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Antioxidant activity of tomato hybrids: correlation with the fertilizer used in crop

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Abstract

The paper presents the antioxidant activity evaluation of four tomato hybrids grown in Banat county (Romania). The raw filtered tomato samples were spectrophotometrically analyzed in the presence of a stable free radical (2,2-diphenyl-1-pycryl-hydrazyl, DPPH) in order to evaluate the antioxidant activity of tomatoes and the DPPH rates were calculated and analyzed for three reaction time intervals.

Keywords: tomato, antioxidant activity, DPPH reaction rate

1. Introduction

Tomatoes (*Lycopersicon* species) are originated from Andean region of South America and grow as wild species and especially as domestic ecotypes all over the world [1-3]. A modern diet (the Mediteraneean diet is the best example) suggest an increasing of the consumption of various fruits and vegetables which will improve the human health [4]. Tomato appear to be one of the most important vegetable for this goal being consumed in large quantities due to the presence of several compounds which could provide protection from or reduce the risk of contracting chronic degenerative diseases [4]. Statistically, significant results were obtained among the lycopene intake and reducing the risk of various cancer types; these observations were associated with the higher consumption of tomatoes and tomato-based products and the strongest correlation was observed for cancers of the prostate, lung, and stomach [5-7]. These pharmacologic actions against diseases seems to be due to the presence of antioxisdants. Antioxidants are substances that oppose oxidation or inhibit the initial reaction of oxygen or peroxides. The importance of the antioxidant content in foods is highly appreciated not only for the conservation of foods but also for maintaining the antioxidants *in vivo*. Through experimental, clinical, and epidemiological development, it can be proved the benefits of antioxidants against oxidation degeneration, diseases caused by aging, cancer [7]. The principal requirements of fruits and vegetables is uniformity of colour, according to E.U. quality standards [8]. The main compounds responsible for tomatoes colour are carrotenoid pigments; during fruit ripening, maximum concentrations of α- and β-carotene occur at the turning to breaking stages, after which lycopene accumulates [8]. Tomatoes are also a valuable source of antioxidants.

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The antioxidant activity of these vegetables is due to a number of antioxidant biomolecules, including lycopene, ascorbic acid, phenolics, flavonoids, and vitamin E, which all contribute to the benefic medical effects of tomatoes. Furthermore, a correlation between fruit colours and total antioxidant concentration (especially for lycopene) could be established [9,10]. More than a half of total antioxidants are located in the epidermis of the fruit [8].

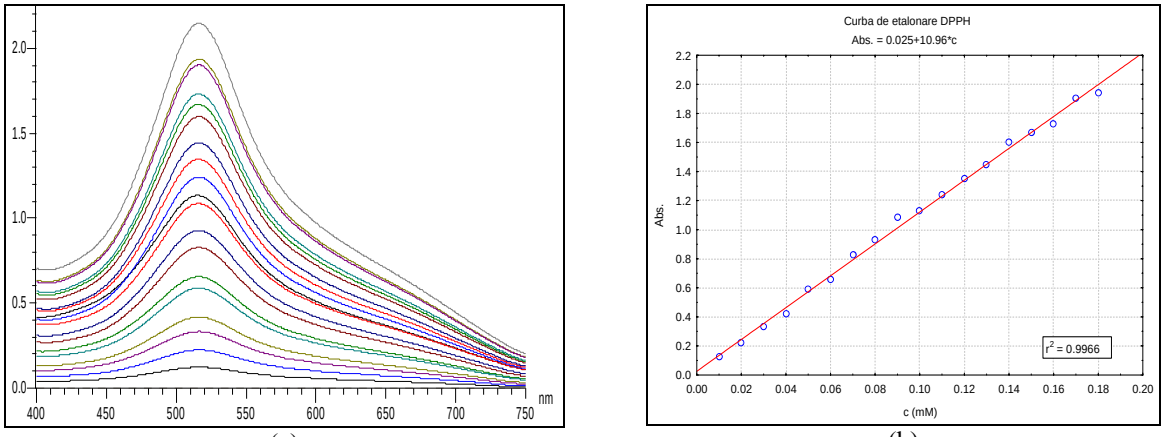
In the present study the antioxidant activity of the raw tomato hybrids grown in the Banat county (Romania) was evaluated by using the DPPH (2,2-diphenyl-1-pycryl-hydrazyl) method and the DPPH reaction rates in the presence of tomato samples were determined from the spectrophotometric analysis.

2. Materials and method

Materials. The tomatoes (four different hybrids – codes A1-4: Abellus F_1, Birdie F_1, Katerina F_1, and Petula F_1, respectively – grown in the presence of seven fertilizers: Bioplasma with algae base, purchased from Hungary market, and Bionat Plus, Bionex, Elstim, Elrom, Fosfertil, Cropmax, purchased from Romanian market, codes B1-B7, respectively) were grown in 2009 in Banat county (Banat's University of Timisoara basis). Ethanol (96%, v/v) used for extraction was acquired from Chimopar, București. 1,1-Diphenyl-2-pycrylhydrazyl (DPPH, purity >99%) used for antioxidant activity evaluation was purchased from Sigma.

Antioxidant activity evaluation. The presence of some flavonoids, carotenoids, ascorbic acid with antioxidant properties in tomatoes can be evaluated by spectrophotometric analysis of tomato extracts in the presence of DPPH. The tomatoes (5 g) were finnely grounded and mixed with 10 mL 20% ethanol, filtered, and spectrophotometrically analyzed in the presence of 1 mM DPPH ethanolic solution. Spectrophotometric analysis of 0.3 mL tomato extract in the presence of 0.3 mL 1 mM DPPH solution (diluted in 96% ethanol in a ratio of 1:10) was performed on a UV-VIS Perkin Elmer spectophotometer and data acquisition and handling were performed by UV-VIS Lambda 25, version 2.85.04 program. The absorbance of the sample-DPPH mixture was recorded at 517 nm for 300 s.

In order to evaluate the DPPH rates in the presence of tomato extracts, Absorbance (517 nm) *vs.* Concentration (DPPH, mM) calibration curve was obtained (Figure 1).



(a) (b)

Figure 1. UV-VIS spectra of standard solutions of DPPH (a) and the corresponding calibration curve, Absorbance (517 nm) *vs.* Concentration (DPPH, mM) (b)

3. Results and Discussion

Antioxidant activity of tomatoes were evaluated by means of DPPH rates calculated from spectrophotometric analysis by using the calibration curve (the absorbance of DPPH at 517 nm disappear after reaction with antioxidant compounds from tomatoes); three main intervals were used for evaluation: 0-20 s (maximum rate), 20-100 s (middle rate), and 100-300 s (slower rate). Thus, the DPPH reaction rates varied slightly in the range of 0.04-0.9 μM/s for the initial studied interval (0-20s) and much more on the intervals 20-100 s and 100-180 s or 100-300 s with values of 3 to 15 times lower than in the previous case; therefore, the variation ranges of DPPH reaction rate was $3 \cdot 10^{-4}$ –

0.1 µM/s in the range of 20-100 s and $2 \cdot 10^{-5}$ – $3.3 \cdot 10^{-2}$ µM/s in the last case (Table 1).

In the case of hybrid A1 samples, the lowest reaction rate v1 on interval 0-20s was recorded for sample A1B5 (hybrid *Abellus* F_1 and fertilizer Elrom). For average rate v2 on the interval 20-100s, the lowest value was 0.041 µM/s for the tomato sample hybrid *Abellus* F_1 / fertilizer *Fosfertil* (A1B6) and the highest value was 0.062 µM/s for the tomato sample hybrid *Abellus* F_1 / fertilizer *Elstim* (A1B4). For the average rate v3 on the interval 100-180/300s, a maximum was recorded for *Abellus* F_1 / fertilizer Elstim (A1B4)with a value of 0.02 µM/s and a minimum for *Abellus* F_1 / fertilizer Bioplasma (A1B1) with a value of 0.012 µM/s (Table 1 and Figure 2).

Table 1. DPPH reaction rates in the presence of tomato extract samples (hybrid *Abellus* F_1, codes A1B1-A1B7) for three significant time intervals: 0-20 s, 20-100 s and 100-180/300 s

Fertilizer	Code	v1 (0-20s) (µM/s)	v2 (20-100s) (µM/s)	v3 (100-180/300s) (µM/s)
Bioplasma	A1B1	0.1	0.046	0.012
Bionat 2	A1B2	0.1	0.041	0.016
Bionex	A1B3	0.2	0.049	0.015
Elstim	A1B4	0.1	0.062	0.02
Elrom	A1B5	0.09	0.045	0.016
Fosfertil	A1B6	0.1	0.041	0.015
Cropmax	A1B7	0.1	0.051	0.017

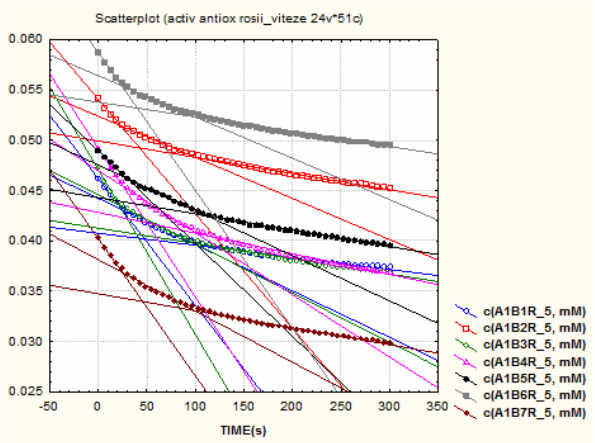


Figure 2. Variation of the concentration of DPPH in the presence of tomato extract samples (hybrid *Abellus* F_1 - A1), with the representation of the main linear correlations which indicate the average reaction rates of DPPH on the intervals 0-20s, 20-100s and, 100-300s

The analysis of the reaction rates of DPPH in the presence of tomato extract samples A2B1-A2B7 (obtained from the representation of the main linear correlations for the specified intervals, which indicate the average reaction rates of DPPH) revealed that the v1 reaction rate was in the range of 0.079 µM/s for A2B3 – tomato hybrid *Birdie* F_1 / fertilizer Bionex and 0.6 µM/s for A2B7 – tomato hybrid *Birdie* F_1 / fertilizer Cropmax. The average rate v2 on the interval 20-100s µM/s was recorded to have values comprised between 0.0005 µM/s for A2B3 – tomato hybrid *Birdie* F_1 / fertilizer Bionex and 0.1 µM/s for A2B7 – tomato hybrid *Birdie* F_1 / fertilizer Cropmax; for the average rate v3 on interval 100-180/300 s a maximum was recorded for the tomato sample *Birdie* F_1 / fertilizer Cropmax (code A2B7) with a value of 0.033 µM/s and a minimum for the sample *Birdie* F_1 / fertilizer Bionex (code A2B3) with a value of 0.0005 µM/s (Table 2 and Figure 3).

Table 2. DPPH reaction rates in the presence of tomato extract samples (hybrid *Birdie* F_1, codes A2B1-A2B7) for three significant time intervals: 0-20 s, 20-100 s and 100-180/300 s

Fertilizer	Code	v1 (0-20s) (µM/s)	v2 (20-100s) (µM/s)	v3 (100-180/300s) (µM/s)
Bioplasma	A2B1	0.2	0.0035	0.0017
Bionat 2	A2B2	0.3	0.029	0.0073
Bionex	A2B3	0.079	0.0005	0.0005
Elstim	A2B4	0.4	0.077	0.019
Elrom	A2B5	0.1	0.0042	0.0011
Fosfertil	A2B6	0.1	0.066	0.02
Cropmax	A2B7	0.6	0.1	0.033

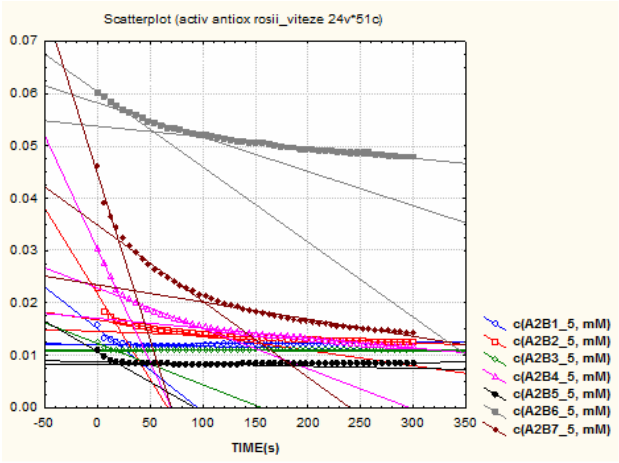


Figure 3. Variation of the concentration of DPPH in the presence of tomato extract samples (hybrid *Birdie* F_1 – A2), with the representation of the main linear correlations which indicate the average reaction rates of DPPH on the intervals 0-20s, 20-100s, and 100-300s

In the case of samples A3B1-A3B7, the reaction rate v1 for the interval 0-20s has a minimum value of 0.047 µM/s for the sample A3B5 (hybrid *Katerina* F_1, fertilizer Elrom) and a maximum value of 0.9 µM/s for the sample A3B4 (hybrid *Katerina* F_1, fertilizer Elstim). In the case of average rate v2 on the interval 20-100s, the lowest value was 0.0003µM/s for the sample *Katerina* F_1 / fertilizer Elstim (code A3B4) and the highest value was 0.059 µM/s for the tomato sample hybrid *Katerina* F_1 / fertilizer Fosfertil (code A3B6). For the average rate v3 on the interval of 100-180/300s a value of 0.023 µM/s maximum was recorded for the tomato sample hybrid *Katerina* F_1 / fertilizer Cropmax (code A3B7) and a minimum value of 0.00002 µM/s for the tomato sample hybrid *Katerina* F_1 / fertilizer Elstim (code A3B4) (Table 3 and Figure 4).

Table 3. DPPH reaction rates in the presence of tomato extract samples (hybrid *Katerina* F_1, codes A3B1-A3B7) for three significant time intervals: 0-20 s, 20-100 s and 100-180/300 s

Fertilizer	**Code**	**v1 (0-20s) (µM/s)**	**v2 (20-100s) (µM/s)**	**v3 (100-180/300s) (µM/s)**
Bioplasma	A3B1	0.2	0.031	0.01
Bionat 2	A3B2	0.076	0.004	0.0009
Bionex	A3B3	0.5	0.024	0.008
Elstim	A3B4	0.9	0.0003	0.00002
Elrom	A3B5	0.047	0.0023	0.0005
Fosfertil	A3B6	0.2	0.059	0.0044
Cropmax	A3B7	0.1	0.044	0.023

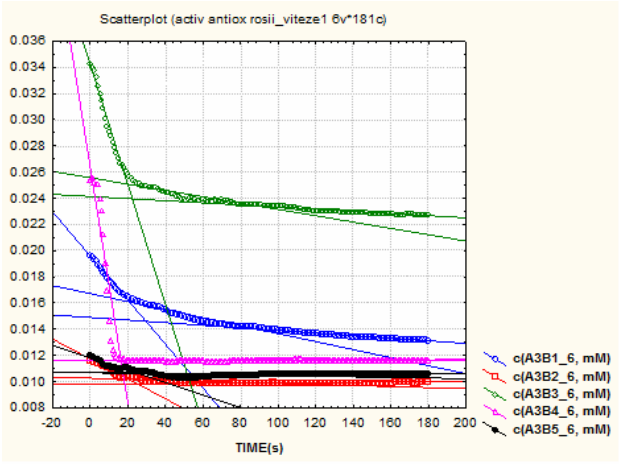


Figure 4. Variation of the concentration of DPPH in the presence of tomato extract samples (hybrid *Katerina* F_1 – A3), with the representation of the main linear correlations which indicate the average reaction rates of DPPH on the intervals 0-20s, 20-100s, and 100-300s

For the variation of DPPH concentration in the presence of tomato extract samples A4B1-A4B7 in time, the average reaction rate v1 of DPPH on interval 0-20s was in the range of 0.077 µM/s for sample A4B7 (hybrid *Petula* F_1 / fertilize Cropmax) to 0.1 µM/s for samples A2B4-A2B5 (hybrid *Petula* F_1 / fertilizers Elstim and Elrom). On the interval 20-100s, the average reaction rate was between 0.012 µM/s for A4B6 (hybrid *Petula* F_1 / fertilizer Fosfertil) and 0.06 µM/s for A4B4 (hybrid *Petula* F_1 / fertilizer Elstim), while for the rate v3 on the interval 100-180/300s, a maximum value of 0.022 µM/s was recorded for the tomato sample *Petula* F_1 / fertilizer Bioplasma (code A4B1) and a minimum value of 0.0019 µM/s for the tomato samples hybrid *Petula* F_1 / fertilizer Bionex (code A4B3) and hybrid *Petula* F_1 / fertilizer Elstim (code A4B4) (Table 4 and Figure 5).

Table 4. DPPH reaction rates in the presence of tomato extract samples (hybrid *Petula* F_1, codes A4B1-A4B7) for three significant time intervals: 0-20 s, 20-100 s and 100-180/300 s

Fertilizer	Code	v1 (0-20s) (µM/s)	v2 (20-100s) (µM/s)	v3 (100-180/300s) (µM/s)
Bioplasma	A4B1	0.2	0.054	0.022
Bionat 2	A4B2	0.1	0.05	0.021
Bionex	A4B3	0.1	0.053	0.019
Elstim	A4B4	0.1	0.06	0.019
Elrom	A4B5	0.1	0.047	0.02
Fosfertil	A4B6	0.2	0.012	0.0083
Cropmax	A4B7	0.077	0.023	0.0084

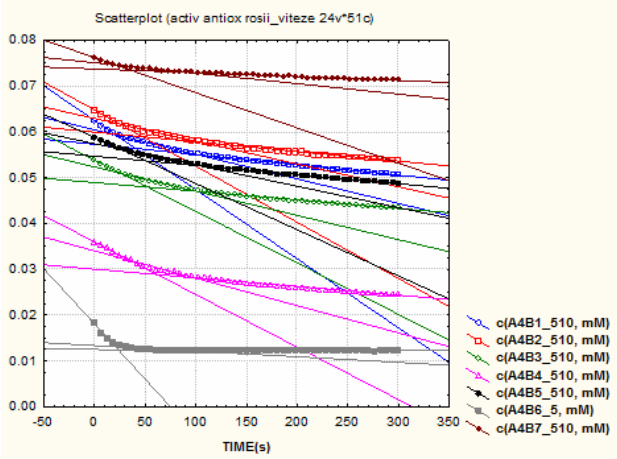


Figure 5. Variation of the concentration of DPPH in the presence of tomato extract samples (hybrid *Petula* F_1 – A4), with the representation of the main linear correlations which indicate the average reaction rates of DPPH on the intervals 0-20s, 20-100s, and 100-300s

4. Conclusion

Taking into account the reaction rates of the free radical 2,2-diphenyl-1-pycrylhydrazyl in the presence of tomato sample extracts it can be established that in the case of Abellus and Petula samples, the reaction rates for the first interval were significantly higher than the rates for the other two intervals. Therefore, in the cases of Abellus and Petula samples, the average rates for the first interval were 0.11±0.04 µM/s and 0.13±0.05 µM/s, respectivelly, while for samples Birdie and Katerina, these were 0.25±0.19 µM/s and 0.29±0.2 µM/s, respectively.

The later intervals revealed lower average rate values, which were important for samples Abellus and Petula: 0.05±0.01 µM/s and 0.04±0.02 µM/s for the middleinterval and ~0.02 µM/s for the last interval studied. The DPPH reaction rate seem to be less significant for the cases of Birdie and Katerina tomato samples (<0.04 µM/s for the last two time intervals).

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