Effects of treatment with autotrophically grown microalgae *Tetradesmus obliquus* and *Graesiella emersonii* biomass extracts on tomatoes

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Introduction

Agriculture provides a general part of the nutrients needed for humans to survive. Besides, as human population enlarges extensively, and most of agricultural crops are treated with chemical fertilizers and pesticides which can be harmful to humans and environment also abroad of the cultivated fields, therefore research efforts for balanced farming are required.

Microalgal biomass can offer more human- and nature-friendly alternative solutions to replace chemical fertilizers and plant growth stimulants, and pesticides. Microalgae contain numerous compounds like phenols, growth hormones, proteins, pigments and lipids, which are essential for agricultural plants as growth stimulants and can be defined as control substances for diseases or harmful insects.

Methods

Microalgae cultures

Microalgae strains *Graesiella emersonii* KM01, *Tetradesmus obliquus* OM02 are freshwater microalgae isolated from different water bodies in Riga, Latvia.

Media and microalgae cultivation conditions

In this study microalgae were cultivated in Erlenmeyer flasks. Media used in experiment was three times nitrogen Bold Basal Media with vitamins. Cultivation was carried out in orbital shaker in presence of LED light source with day : night cycle 16:8 h and light intensity of 80 µmol/m^{2}s in temperatures ranging from 5℃ till 25℃.

Extract preparation

To obtain microalgal extracts for further tomato plant treatment, microalgal biomass grown at the optimal growth temperature of 25°C in closed photobioreactors was used to prepare extracts (equal parts of water and ethanol 96.3%).

Greenhouse experimental design

The experiment was carried out in polycarbonate greenhouse. Seeds of tomato hybrid cultivar 'Belle' F1 (Enza Zaden) were sown in plastic cassettes filled with peat (producer Laflora Ltd., pH$_{KCl}$ 5.5). At the stage of early growth (18th day), seedlings were replanted in vegetation pots (1 L) filled with the same substrate. During experiment, plant care was provided for tomato seedlings. Since germination seedlings had been sprayed once a week for four weeks with the solution of ethanol extractions of different microalgae species *T. obliquus* OM02 and *G. emersonii* KM01. Two concentrations of the extracts were used – 10% and 20% (v/v) as well compared with control sprays with corresponding ethanol solution: 2% and 4% (v/v) and drinking water. At the age of 35 days, seedlings were replanted in 25 L containers for a further investigation. As well there have been separate plants, that have been grown at the same conditions and started to spray after replanting in 25 L containers at 35th day. The treatment was the same as for seedlings, i.e. they were sprayed once a week for four weeks till fruit ripening stage.

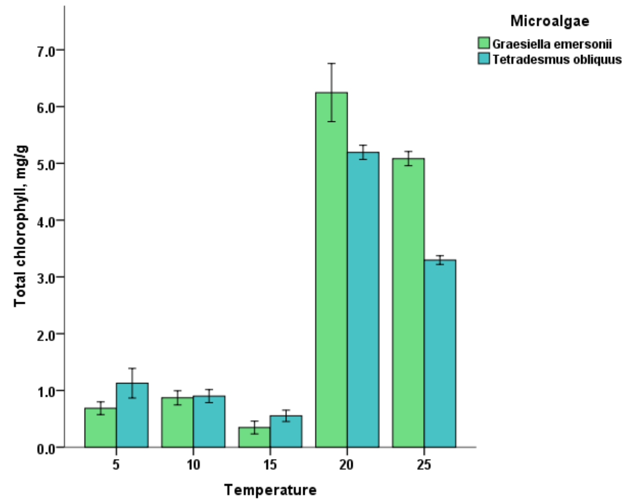

Figure 1. Autotrophically cultivated microalgae (*T. obliquus* and *G. emersonii*) total chlorophyll content (mg/g DW) at different suboptimal growth temperatures.

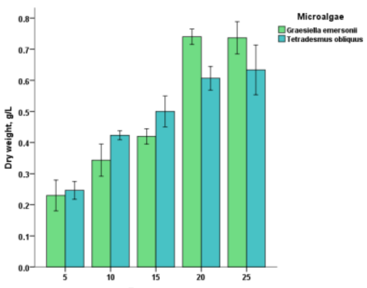

Figure 2. Autotrophically cultivated microalgae (*T. obliquus* and *G. emersonii*) dry weight (g/L) at different suboptimal growth temperatures.

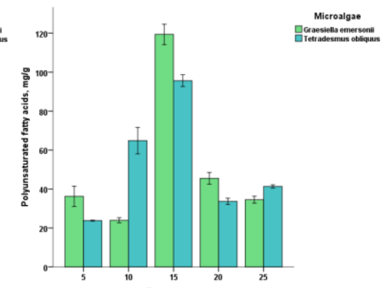

Figure 3. Autotrophically cultivated microalgae (*T. obliquus* and *G. emersonii*) polyunsaturated fatty acids content (mg/g DW) at different suboptimal growth temperatures.

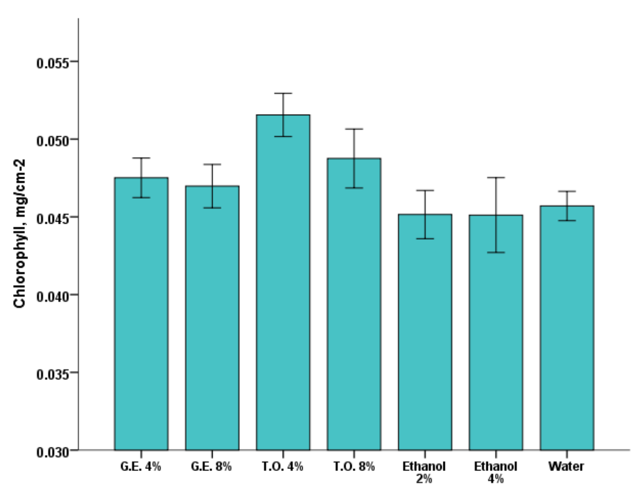

Figure 4. Chlorophyll (mg/cm^{-2}) content in tomato leaves at the end of experiment after exposure to microalgae extracts T.obliquus (T.O.) and G. emersonii (G.E.) in different concentrations, compared to controls (water, ethanols 2 % and 4 %).

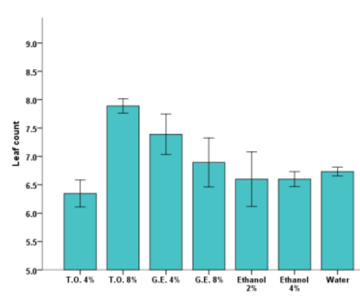

Figure 5. Tomato seedling leaf count at the end of experiment after exposure to microalgae extracts of *T.obliquus* (T.O.) and G. *emersonii* (G.E.) in different concentrations, compared to controls (water, ethanols 2 % and 4 %).

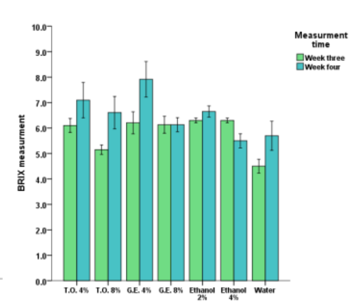

Figure 6. Soil soluble solid content (BRIX) measurements in last two weeks of experiment after exposure to microalgae extracts T.obliquus (T.O.) and G. emersonii (G.E.) in different concentrations, compared to controls (water, ethanols 2 % and 4 %).

Results

Microalgae growth experiments at suboptimal temperatures showed that polyunsaturated fatty acids (PUFA) and pigments production is promoted at a lower temperatures - 15℃ and 20℃ degrees, respectively, compared to the optimal growth temperature. Increase of PUFA (figure 3) at 15℃ was by 56,74% and 30,08% and microalgal chlorophyll (figure 1) at 20℃ was by 36,42% and 18,72%, respectively *T. obliquus* OM02 and *G. emersonii* KM01. Although the increase of biomass (figure 2) was lower at suboptimal temperatures compared to the optimal by 60,32% *T. obliquus* OM02 and 68,92% *G. emersonii* KM01 at 5℃ temperature.

It has been shown that chlorophyl content changes in leaves (figure 4) compared with all three-control groups, have increased in leaves that were treated with microalgal extract. Tomato leaves sprayed with *T. obliquus* OM02 4% extract showed 13.46% higher chlorophyl content compared to the control, and *G. emersonii* KM01 4% extract 6,25% higher, respectively. Furthermore, tomato leaves, the count on each tomato stem increased where they were sprayed with microalgae extract compared to the control group (figure 5). *G. emersonii* KM01 4% extract increased leaf count by 10.69% and 8.93% and *T. obliquus* OM02 8% extract by 16.35% and 14.70%, respectively compared to ethanol control and water control, respectively.

After soluble soil content measurements in BRIX (figure 6), it can be seen that soil with tomatoes sprayed with both microalgae extracts showed higher BRIX values compared to control groups, respectively by 23% with *T. obliquus* OM02 and 30% with *G. emersonii* KM01.

Conclusion

Lower temperatures can enhance PUFA and pigment production in microalgae, although overall biomass is lower compared to optimal growth temperatures. Despite this, higher concentrations of PUFA or pigments can benefit tomato plants as biostimulants and protectors against diseases.

Spraying tomato plants with microalgae extracts increases leaf count and chlorophyll content. As chlorophyll is green it absorbs red and blue parts of the electromagnetic spectrum and reflects the green part of the spectrum. Which leads to that, that leaves with more chlorophyll are better able to absorb the light required for photosynthesis. Energy that has been manufactured in the photosynthesis process is stored and later used to convert carbon dioxide (which is accumulated from air) and water to glucose. Later plants can use converted glucose together with nutrients up taken from soil to grow new leaves and stems as well as increase overall plant yield.

As for BRIX levels in soil. Tomato plants sprayed with both microalgae extracts showed higher levels. This means that tomato plants have more of the cell needed nutrients which leads to better overall plant health and growth as well as more tasty and flavorful fruits.

Acknowledgement

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