

Effect of photosensitization on the folate content in commercial strawberry cultivars

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Introduction

Strawberries can be a good source of vitamins such as folate, which is essential for nucleic acid synthesis and known to have protective effects against neural tube defects such as spina bifida in newborns. However, at room temperature, this fruit is highly perishable and has a relative short shelf life of only a couple of days. An innovative, cost effective and environmentally friendly technique, photosensitization, has been applied with the aim to extend the shelf life of strawberries and to retain their nutritional quality. Photosensitization is based on the combined action of a photosensitizer, light and oxygen, which produce reactive oxygen species that inactivate microorganisms. Curcumin, known for its antifungal and antibacterial activity was used as the photosensitizer in this study.

Specific Aim

To determine the effects of photosensitization, as an antimicrobial photodynamic tool, on the folate content of two commercial strawberry cultivars, Red Rhapsody and Ruby Gem.

Materials and Methods

Photosensitizer and light source

Curcumin (50 μM) solution was prepared for spraying on Red Rhapsody and Ruby Gem strawberries and visible light dose (15, 21 and 24 J/cm^2) from a light-emitting diode (LED) light source was used as the illumination source. Visible light at 433 nm was applied for 10 minutes at a distance of 10 cm (Fig.1-2).

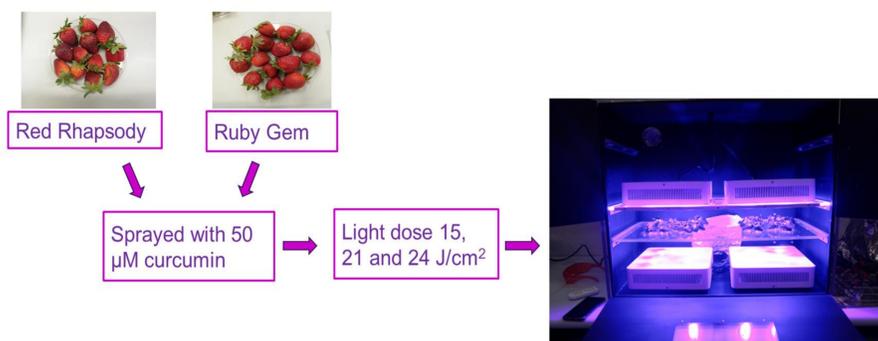


Fig. 1: Process of photosensitization



Fig. 2: Physical appearance of both control and treated Red Rhapsody and Ruby Gem strawberries

Folate content

The effect of photosensitization on the folate content was determined by stable isotope dilution assay (SIDA) (Striegel et al., 2018).

Results

Five folate vitamers (folic acid (FA), tetrahydrofolate (THF), 5-methyl-THF, 5-formyl-THF and 10-formyl-FA) were quantified. There were no differences ($p > 0.05$) in folate content between treated and untreated (control) Red Rhapsody strawberries for all light dosages (Fig.3). However, an increase ($p < 0.05$) in 5-methyl-THF, the main folate vitamer in strawberry fruit, was observed in Ruby Gem, photosensitized with 24 J/cm^2 light dosage in comparison to the control samples (Table 1).

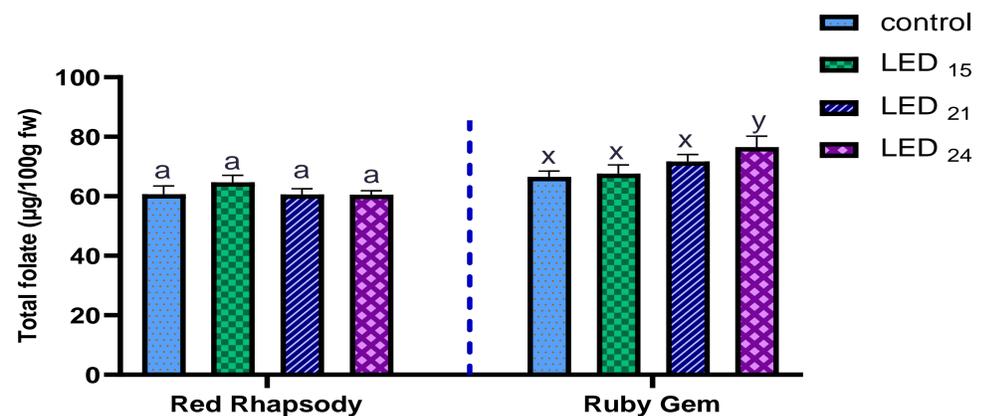


Fig. 3: Effect of photosensitization on total folate content in strawberries. Data present means \pm SD ($n = 3$); data with different letters in the bars are significantly different ($p < 0.05$) using Tukey's post hoc test.

Table 1: Effect of photosensitization on individual folate content in strawberries

| Cultivar | | FA ($\mu\text{g}/100 \text{ g fw}$) | THF ($\mu\text{g}/100 \text{ g fw}$) | 5-CH ₃ -THF ($\mu\text{g}/100 \text{ g fw}$) | 5-CHO-THF ($\mu\text{g}/100 \text{ g fw}$) | 10-CHO-FA ($\mu\text{g}/100 \text{ g fw}$) |
|--------------|-----------------|---------------------------------------|--|---|--|--|
| Red Rhapsody | Control | 0.06 \pm 0.05 ^a | 0.68 \pm 0.03 ^a | 59.4 \pm 2.7 ^b | 0.53 \pm 0.01 ^a | 0.04 \pm 0.01 ^a |
| | L ₁₅ | 0.05 \pm 0.05 ^a | 0.83 \pm 0.05 ^a | 63.3 \pm 2.4 ^a | 0.50 \pm 0.05 ^c | 0.03 \pm 0.01 ^a |
| | L ₂₁ | 0.05 \pm 0.01 ^a | 0.76 \pm 0.10 ^a | 59.3 \pm 2.0 ^b | 0.51 \pm 0.02 ^c | 0.02 \pm 0.01 ^a |
| | L ₂₄ | 0.05 \pm 0.04 ^a | 0.63 \pm 0.10 ^a | 59.3 \pm 1.3 ^b | 0.58 \pm 0.14 ^c | 0.01 \pm 0.02 ^a |
| Ruby Gem | Control | 0.04 \pm 0.03 ^a | 4.09 \pm 0.21 ^a | 60.7 \pm 2.2 ^c | 1.41 \pm 0.10 ^a | 0.22 \pm 0.02 ^a |
| | L ₁₅ | 0.04 \pm 0.02 ^a | 3.50 \pm 0.19 ^a | 62.4 \pm 2.9 ^c | 1.41 \pm 0.16 ^a | 0.27 \pm 0.02 ^a |
| | L ₂₁ | 0.02 \pm 0.01 ^a | 4.22 \pm 0.47 ^a | 65.9 \pm 2.2 ^b | 1.35 \pm 0.03 ^a | 0.21 \pm 0.03 ^a |
| | L ₂₄ | 0.02 \pm 0.02 ^a | 3.93 \pm 0.43 ^a | 70.8 \pm 3.3 ^a | 1.54 \pm 0.06 ^a | 0.25 \pm 0.09 ^a |

Data present means \pm SD ($n = 3$); data with different letters in the same column are significantly different ($p < 0.05$) using Tukey's post hoc test. FA, folic acid; THF, tetrahydrofolate; 5-CH₃-THF, 5-methyl-THF; 5-CHO-THF, 5-formyl-THF and 10-CHO-FA, 10-formyl-FA.

Conclusions

The results clearly show that LED-based photosensitization mediated by curcumin has no "negative" effect on folates in strawberry fruit. This technology seems to be positive in preserving this critical vitamin.

Future work

Bioaccessibility and bioavailability of folates in both untreated and treated strawberries will be evaluated using *in vitro* digestion models and human studies.

References

STRIEGEL, L., CHEBIB, S., NETZEL, M. E. & RYCHLIK, M. 2018. Improved Stable Isotope Dilution Assay for Dietary Foliates Using LC-MS/MS and Its Application to Strawberries. *Frontiers in Chemistry*, 6, 11.

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