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ORGANOLEPTIC AND QUALITY PROPERTIES OF TOMATO FRUITS UNDER TREATMENT WITH MICROALGAE EXTRACTS

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ABSTRACT

The quality parameters of tomatoes can vary depending on different factors, including cultivar, fruits maturity stage, fertilisation and growing conditions. The research aimed to the evaluation of the organoleptic and quality properties of tomato fruits under treatment with microalgae extracts. Tomatoes (cultivar 'Belle' F1, Enza Zaden) were grown in peat (producer Laflora LTd, pH_{KCl} 5.5) in the conditions of polycarbonate greenhouse. From seedlings planting till start of harvesting plants were sprayed weekly (for a total of five times) with the solution of ethanol extractions of different microalgae species: *Spirulina* sp., *Dunaliella* sp., C*hlorella* sp., two concentrations of the extracts were compared with sprays with corresponding ethanol solution as a control. In total, nine plants per treatment were used. Yield was harvested 13 times from 30/09 till 23/12 once per week at the stage of full ripen. Colour components of L*, a*, b*, organoleptic properties, taste index and maturity index were determined. No negative effects of any tested treatments on organoleptic and quality properties as well as fruits` shape, diameter, number of locules were determined for tomato yield. Different fruit parameters including shape, diameter, number of locules, taste index and maturity index were determined. No negative effects of any tested treatments on organoleptic and quality properties as well as of tomato fruits were observed. Maturity index was higher for control treatment with drinking water (17.60), but the highest taste index (0.57) was observed for variant with *Spirulina*, concentration 10% v/v. The effect of microalgae extract on the organoleptic indicators of the fruit was not detected, which can be evaluated positively, and this moment indicates the stability of the cultivar.

Keywords: *Microalgae, Biostimulants, Quality parameters.*

INTRODUCTION

Tomato (*Solanum lycopersicum* L.) is one of the most economically important and widely cultivated vegetables in the world, consumed fresh or processed (Duckena at al., 2003; Alsina et al., 2023). Tomatoes` quality parameters can vary depending on different factors, including cultivar, growing conditions, fertilisation as well as fruits maturity stage. Concentrations of bioactive compounds in tomato fruits as well as their organoleptic properties can be genetically and environmentally determined (Carli et al., 2011).

Fruit colour is one of the most important attributes of fruit quality, especially in the case of choosing fresh tomatoes by consumers (Radzevičius et al., 2014; Tadesse et al., 2015; Ilahy et al., 2016;). It is observed, that colour is the primary factor that consumer evaluate before any fresh produce purchase (Ilahy et al., 2016). The complexity of tomato colour is due to the presence of a diverse carotenoid pigment system with appearance conditioned by pigment types and concentrations (Pandurangaiah et al., 2020).

By Felföldi et al. (2022), for increasing the economic efficiency, producers pay more attention to productivity of tomatoes than quality parameters, including organoleptic properties of fruits, especially savour. By Duma et al. (2019), medium sized tomatoes are less tasty, despite the tomato colour. As well as in other research of Duma et al. (2022) was observed, that tomatoes harvested in autumn contain more biologically active substances than harvested in spring.

Biostimulants from seaweeds have positive effect on the growth, yield and yield`s quality as well as on the tolerance of plants to abiotic and biotic stresses (Arioli et al., 2015; Shukla et al., 2019). By Santos de Paula et al. (2021), for mini tomato plants, treatment with algae extracts significantly affected the yield, diameter, length, colour and Brix degree of the fruits. But fruit volume and weight as well as the number of cracked fruits did not change.

The research aimed to the evaluation of the organoleptic and quality properties of tomato fruits under treatment with microalgae extracts.

MATERIAL AND METHODS

In August 2023, tomato seedlings (cultivar 'Belle' F1, Enza Zaden) were planted in 25 L pots, filled with peat (producer Laflora LTd., pH_{KCl} 5.5) and grown in polycarbonate greenhouse. Plants were sprayed weekly from seedlings` till start of harvesting, for a total of five times, with the solution of ethanol extractions of different microalgae species: *Spirulina* sp., *Dunaliella* sp., C*hlorella* sp. Two concentrations of the extracts 10% and 20% v/v were compared with sprays with corresponding ethanol solution as a control 2% and 4% v/v as well as with control spray with drinking water. In total, nine plants per treatment were used.

Yield was harvested 13 times from 30/09 till 23/12 once per week at the stage of full ripen. During vegetation, plants were regularly watered and fertilized, phytosanitary measures were provided. Additional lighting was provided by high-pressure sodium lamps as well as automatic ventilation was carried out by necessity. Plants were pruned by traditional scheme.

Colour components of L*, a*, b*, organoleptic properties, taste index and maturity index as well as fruits` shape, diameter, number of locules were determined for tomato yield.

Colour analysis. Colour of samples were measured in CIE L*a*b* colour system using a colorimeter ColorTec PCM (Accuracy Micro sensors Inc., USA). Before the measurement, the colorimeter was calibrated using a white reference tile and a light trap (black tile). Ten random tomato fruit were measured per each sample. Three coordinates CIE L*a*b* represent: the lightness of the colour L* = 0 means black and L* = 100 indicates diffuse white; negative value of a* indicate green while positive values indicate red; negative values of b* indicate blue and positive values indicate yellow (Radzevičius et al., 2014; Tarhan et al., 2010).

Morphometric and organoleptic indices. For tomato fruits such morphometric indices as shape, diameter, number of locules were determined by methodology of ECPGR descriptor (codes 7.2.2.5, 7.2.2.10, 7.2.2.31) (Descriptors..., 1996). Organoleptic indices of samples were evaluated at the stage of full ripen by 10 people. For tomato fruits, appearance, shape, aroma, taste, aftertaste and firmness were analysed using the marks from 1 to 10 (1 – very weak; 3 – medium; 5 – very high) (Kalnina et al., 2016).

Statistical analysis. Analysis of variance was used for data statistical processing, whereas the significance of differences between mean values was evaluated with p-value.

RESULTS AND DISCUSSION

For all variants slightly flattened fruit shape was dominant (Figure 1). For samples, fruits` diameter at the stage of full ripen was not significantly different ($p<0.05$). Maximal diameter (9 cm) was observed for fruits under treatment with *Spirulina* sp. extract, 20% v/v, for control variant with ethanol, 2% v/v as well as for control variant with drinking water. Minimal diameter (7 cm) was characterised for fruits under both variants with *Dunaliella* sp. extract.

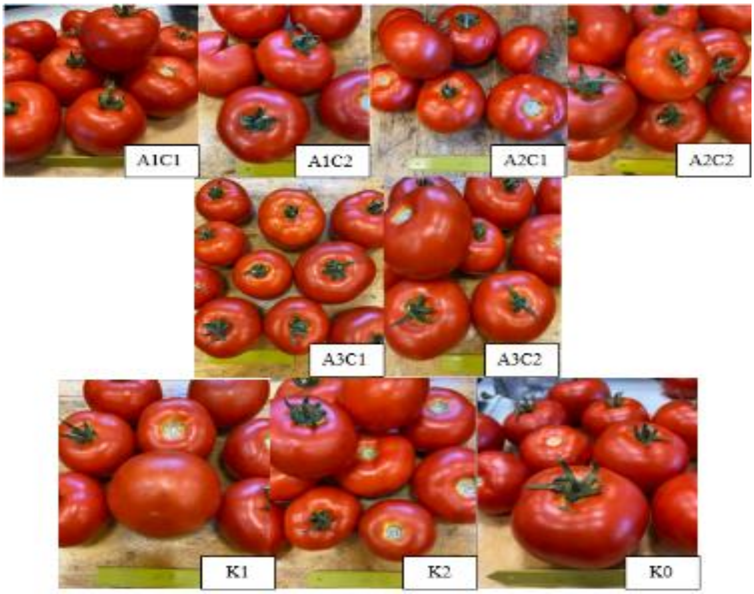

Figure 1. Appearance of tomato fruits according to variants:
A1C1 – *Spirulina* sp. extract, 10% v/v, A1C2 – *Spirulina* sp. extract, 20% v/v
A2C1 – *Dunaliella* sp. extract, 10% v/v, A2C2 – *Dunaliella* sp. extract, 20% v/v,
A3C1 – *Chlorella* sp. extract, 10% v/v, A3C12 – *Chlorella* sp. extract, 20% v/v,
K1 – control, ethanol, 2% v/v, K2 – control, ethanol, 4% v/v, K0 – drinking water.

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The two-colour space system known as L*a*b* is commonly used commercially for food colour measurement as it closely approximates the colour perception by humans. This system mathematically describes all perceivable colours in three dimensions and measures three values: the achromatic component L* (light vs. dark) and two colour descriptors a* (red vs. green) and b* (yellow vs. blue) values (Radzevičius et al., 2014). Differences between colour parameters presented in Table 1.

Table 1. Colour characteristics of the tomato fruits

Plant material	Colour parameter values		
	L*	a*	b*
Spirulina sp. extract, 10% v/v	33.05±2.21ab	33.77±0.94a	30.46±1.42a
Spirulina sp. extract, 20% v/v	31.09±2.03ab	34.60±1.53a	31.76±0.71a
Dunaliella sp. extract, 10% v/v	30.44±1.53ab	32.03±0.82a	26.25±1.63a
Dunaliella sp. extract, 20% v/v	31.47±.0.97ab	32.42±1.52a	27.28±0.82a
Chlorella sp. extract, 10% v/v	38.07±0.96c	30.94±1.84a	32.97±1.55a
Chlorella sp. extract, 20% v/v	33.19±0.78ab	32.81±0.92a	31.32±0.94a
Control, ethanol, 2% v/v	28.93±0.72a	31.15±1.53a	27.03±1.22a
Control, ethanol, 4% v/v	33.80±1.04bc	33.70±1.74a	31.24±1.11a
Drinking water	32.55±1.22ab	32.19±1.08a	28.37±1.96a

** Values represent the mean of ten replicates± standard deviation. Values, marked with the same letter, are not significantly different (p>0.05).*

The highest colour component L* value, related to the lightness, were found for *Chlorella* sp. extract, 10% v/v, but the lowest value – for control variant with ethanol, 2% v/v (indicates a darker colour intensity). By López Camelo and Gómez (2004) this characterises changes of colour from pink to full red. For variants, L* colour values were not significantly different ($p<0.05$). The highest values of colour components a* (indicates the redness) were obtained for samples under *Spirulina* sp. extract, 20%, but lowest – under *Chlorella* sp. extract, 10% v/v. In experiment, it was proved that the colour a* values were not significantly different ($p<0.05$), that means not change in the context of the redness.
For tomato samples under treatment with *Chlorella* sp. extract, 10% v/v the highest colour component`s b* value was determined, but the lowest was observed under *Dunaliella* sp. extract, 10% v/v. The difference between the lowest and highest colour b* value (related to yellowness) also was not significant ($p<0.05$). Results can be explored by the fact that carotenes reach their highest concentration before full ripening, where lycopene (red colour) and β-carotene (orange colour) achieve their peaks (López Camelo and Gómez, 2004). Obtained L*, a*, b* values are in accordance with data about tomatoes grown under different geographical areas (Ilahy et al., 2016).
Information about taste index and maturity index is presented in Figure 2. Per variants, both indices were significantly different ($p<0.05$).

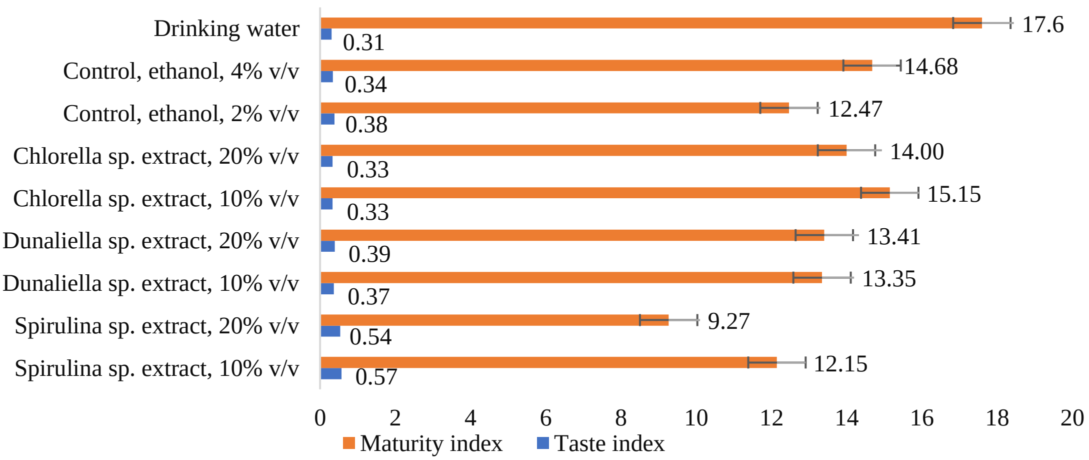

Figure 2. Taste index and maturity index for tomato fruits

In this research, maturity index was higher for control treatment with drinking water, but the highest taste index was observed for variant with *Spirulina*, concentration 10% v/v. Results were similar to data, described in research of Alsiņa et al. (2023), but observed average taste index was lower than described by Dūma et al. (2022).

During harvesting period, for fruits at the stage of full ripen, number of locules were not significantly different ($p>0.05$): five symmetric locules (Figure 3) were characterised for tomato fruits.

Figure 3. Tomato fruit in cross section, in average for all variants.

Figure 4 presents the results of organoleptic testing of tomato fruits. It is interesting, that colour was the least evaluated indice. Per variants, scores were not significantly different ($p>0.05$), it can be described with stability of the cultivar 'Belle' to different growing conditions, including application of extracts, explored in this research.

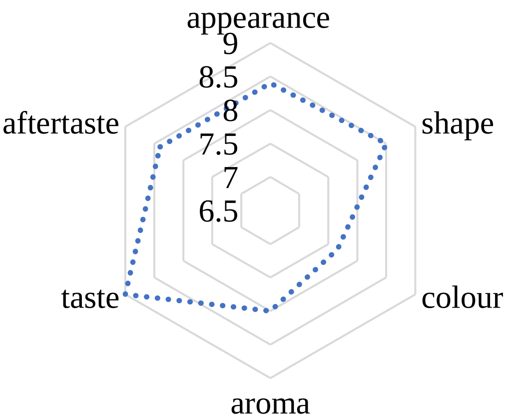

Figure 4. Organoleptic properties of tomato fruits, in average for all variants.

No negative effects of any tested treatments on quality properties of tomato fruits were observed.

CONCLUSIONS

Under treatments with ethanol, 2% v/v, tomato fruits were darker, but under *Chlorella* sp., 10% v/v tomatoes were lighter. The effect of microalgae extract on the organoleptic indicators of the fruit was not detected, which can be evaluated positively, and this moment indicates the stability of the cultivar. No negative effects of any tested treatments on tomato fruits` quality were observed.

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