error of means of 3 experiments. Values with the same letters in the same column are not significantly different at p < 0.05

Table 2. Macronutrient composition of four varieties of tomato per 100 g of fresh tomato

	Carbohydrates (g)	Lipids (g)	Proteins (g)	Energy value (Kcal)	Fibers (g)
UC82b	4.40 ± 0.02 [b]	0.05 ± 0.01 [a]	0.74 ± 0.06 [a]	21.02 ± 0.43 [a]	1.02 ± 0.11 [a, b]
Amiral F1	3.48 ± 0.02 [a]	0.11 ± 0.01 [a, b]	0.76 ± 0.01 [a]	17.99 ± 0.09 [a]	0.701 ± 0.03 [a]
Local cotelette	5.58 ± 0.14 [c]	0.43 ± 0.23 [b, c]	1.46 ± 0.06 [c]	32.03 ± 1.50 [c]	2.04 ± 0.38 [c]
Local cerise	3.56 ± 0.08 [a]	0.79 ± 0.14 [c]	0.95 ± 0.05 [b]	25.15 ± 1.73 [b]	1.48 ± 0.04 [b]

These values are mean value ± standard error of means of 3 experiments. Values with the same letters in the same column are not significantly different at p < 0.05

< energy value (*UC82b*) < energy value (*Local cerise*) < energy value (*Local cotelette*).

3.2.2 Micronutrient contents

Various mineral contents (Calcium, Iron, Magnesium, Phosphorus, Potassium, Manganese and Zinc) of four varieties of tomato grown in Cote d'Ivoire (*UC82b, Amiral F1*, *Local cotelette* and *Local cerise*) are summarized in Table 3. They present varying proportions of minerals such as calcium, iron, magnesium, phosphorus, potassium, manganese and zinc. Among those, *Local cotelette* is the richest in calcium (31 mg), magnesium (21 mg) and potassium (332.6 mg) while *UC82b* is the best source of zinc (0.11 mg) and phosphorus (22.62 mg). However, iron and manganese contents of the four varieties of tomato are not significantly different at $p < 0.05$.

3.3 Antioxidant Compound Contents

Antioxidant compounds content (vitamin C, carotenoid, lycopene, total polyphenols and total flavonoids) of four varieties of tomato (*UC82b, Amiral F1*, *Local cotelette* and *Local cerise*) grown in Cote d'Ivoire are given in Table 4. Vitamin C content of four studied varieties of tomato ranges from 9 to 35.4 mg per 100 g of fresh tomato. *Local cotelette* variety is the richest in vitamin C while *Amiral F1* variety is the least rich in vitamin C. Carotenoid content of four varieties of tomato varies from 13 to 21.6 mg equivalent β-carotene per 100 g of fresh tomato. *UC82b* variety has the highest carotenoid content while *Amiral F1* variety has the lowest carotenoid content. Statistical analyzes showed that there was no significant difference at $p < 0.05$ between carotenoid contents of *Local cerise* and *Local cotelette* varieties. Lycopene content of four varieties of tomato ranges from 1.7 to 2.9 mg per 100 g of fresh tomato. *Local cotelette* variety has the highest lycopene content (2.9 mg). In contrast, *Amiral F1* variety has the lowest lycopene content (1.7 mg). Classification from the lowest to the highest lycopene content is as follows: *Amiral F1* (1.7 mg) < *UC82b* (2.04 mg) < *Local cerise* (2.15 mg) < *Local cotelette* (2.95 mg). However, statistical analyzes showed that lycopene levels of *UC82b* and *Local cerise* varieties are not significantly different at $p < 0.05$. Total polyphenol content of four varieties of tomato ranges from 13 to 17.5 mg/100 g EAG of fresh tomato. *Amiral F1* variety contains the highest polyphenol content and *Local cerise* variety has the lowest polyphenol content.However, *Local cotelette* and *UC82b* polyphenol content does not show a significant difference at $p < 0.05$.

Total flavonoid content of the four varieties of tomato ranges from 2 to 3.1 mg/100 g quercetin equivalent of fresh tomato. Flavonoid level is highest in *Local cerise* variety (3.1 mg) whereas *UC82b* variety (1.98 mg) has the lowest flavonoid content. Flavonoid content of the different varieties of tomato in ascending order is as follows: *UC82b* (1.98 mg) < *Local cotelette* (2.5 mg) < *Amiral F1* (2.6 mg) < *Local cerise* (3, 1 mg). Statistical analyzes have also shown that there is no significant difference between flavonoid content of *Amiral F1* and *Local cotelette* varieties at $p < 0.05$.

3.4 Antioxidant Activity of Different Varieties of Tomato

Table 5 shows antioxidant activity of four varieties of tomato grown in Cote d'Ivoire (*UC82b*, *Amiral F1*, *Local cotelette* and *Local cerise*) using efficient concentration at 50 % (CE_{50}). CE_{50} of different varieties of tomato is ranged between 3.47 and 6.74 mg / mL of extract. It represents the amount of the extract which can reduce the DPPH radical at 50%. So, when the inhibitory concentration is low, the antioxidant capacity of the extract is higher [24]. In descending order, *Local cerise* variety has the highest efficient concentration at 50% and then *UC82b*, *Local cotelette* and *Amiral F1*. The antioxidant activity is as follows: *Amiral F1* > *Local cotelette* > *UC82b* > *Local cerise*. These varieties of tomato have lower antioxidant power than vitamin C.

Table 3. Mineral compositions of four varieties of tomato in mg per 100 g of fresh tomato

	UC82b	*Amiral F1*	*Local cotelette*	*Local cerise*
Ca	20.65 ± 0.52 ^{a}	19.88 ± 0.07 ^{a}	30.99 ± 0.30 ^{b}	22.23 ± 2.38 ^{a}
Fe	0.065 ± 0.02 ^{a}	0.046 ± 0.13 ^{a}	0.05 ± 0.02 ^{a}	0.05 ± 0.03 ^{a}
Mg	15.89 ± 0.57 ^{b}	11.85 ± 0.04 ^{a}	20.99 ± 0.20 ^{c}	17.02 ± 1.82 ^{b}
P	22.62 ± 0.82 ^{c}	12.90 ± 0.05 ^{a}	16.41 ± 0.14 ^{b}	19.68 ± 2.10 ^{c}
K	313.47 ± 11.40 ^{b}	248.39 ± 1,14 ^{a}	332.67 ± 3.12 ^{b}	313.04 ± 32.79 ^{b}
Mn	0.09 ± 0.03 ^{a}	0.06 ± 0,03 ^{a}	0.06 ± 0.01 ^{a}	0.07 ± 0.02 ^{a}
Zn	0.11 ± 0.03 ^{b}	0.06 ± 0.01 ^{a}	0.08 ± 0.01 $^{a, b}$	0.07 ± 0.00 $^{a, b}$

These values are mean value ± standard error of means of 3 experiments. Values with the same letters in the same column are not significantly different at p < 0.05

Table 4. Antioxidant compounds content of four varieties of tomato per 100 g of fresh tomato

	Vitamin C (mg)	Carotenoids (mg eq β-carotene)	Lycopenes (mg)	Polyphenols (mg EAG)	Flavonoids (mg EQ)
UC82b	20.34 ± 0.00 ^{b}	21.60 ± 1.00 ^{c}	2.04 ± 0.30 ^{b}	16.50 ± 1.30 ^{b}	1.98 ± 0.50 ^{a}
Amiral F1	9.04 ± 0.00 ^{a}	13.00 ± 0.30 ^{a}	1.77 ± 0.03 ^{a}	17.49 ± 3.70 ^{c}	2.60 ± 0.00 ^{b}
Local cotelette	35.40 ± 6.52 ^{c}	15.90 ± 0.10 ^{b}	2.95 ± 0.14 ^{c}	16.20 ± 2.00 ^{b}	2.50 ± 1.50 ^{b}
Local cerise	31.64 ± 0.00 ^{c}	17.00 ± 0.30 ^{b}	2.15 ± 1.20 ^{b}	12.80 ± 1.50 ^{a}	3.10 ± 1.00 ^{c}

These values are mean value ± standard error of means of 3 experiments. Values with the same letters in the same column are not significantly different at p < 0.05

4. DISCUSSION

Abundant presence of water in food promotes growth of several micro-organisms (other bacteria, yeasts and molds) [25]. The high perishability of tomatoes is due to this high water content. It causes difficulties in their conservation. However, acidity of these tomatoes could inhibit most of microorganisms which can deteriorate them except for acidophilic bacteria, yeasts and molds [26].

Ash content of various analyzed tomatoes is similar to those reported by Guil-Guerrero and Rebolloso-Fuentes [27] and Pinela et al. [28] who obtained ash levels of their studied tomatoes ranging from 0.6 to 1.4%. Existence of these ashes is a presumption of minerals presence in these different varieties. Protein, lipid and carbohydrate composition of these tomatoes also is close to those obtained by these same authors [28,27] except for *Local cerise* variety, which has a lipid content of 0.79%. This high lipid content of *Local cerise* may be due to the fact that climatic, environmental, maturity and tomato variety conditions significantly influence tomatoes nutrient content [14].

Micronutrient content of four varieties of tomato is close to that of tomatoes studied by Halevy et al. [29], Guil-Guerrero and Rebolloso-Fuentes [27]. These micronutrients vary slightly from one variety to another. These minerals are very important to prevent against several pathologies. Indeed, zinc and manganese can fight against inflammatory diseases [30]. They also promote the trapping of free radicals [31]. Potassium contributes to regulate arterial blood pressure [32,33]. Houston and Whelton have shown that 4700 mg by day of potassium supplementation will decrease arterial blood pressure from 4.4 to 2.5 mmHg. However, calcium has anti carcinogenic activity because it reduces colorectal cancer risk [34]. So with phosphorus, calcium can help to fight osteoporosis which is the weakening of bones due to calcium deficiency [35]. Magnesium is an enzymatic cofactor which limits conversion of linoleic acid to γ-linolenic acid. This latter may contribute to prostaglandin synthesis (substances causing brain disorders) [36,37].

If minerals are bioavailable, consumption of these different varieties of tomato could prevent hypertension, cancer and oxidative stress by trapping free radicals.

Among analyzed varieties, only vitamin C content of *UC82b* variety (20.34 mg) is similar to those obtained by Halevy et al. [29] and Raffo et al. [38] which have a content ranging between 11 and 21 mg per 100 g of fresh tomato. Vitamin C contents of *Local cerise* (31.64 mg) and *Local cotelette* (35.4 mg) varieties are higher than this

Table 5. Antioxidant activity of four varieties of tomato

		EC_{50} (mg/mL)
Variety of tomato	*UC82b*	6.27 ± 0.14 [d]
	Amiral F1	3.47 ± 0.16 [b]
	Local cotelette	4.26 ± 0.16 [c]
	Local cerise	6.74 ± 0.27 [e]
Reference	*Vitamin C*	2.72 ± 0.06 [a]

These values are mean value ± standard error of means of 3 experiments. Values with the same letters in the same column are not significantly different at $p < 0.05$

value. Also, *Amiral F1* variety which has a vitamin C content of 9 mg is lower compared to this value. These differences in vitamin C content between varieties may be due to the degree of maturity or the post-harvest conservation technique [38]. The presence of vitamin C in these tomatoes could be beneficial for consumer because it inhibits free radicals 'production and reduces oxidative stress [39]. In addition, it helps to regulate insulin levels about diabetic patients [40,41].

The α-carotene, β-carotene, β-cryptoxanthin, lycopene and many other carotenoids are responsible for tomatoes red color [42,43]. These compounds are mostly pro-vitamin A and also powerful antioxidants. Therefore, presence of these compounds in these tomatoes could help consumer to fight against vitamin A deficiency. Moreover, these compounds could reduce oxidative stress by the trapping of free radicals. Lycopene levels of various analyzed tomatoes is similar to those obtained by Schierle et al. [44] and Gross [45]. These authors are obtained a lycopene content ranging between 0.88 and 4.2 mg per 100 g of fresh tomato. Lycopene is the main carotenoid of tomatoes [4]. It contributes to the red coloring of tomatoes [3]. It has best antioxidant properties. It is very important about trapping of free radicals [24]. It's because tomatoes get the strong antioxidant power.

Polyphenol contents determined in tomatoes are lower than those obtained by Pinela et al. (2012) which are ranging between 21.34 and 31.23 mg/100 g EAG. This difference in polyphenol content may be due to either tomato variety, tomato maturity stage or agronomic and environmental conditions during cultivation as described by Abushita et al. [46], Binoy et al. [47], Leonardi [48] and Strazzullo [49]. However, phenolic compounds extracting procedure can influence phenolic compounds content [50,51].

Antioxidant compound of tomatoes can be hydrophilic or lipophilic. The hydrophilic fraction is vitamin C and phenolic compounds. Lipophilic fraction is carotenoids and vitamin E. These antioxidant compounds in tomatoes interact synergistically to prevent oxidative stress and contribute to health [52,53,48]. *Amiral F1* variety has the highest antioxidant power and the highest level of total polyphenols. These results confirm the strong antioxidant properties of phenolic compounds [54,55]. Obrenovich et al. [56] showed a strong impact of phenolic compounds on cancer risks and chronic diseases reduction.

5. CONCLUSION

This study showed that nutrient composition, antioxidant compounds and antioxidant capacity depend to variety. Among studied varieties of tomato, *Amiral F1* has the best profile because it has the lowest energy value and the strongest antioxidant power. All of these varieties are good sources of micronutrients. Their consumption can thus make it possible to fight against deficiency of these nutrients. In addition, the presence of antioxidant compounds such as vitamin C, polyphenols and lycopene in these tomatoes could make them a real source of antioxidant. So, their regular consumption can help to fight against oxidative stress.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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