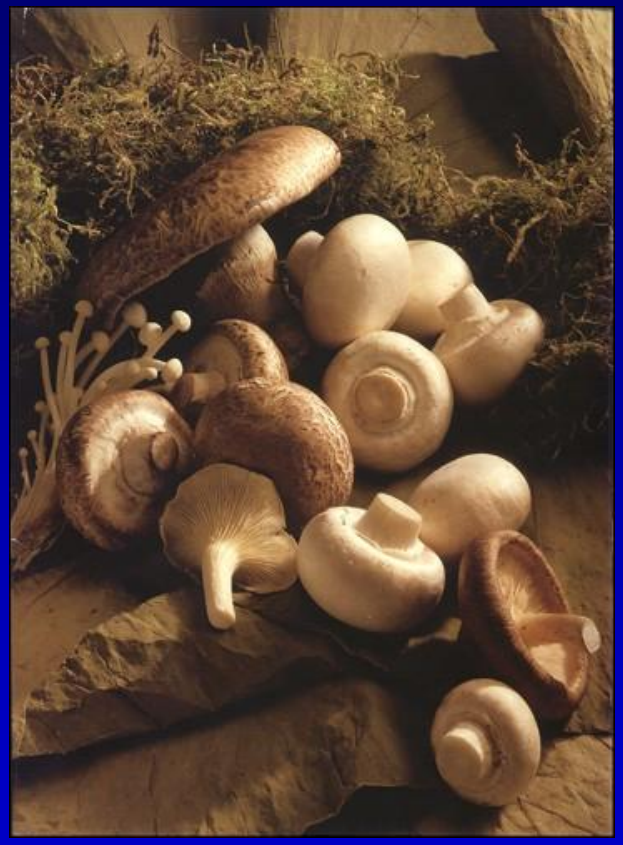
Vitamin D and Mushrooms:
Enrichment With Pulsed UV Light



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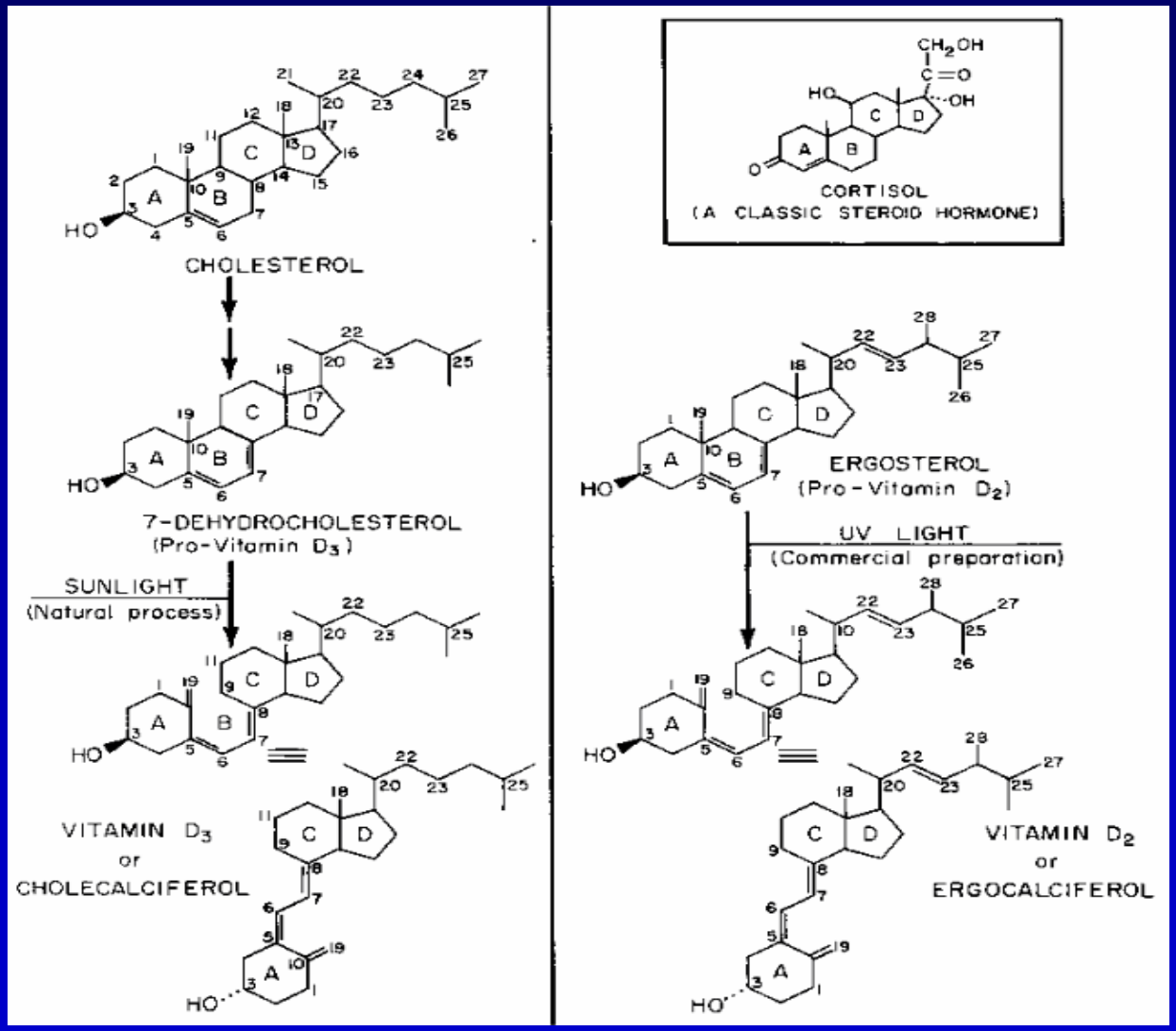
Vitamin D Synthesis



Source: http://vitamind.ucr.edu/Images/chem1.gif

Vitamin D In Foods

Food	International Unit (IU) per serving	Percent DV*
Cod liver oil, 1 Tablespoon	1,360	340
Mushrooms, enriched with vitamin D, 3 ounces	400	100
Salmon, cooked, 3½ ounces	360	90
Mackerel, cooked, 3½ ounces	345	90
Tuna fish, canned in oil, 3 ounces	200	50
Sardines, canned in oil, drained, 1¾ ounces	250	70
Milk, nonfat, reduced fat, and whole, vitamin D fortified, 1 cup	98	25
Margarine, fortified, 1 Tablespoon	60	15
Pudding, prepared from mix and made with vitamin D fortified milk, ½ cup	50	10
Ready-to-eat cereals fortified 10% of the DV for Vitamin D, ¾ cup to 1 cup servings (servings vary according to the brand)	40	10
Egg, 1 whole (Vitamin D is found in egg yolk)	20	6
Liver, beef, cooked, 3½ ounces	15	4
Cheese, Swiss, 1 ounce	12	4

Source: http://ods.od.nih.gov/factsheets/vitamind.asp

Vitamin D Era?

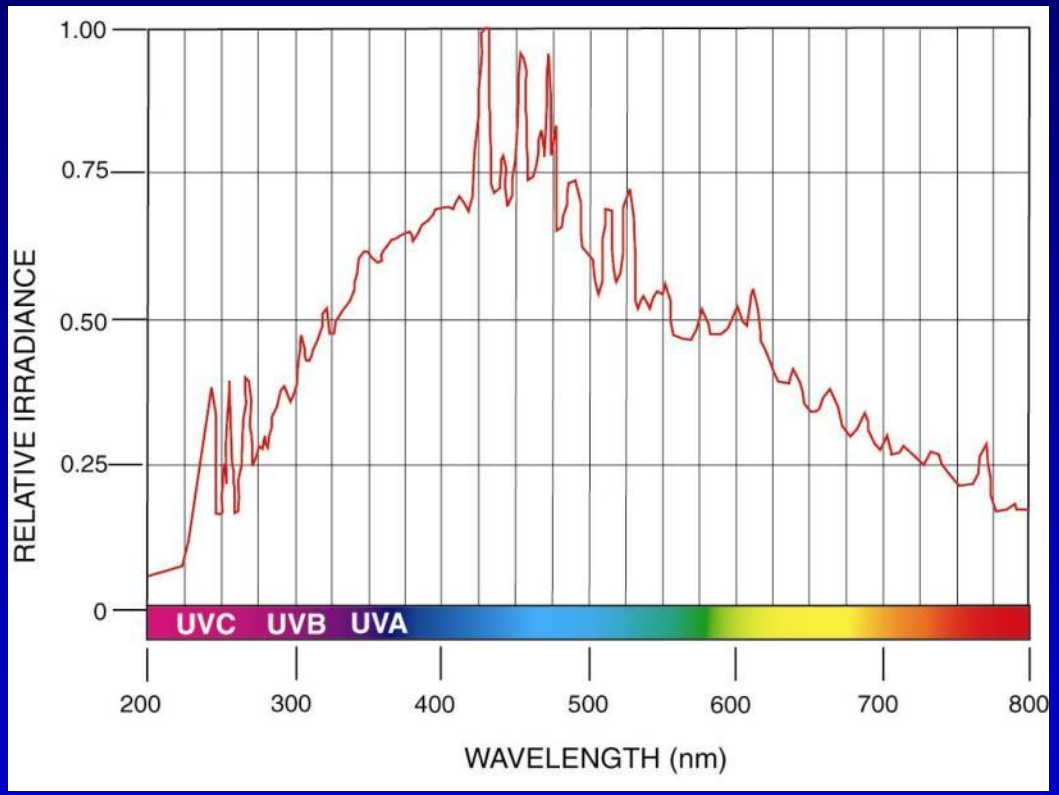
- Vitamin D Deficiency linked to:
  - Cancer
  - CHD
  - Hypertension & Stroke
  - MS, RA
  - Inflammatory Bowel Disease
  - Mental illness
  - Chronic Back Pain

Source: Cannell et al., Expert Opn. Pharmacother 9:1-9(2008)

Vitamin D_2 Enrichment of Fresh Mushrooms Using Ultraviolet Light

Pulsed UV-Light

- Broad Spectrum (100-800 nm)
- High intensity pulses
- Short exposure times



Courtesy: Xenon Corporation

Experimental Pulsed UV Light System

Objectives

- To determine methods needed to optimize pulsed UV light treatment using a B-type lamp to produce significant amounts of vitamin D_2 in fresh mushrooms using short exposure times and to study the potential factors influencing the amount of vitamin D_2 produced.
- To determine retention of vitamin D_2 through shelf life.
- To determine effects on shelf life and quality attributes.

Experiments

- Dose/Response Study
- Whites vs. browns
- Sliced vs. wholes
- Package weight
- Distance from lamp

- Retention of vitamin D_2 through shelf life

- Microbial population
  - Total Aerobic Plate Count
  - Yeasts and Molds

- Quality
  - Weight loss during storage
  - Color
    - Color readings
    - Digital photographs

Methods

- Treatment: 3 pulses
- 3 replications
- All samples frozen and freeze dried immediately and ground into powders.
- Samples sent to Medallion Labs for vitamin D_2 analysis.
- Vitamin D content expressed as IU/100g FW and %DV/84g Serving where appropriate

Dose/ Response

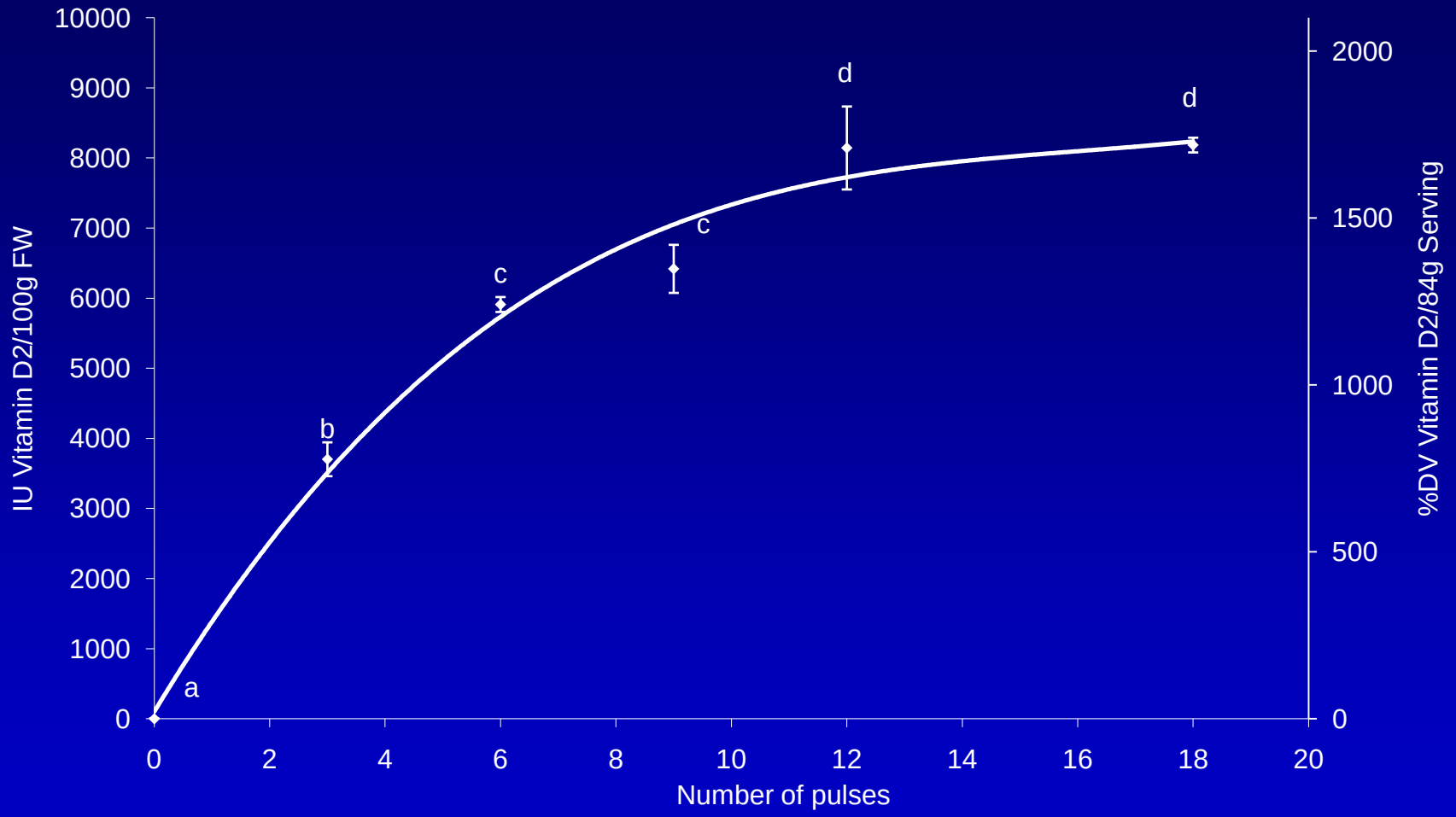


Figure 1. Vitamin D_2 content of sliced fresh white button (*Agaricus bisporus*) mushrooms treated with p ulsed UV light in increments of 3 pulses (3 pulses = 1 s exposure time). Error bars represent standardd eviation. Lower case letters that are the same are not significantly different (p=0.05).

White & Brown, Sliced & Whole

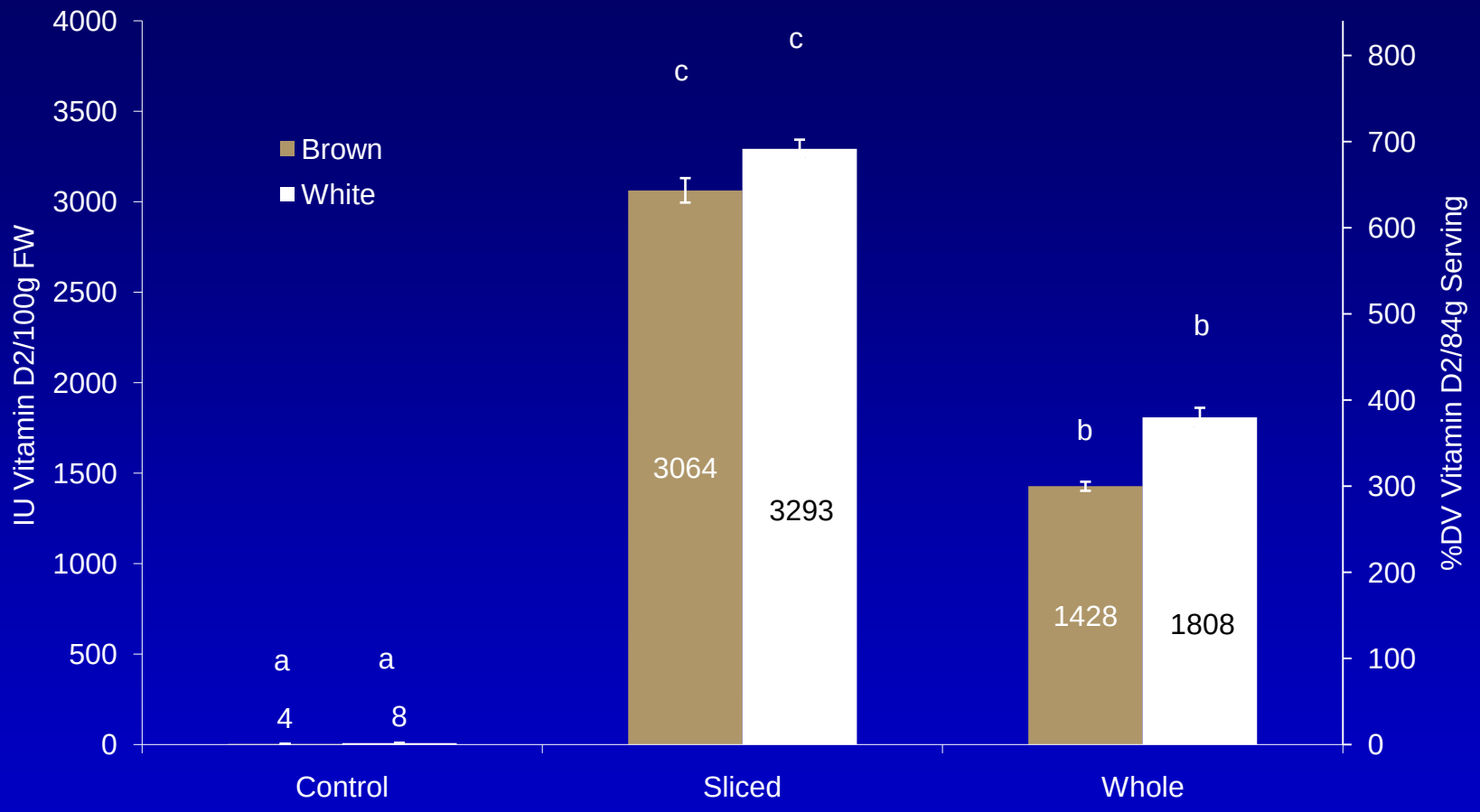


Figure 2. Vitamin D_2 content of sliced fresh white and brown button (*Agaricus bisporus*) mushrooms t reated with pulsed UV light (3 pulses = 1 s exposure time, control mushrooms received 0 pulses) in ei ther sliced or whole form. Error bars represent standard deviation. Lower case letters that are the sa me are not significantly different (p=0.05).

Amount Treated

Figure 3. Vitamin D_2 content of sliced fresh white button (*Agaricus bisporus*) mushrooms treated in two different weight packages with pulsed UV light (3 pulses = 1 s exposure time). Error bars represent standard deviation. Lower case letters that are the same are not significantly different (p=0.05).

Distance From Lamp

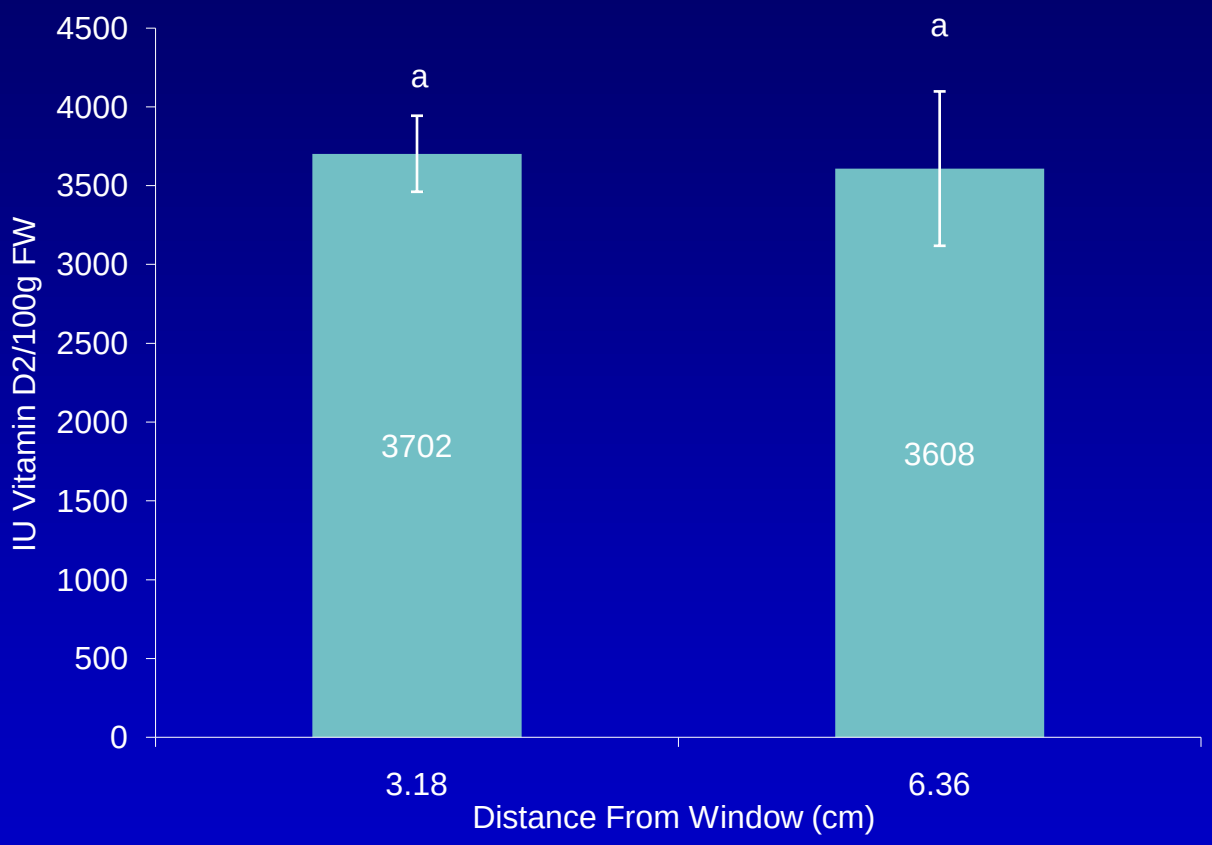


Figure 4. Vitamin D_2 content of sliced fresh white button (*Agaricus bisporus*) mushrooms treated with pulsed UV light (3 pulses = 1 s exposure time) at two distances from the quartz window of the pulsed UV light system. Error bars represent standard deviation. Lower case letters that are the same are not significantly different (p=0.05).

Retention

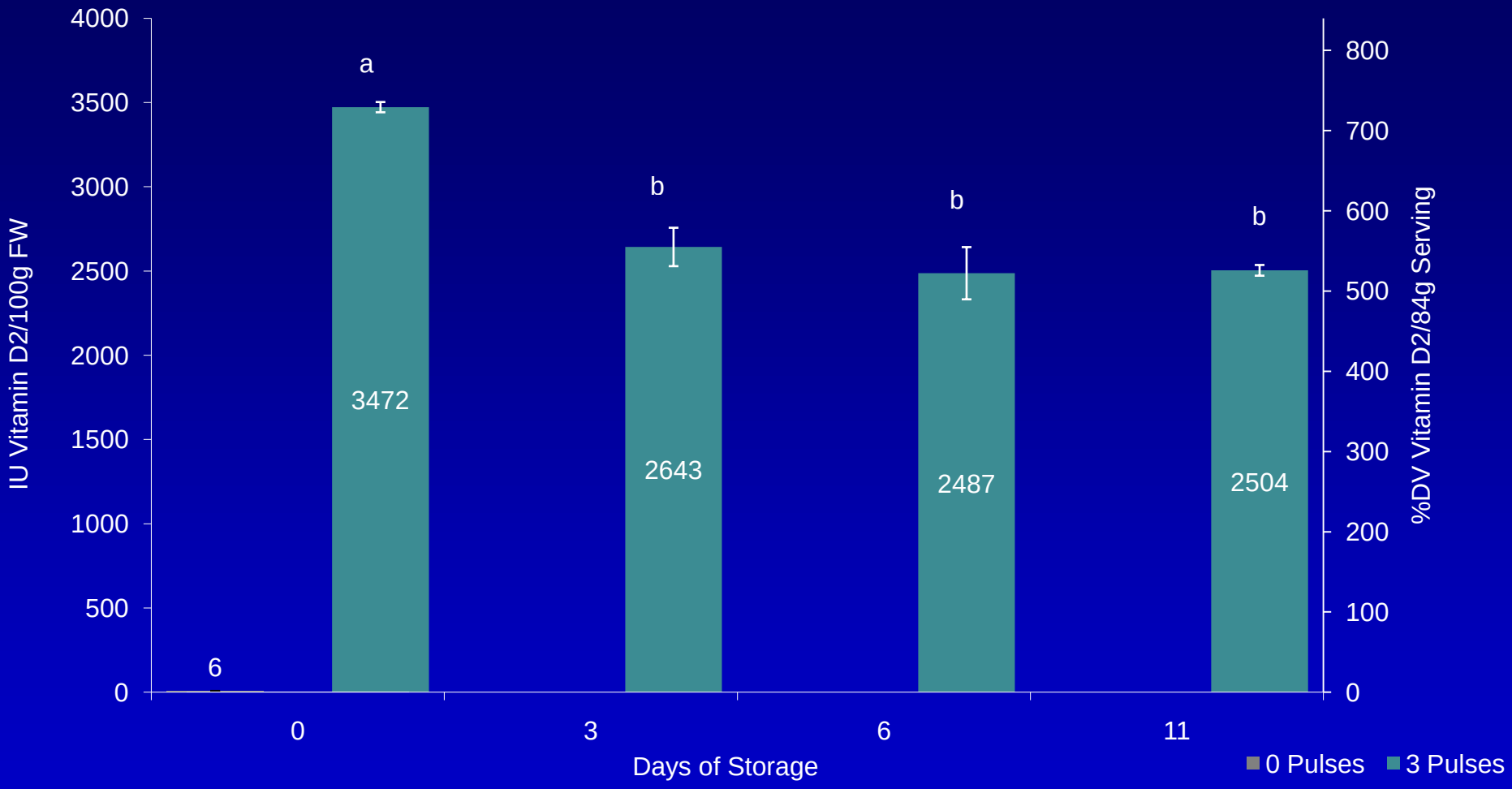


Figure 5. Vitamin D_2 content of sliced fresh white button (*Agaricus bisporus*) mushrooms treated with pulsed UV light (3 pulses = 1 s exposure time) and stored for up to 11 days at 3°C. Error bars represent standard deviation. Lower case letters that are the same are not significantly different ($p=0.05$).

Total Aerobic Plate Count

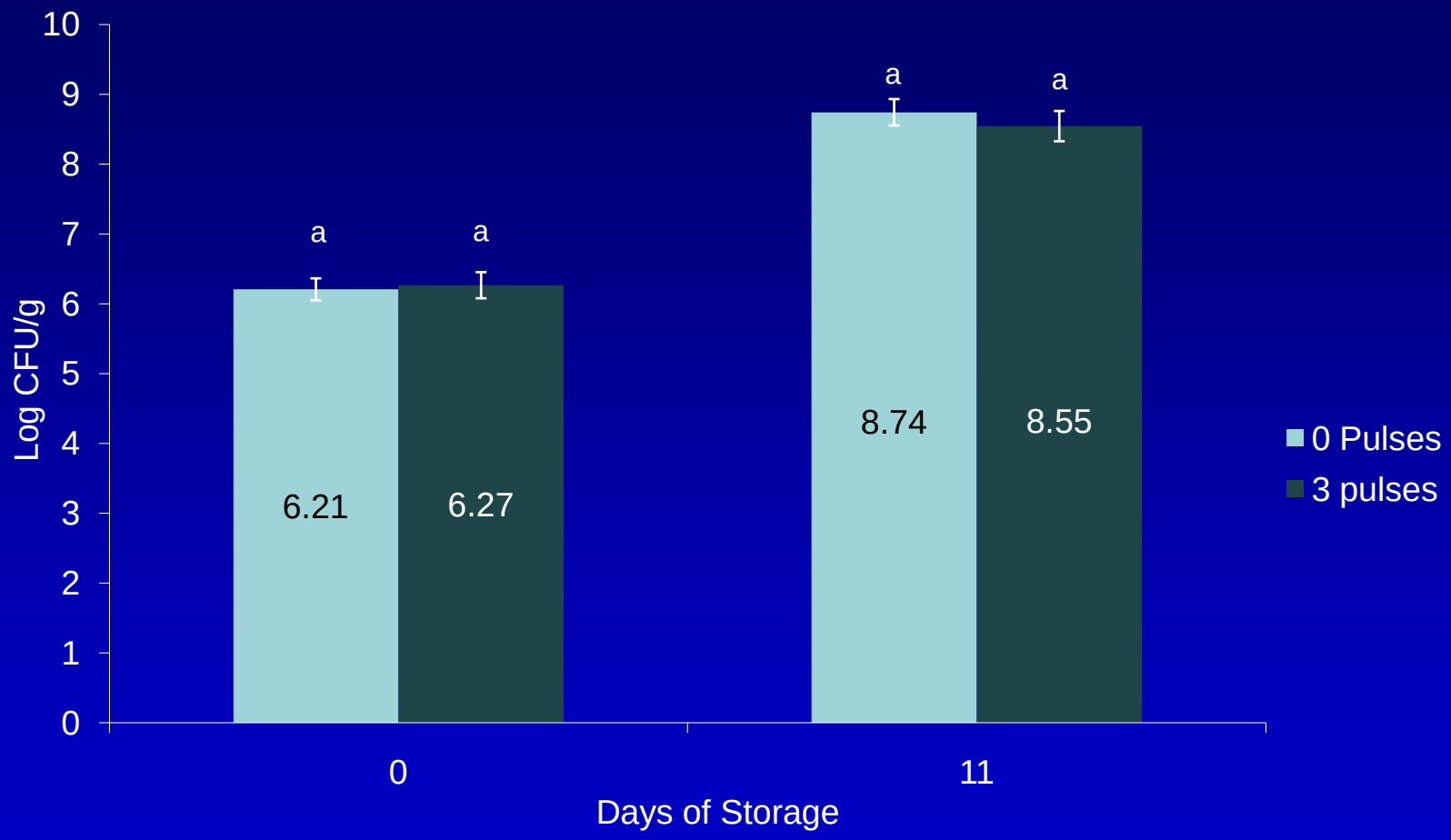


Figure 6. Total aerobic plate counts of pulsed UV treated (3 pulses) and untreated sliced white button (*Agaricus bisporus*) mushrooms directly following treatment and after 11 days of storage at 3°C. Error bars represent standard deviation. Lower case letters that are the same are not significantly different (p=0.05).

Yeasts and Molds

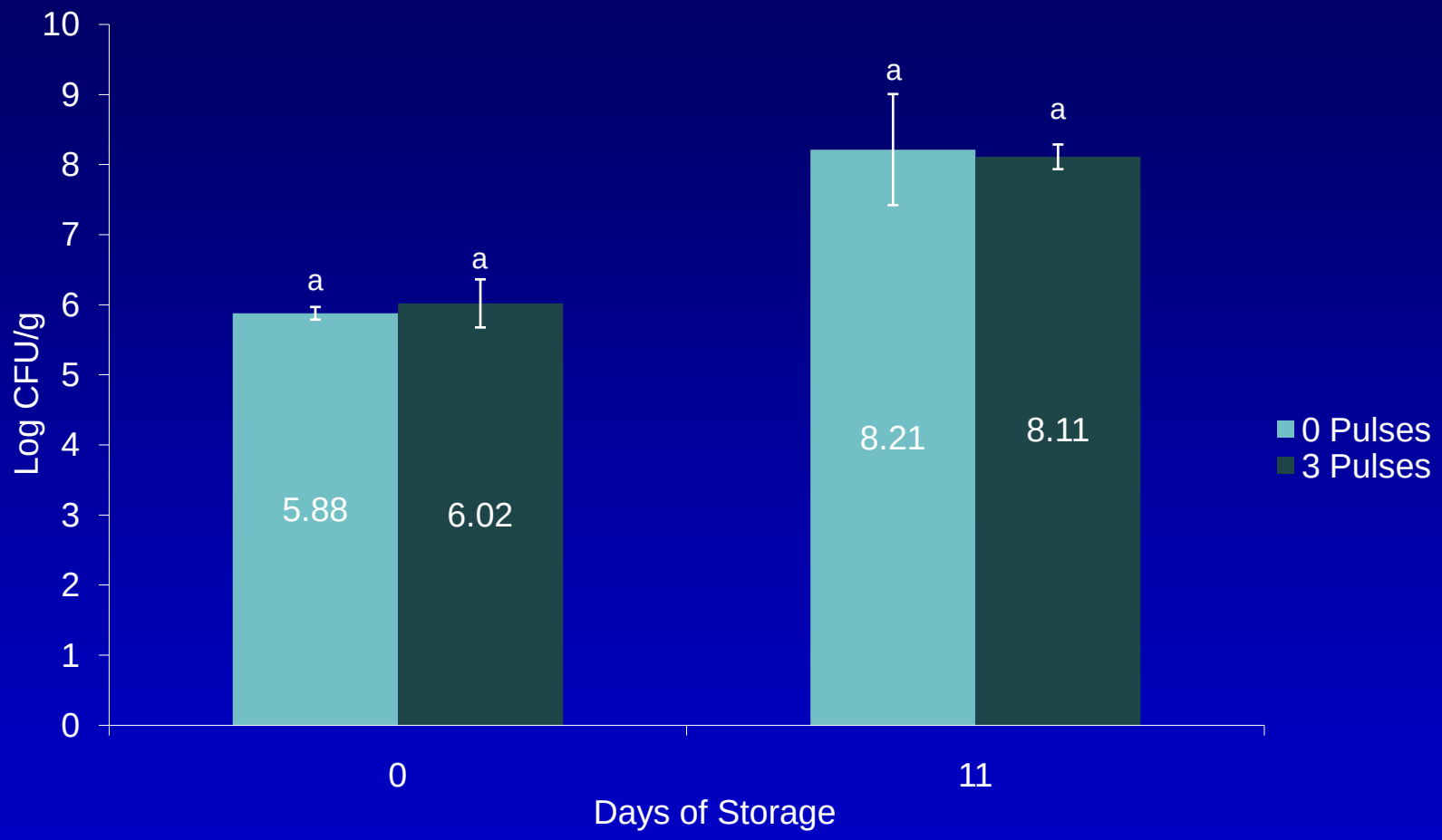


Figure 7. Yeast and mold counts of pulsed UV treated (3 pulses) and untreated sliced white button (*Agaricus bisporus*) mushrooms directly following treatment and after 11 days of storage at 3°C. Error b ars represent standard deviation. Lower case letters that are the same are not significantly different (p=0.05).

% Weight Loss

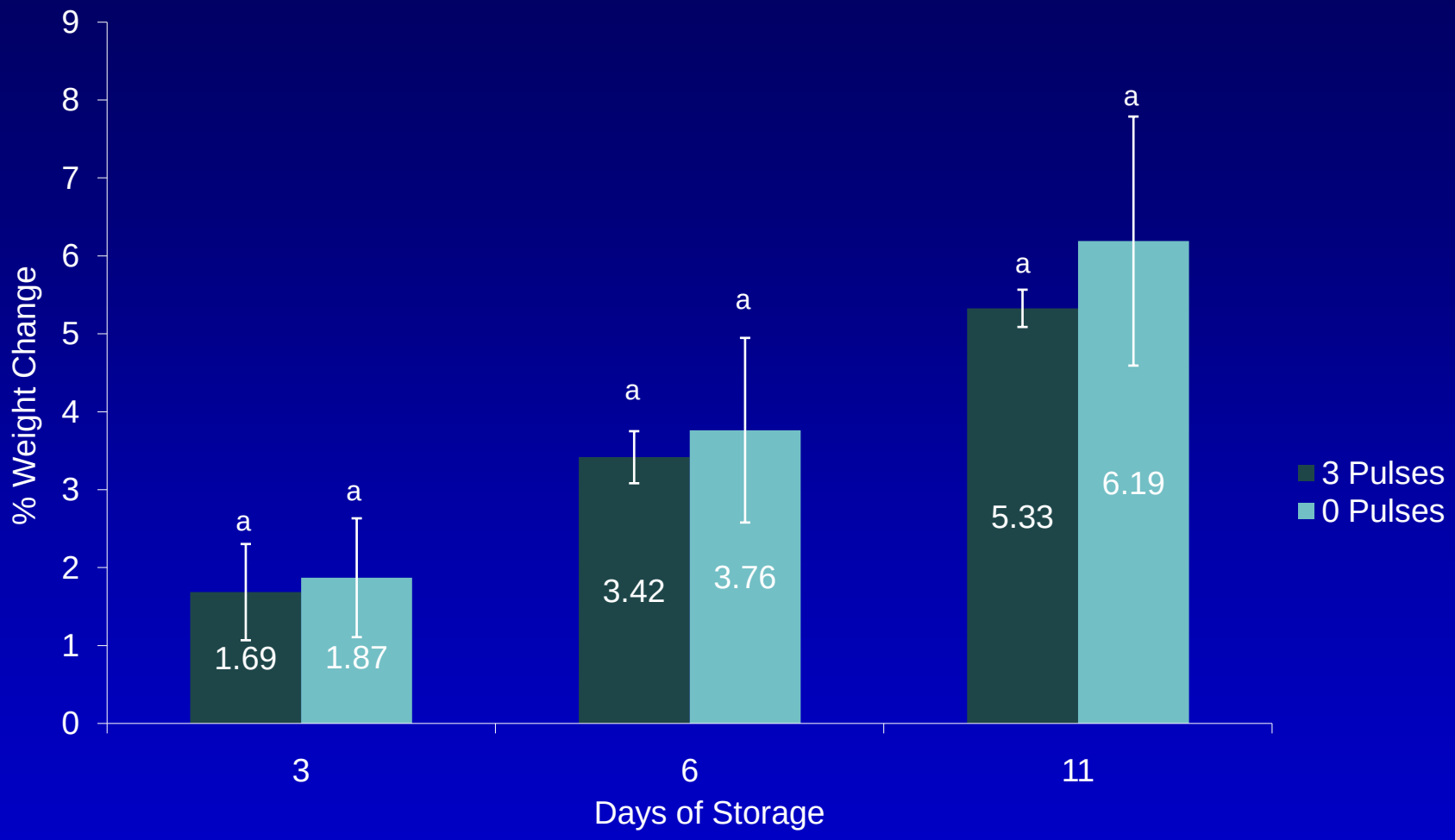


Figure 8. % Weight change in pulsed UV treated sliced fresh white button (*Agaricus bisporus*) mushrooms from initial weight (150 g) after storage at 3°C for up to 11 days. Error bars represent standard deviation. Lower case letters that are the same are not significantly different (p=0.05).

Whiteness

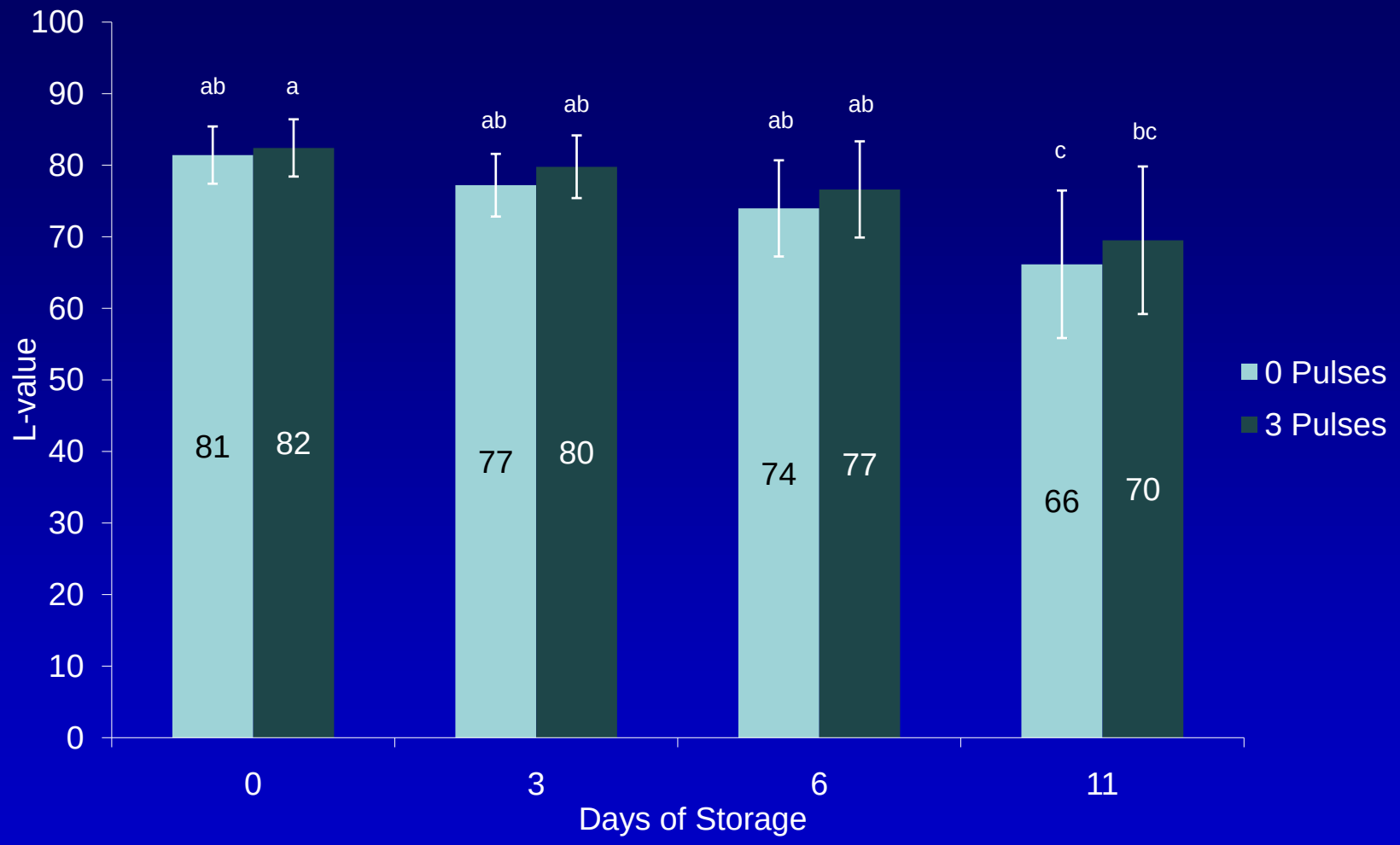


Figure 9. Whiteness (L-value) of untreated and pulsed UV light treated sliced fresh white button (*Agaricus bisporus*) mushrooms. An L-value of 100 = white and 0= black). Error bars represent standard deviation. Lower case letters that are the same are not significantly different (p=0.05).

Figure 10. Photograph of sliced fresh white button mushrooms after storage at 3°C for 0 days (a), 3 days (b) 6 days (c) and 11 days (d). The top row of each quadrant are untreated, the bottom row was treated with 3 pulses of pulsed UV light.

Pulsed UV Light Treatment Conclusions

- Vitamin D_2 levels off around 1700% DV
- Slicing mushrooms produces more vitamin D_2 than whole
- Brown buttons convert slightly less, when treated whole
- Increased amount of mushrooms treated in batch decreases amount of vitamin D_2 produced
- Vitamin D_2 decreases approximately 24% after 3 days storage at 3°C (~37°F), but remains steady through 11 days
- No difference in microbial populations
- No change in quality

Thanks

Mushroom Council

AMGA

Dr. Robert Beelman
Dr. Ali Demirci


Questions?

Mushroom Type	Sliced/ Whole	Pulses	Other Factors	Vitamin D2 Content (%DV/ 84 g Serving)	Vitamin D2 Content (IU/100 g FW)
Figure 1- Dose/Response					
White	Sliced	0	N/A	0.303	1.11
White	Sliced	3	N/A	777	3702
White	Sliced	6	N/A	1241	5909
White	Sliced	9	N/A	1348	6414
White	Sliced	12	N/A	1710	8142
White	Sliced	18	N/A	1718	8041
Figure 2- Brown/White, Sliced/Whole					
White	N/A	0	N/A	2	7.91
White	Sliced	3	N/A	692	3293
White	Whole	3	N/A	380	1808
Brown	N/A	0	N/A	1	3.81
Brown	Sliced	3	N/A	643	3064
Brown	Whole	3	N/A	300	1428
Figure 3- Weight Treated					
White	Sliced	3	150 g	743	3394
White	Sliced	3	230 g	447	1984
Figure 4- Distance From Quartz Window					
White	Sliced	3	3.18 cm	777	3702
White	Sliced	3	6.36 cm	781	3717
Figure 5- Shelf Life					
White	Sliced	0	0 days	1	6.19
White	Sliced	3	0 days	729	3472
White	Sliced	3	3 days	555	2643
White	Sliced	3	6 days	522	2487
White	Sliced	3	11 days	526	2504