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Effects of Green LED Light on Lentinula edodes Respiration and Biomass

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Introduction

The effects of green light on mushrooms have not been studied as thoroughly as those of full spectrum, red, and blue light, yet a study done by Glukhova et Al. (2014), reported that *Lentinula edodes* (shiitake mushroom) mycelia had increased biomass after being exposed to Green LED light at an intensity no greater than 1.8W/m^2 for no longer than 30 minutes per day.

This study Iinvestigated whether green LED illumination at an approximate intensity of .44W/m^2 for 2 minutes a day would significantly increase the biomass and affect the respiration rate of *L. edodes* mushrooms grown in a commercial setting.

It was hypothesized that if green LED illumination has an effect on biomass production and respiration of *L. edodes*, then mushrooms exposed to green LED light would show higher respiration rates and greater biomass.

Objectives

1. Record and compare the respiration rates of shiitake mushrooms subjected to different light treatments.
2. Record and compare the masses and densities of shiitake mushrooms subjected to different light treatments.
3. Determine if illumination by green LEDs is relevant in producing higher growth yields of shiitake mushrooms grown in a commercial setting.

Methods

Mushrooms were exposed to LED lights at an intensity of .44 W/m^2. for 2 minutes a day for 7 days. On the eighth through tenth days, 5 mushrooms from both the treatment and control groups were collected per day. Mushrooms were matched for size across treatment groups. Mushrooms were immediately brought back to the lab. Fresh masses were recrded.

Respiration rates of the mushrooms were then measured using an infrared gas analyzer. Respiration was measured using a mass-based equation.

Mushrooms were then placed in a drying chamber for 3 hours. Dry masses were recorded. Dry volumes were then measured using a 1000ml graduated cylinder so that density could be calculated.

Results

- Dry respiration rates were calculated by multiplying the fresh respiration rate by the ratio of fresh mass to dry mass.

Dry respiration= (fresh mass/dry mass) x fresh respiration

- Measured and calculated values were compiled using Microsoft excel software and statistical tests were run using Minitab statistical software.

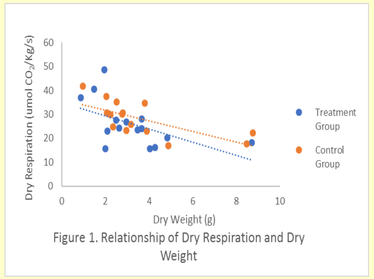


Figure 1. Relationship of Dry Respiration and Dry Weight

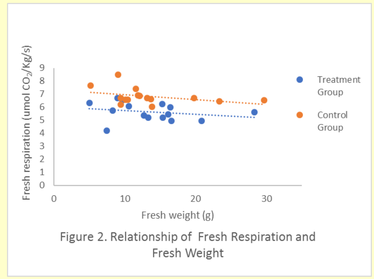


Figure 2. Relationship of Fresh Respiration and Fresh Weight

Figure 4. Relationship of Fresh Respiration and Day

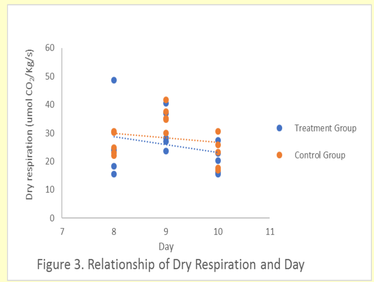


Figure 3. Relationship of Dry Respiration and Day

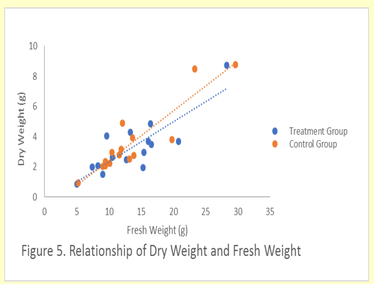


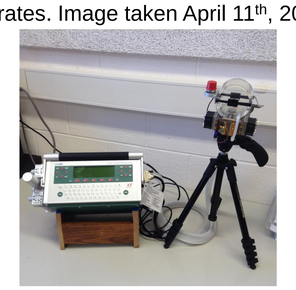
Figure 5. Relationship of Dry Weight and Fresh Weight

Table 1. Comparison of mean values

	Treatment (n=15)	Control (n=15)	P-Value
Mean Fresh Mass (g):	13.7	13.5	p=.948
Mean Dry Mass (g):	3.3	3.6	p=.695
Mean H_2O Mass (g):	10.4	9.9	p=.782
Mean % H_2O:	76.1	74.5	p=.538
Mean Dry Mushroom volume (ml):	10.9	10.5	p=.888
Mean Dry Density (g/ml):	0.312	0.342	p=0.278
Mean Fresh Respiration (umol*kg^{-1}*s^{-1}):	5.6	6.8	p=0.000
Mean Dry Respiration (umol*kg^{-1}*s^{-1}):	25.9527207	28.30733	p=0.453

Figure 6. Shiitake mushrooms growing in a commercial grow room. Image taken April 11th, 2018.

Figure 7. Licor 6400 XT Photosynthesis System used to measure fresh respiration rates. Image taken April 11th, 2018.



Discussion

Due to the similarities between the fresh and dry masses and density, it can be concluded that exposure to green light did not have a significant effect on biomass production. Taking into account the aforementioned results of Glukhova et al. (2014), the data suggests that there may be a physiological change between the mycelial and reproductive cell stages that causes the cellular mechanisms by which green light stimulates growth to be suppressed.

Interestingly, the fresh respiration rates of the treatment group were shown to be less than the those of the control group ($P < 0.01$) while the dry respiration rates were not shown to be different between the two groups. Despite these contradictions, however, the data does not show any sign of increased respiration rates within the treatment group, and so the original hypothesis can safely be rejected.

Because the fresh respiration rate and dry mass of a mushroom were used to calculate its dry respiration rate, it is especially unclear why there is a significance difference between the fresh respiration rates but not the dry rates. It is possible that the sample size was not large enough resulting in a difference being wrongfully observed. It is also possible that exposure to green light caused a physiological change in the mushrooms that allowed for lower respiration rates while maintaining similar biomass production. Such a phenomenon has never been observed however, and the current evidence is not compelling enough to support such a hypothesis, nor would it account for the insignificant difference between dry respiration rates.

Conclusions

1. Exposure to green LED light did not stimulate respiration rates in shiitake mushrooms.
2. Exposure to green LED light did not stimulate biomass production in shiitake mushrooms.
3. Green LED light are not relevant for increasing growth yields of shiitake mushrooms in commercially grown settings.
4. Further research is necessary to determine if exposure to green LED light truly causes lower respiration rates.

References

- Glukhova, L., Sokolyanskaya, L., Plotnikov, E., Gerasimchuk, A., Karnachuk, O., Solioz, M., & Karnachuk, R. (2014). Increased mycelial biomass production by lentinula edodes intermittently illuminated by green light emitting diodes. *Biotechnology Letters*, *36*(11), 2283-2289. doi:10.1007/s10529-014-1605-3