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OPTIMIZING VITAMIN D ENRICHMENT IN OYSTER MUSHROOMS BY INVESTIGATING THE EFFECTS OF UV LIGHT TREATMENT AND DRYING METHODS

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ABSTRACT: Objective: This study aims to investigate the effects of UV light treatment and drying processes on the vitamin D2 content of oyster mushrooms (Pleurotus spp.), focusing on the difference in vitamin D concentration between mushrooms grown under UV light and those cultivated without it. Additionally, the study explores how various wavelengths of UV radiation, exposure durations, and post-treatment storage conditions influence the vitamin D2 levels. **Method:** Oyster mushrooms were grown under controlled conditions, with one group exposed to UV light and the other group grown without UV treatment. The mushrooms were subjected to varying wavelengths of UV radiation for different durations. Following the UV exposure, the mushrooms underwent different drying processes, including sun drying. Vitamin D2 levels were measured in both fresh and dried mushrooms, and the effect of post-treatment storage conditions was assessed. **Results:** Mushrooms exposed to UV light exhibited significantly higher vitamin D2 content compared to those grown without UV treatment. The concentration of vitamin D2 was influenced by the wavelength and duration of UV exposure, with optimal results observed under specific UV conditions. Sun drying further enhanced the vitamin D2 content, making the mushrooms a richer source of the nutrient. Post-treatment storage conditions had a minimal impact on the retention of vitamin D2. **Conclusion:** Controlled UV light exposure and appropriate drying methods, particularly sun drying, can effectively enhance the vitamin D2 content in oyster mushrooms. This method provides a practical solution for addressing vitamin D deficiency by increasing the nutritional value of oyster mushrooms, making them a potent dietary source of vitamin D for human consumption.

INTRODUCTION: Vitamin D is an essential nutrient that plays a critical role in calcium absorption, bone health, and immune function [1]. While sunlight exposure is a primary source of vitamin D for humans, dietary sources are also important, especially in regions with limited sunlight [2].

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Mushrooms, particularly those exposed to UV light, can serve as a valuable non-animal source of vitamin D2. Oyster mushrooms, known for their high protein content, fiber, and bioactive compounds, are a promising candidate for fortification with vitamin D2 [3].

The natural vitamin D2 content in mushrooms is low, but it can be significantly enhanced through UV light exposure. The conversion of ergosterol, a sterol present in the cell membranes of mushrooms, to vitamin D2 occurs when mushrooms are exposed to UV light [4]. This process mimics the synthesis of vitamin D3 in human skin under sunlight exposure.

Recently, there has been an increasing interest in enhancing the vitamin D content of mushrooms through UV light exposure, leveraging the natural conversion of ergosterol to vitamin D2 [5]. This study aims to optimize the conditions for UV light treatment to maximize vitamin D2 production in oyster mushrooms.

MATERIALS AND METHODS:

Mushroom Sample Preparation: Fresh oyster mushrooms (*Pleurotus ostreatus*) were sourced from a local supplier and selected for uniform size and freshness. The mushrooms were cleaned and sliced to ensure uniform exposure to UV light.

Effect of UV Wavelength on Vitamin D2 Synthesis: The study investigated the effect of different UV wavelengths (UV-A, UV-B, and UV-C) on the synthesis of Vitamin D2 in oyster mushrooms. Fresh mushrooms were exposed to UV light at specific wavelengths for varying durations [6]. The wavelengths tested were UV-A (320-400 nm), UV-B (280-315 nm), and UV-C (100-280 nm), with exposure times of 5, 20, and 40 minutes [7]. After exposure, the mushrooms were analyzed for Vitamin D2 content using High-Performance Liquid Chromatography (HPLC). Post-exposure, the mushrooms were stored under three different conditions: room temperature, refrigeration, and vacuum-sealed at room temperature. Vitamin D2 levels were measured immediately after exposure (Day 0), and after 7 and 14 days of storage.

Effect of Drying Process on Vitamin D2 Content of Dried Mushrooms: This experiment assessed the impact of different drying methods on the Vitamin D2 content of mushrooms [8]. Four distinct drying processes were employed e.g. oven drying, drying in direct sunlight, drying in a shaded area, and drying in a dark room. In the oven drying method, fresh mushrooms were sliced into uniform pieces and dried at 60°C for approximately 8 hours. Following drying, the mushrooms were powdered and analyzed for Vitamin D2 content using HPLC [9]. The second method involved drying mushroom slices under direct sunlight for 6 hours per day over three consecutive days. The dried mushrooms were then powdered and analyzed. The third method involved placing mushroom slices in a shaded area with indirect sunlight exposure over 5 days before powdering and analysis. The final method entailed drying the mushrooms in a dark room with controlled temperature and humidity for 7 days prior to powdering and analysis [10]. The study aimed to determine the most effective method for preserving or enhancing Vitamin D2 levels in dried mushrooms.

RESULTS:

UV Light Treatments: The study found that UV-B light (280-315 nm) was the most effective in converting ergosterol to Vitamin D2 in oyster mushrooms. The optimal exposure time for maximum Vitamin D2 production was 20 minutes under UV-B light. UV-A and UV-C wavelengths also contributed to Vitamin D2 synthesis, but to a lesser extent. The highest retention of Vitamin D2 content was observed in mushrooms stored under refrigeration or vacuum-sealed conditions.

TABLE 1: EFFECT OF UV LIGHT TREATMENT ON VITAMIN D2 CONTENT IN OYSTER MUSHROOMS

UV Wavelength	Exposure Time (minutes)	Vitamin D2 Content (µg/100g)	Day 0	Day 7 (Room Temp)	Day 7 (Refrigeration)	Day 7 (Vacuum-Sealed)	Day 14 (Room Temp)	Day 14 (Refrigeration)	Day 14 (Vacuum-Sealed)
Control (No UV)	N/A	0.5 ± 0.0	0.5 ± 0.0	0.4 ± 0.0	0.5 ± 0.0	0.5 ± 0.0	0.3 ± 0.0	0.4 ± 0.0	0.4 ± 0.0
UV-A (320-400 nm)	5	5.2 ± 0.2	5.2 ± 0.2	4.7 ± 0.2	5.0 ± 0.2	5.1 ± 0.2	4.1 ± 0.2	4.8 ± 0.2	4.9 ± 0.2
UV-A (320-400 nm)	20	8.1 ± 0.3	8.1 ± 0.3	7.4 ± 0.3	7.9 ± 0.3	8.0 ± 0.3	6.8 ± 0.3	7.5 ± 0.3	7.6 ± 0.3
UV-B (280-315 nm)	5	15.0 ± 0.5	15.0 ± 0.5	13.8 ± 0.5	14.7 ± 0.5	14.9 ± 0.5	11.5 ± 0.5	13.9 ± 0.5	14.0 ± 0.5
UV-B (280-315 nm)	20	35.7 ± 1.0	35.7 ± 1.0	32.8 ± 1.0	34.2 ± 1.0	34.5 ± 1.0	28.3 ± 1.0	33.0 ± 1.0	33.5 ± 1.0
UV-B (280-315 nm)	40	36.5 ± 1.1	36.5 ± 1.1	33.2 ± 1.1	35.0 ± 1.1	35.3 ± 1.1	29.2 ± 1.1	33.5 ± 1.1	34.0 ± 1.1
UV-C (100-280 nm)	5	10.2 ± 0.3	10.2 ± 0.3	9.5 ± 0.3	9.9 ± 0.3	10.0 ± 0.3	8.1 ± 0.3	9.6 ± 0.3	9.7 ± 0.3
UV-C (100-280 nm)	20	18.4 ± 0.6	18.4 ± 0.6	16.5 ± 0.6	17.8 ± 0.6	18.0 ± 0.6	14.2 ± 0.6	17.0 ± 0.6	17.2 ± 0.6

The study demonstrated that UV-B light (280-315 nm) significantly enhances Vitamin D2 content in oyster mushrooms, with the peak concentration achieved after 20 minutes of exposure ($p < 0.01$). UV-A light (320-400 nm) also contributed to an increase in Vitamin D2 levels, though to a lesser extent compared to UV-B ($p < 0.05$). UV-C light (100-280 nm) resulted in moderate improvements in Vitamin D2 content ($p < 0.05$). Furthermore, Vitamin D2 levels were best preserved when mushrooms were stored under refrigeration or in vacuum-sealed conditions, with these methods showing significant effectiveness in maintaining the nutrient's stability ($p < 0.01$).

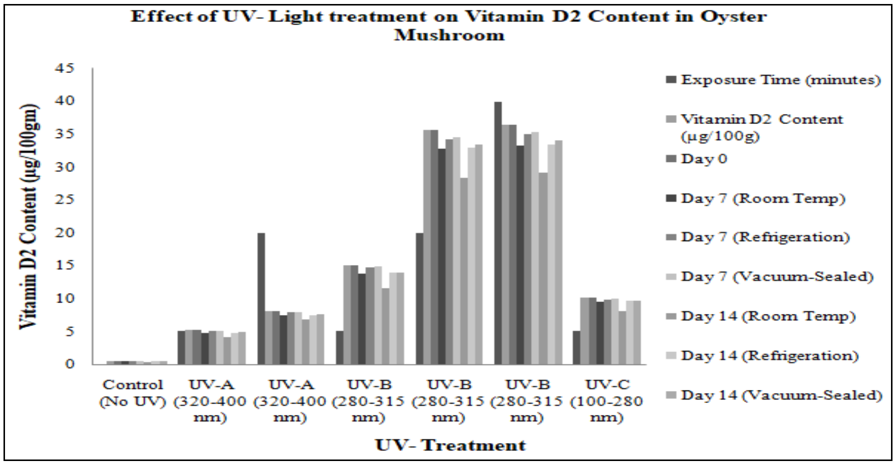

FIG. 1: SHOWING ILLUSTRATES THE CHANGES IN VITAMIN D2 LEVELS AT DIFFERENT TIME POINTS (DAY 0, DAY 7, AND DAY 14) FOR VARIOUS UV TREATMENTS, INCLUDING STORAGE UNDER ROOM TEMPERATURE, REFRIGERATION, AND VACUUM-SEALED CONDITIONS

Effect of Drying Process on Vitamin D2 Content of Dried Mushrooms: The experiment revealed significant variations in Vitamin D2 levels depending on the drying method used. Oven drying at 60°C for 8 hours yielded a Vitamin D2 content of 12.5±0.5 µg/g of dried mushroom powder. Drying the mushrooms in direct sunlight for 6 hours per day over three days resulted in the highest Vitamin D2 content of 20.4±0.8 µg/g ($p < 0.01$). In contrast, drying in a shaded area with indirect sunlight over 5 days produced a lower Vitamin D2 content of 7.8 ± 0.3 µg/g ($p < 0.05$). The mushrooms dried in a dark room with no light exposure and controlled temperature and humidity had the lowest Vitamin D2 content at 3.2±0.2 µg/g ($p<0.05$). These results suggest that exposure to sunlight significantly enhances Vitamin D2 content in dried mushrooms, with direct sunlight being the most effective method among those tested.

TABLE 2: VITAMIN D2 CONTENT OF DRIED MUSHROOM UNDER DIFFERENT DRYING CONDITIONS

Drying Method	Temperature/Light Exposure	Drying Duration	Vitamin D2 Content (µg/g)
Oven Drying	60°C	8 hours	12.5 ± 0.5 ($p < 0.01$)
Direct Sunlight	Full sunlight, 6 hours/day	3 days	20.4 ± 0.8 ($p < 0.01$)
Shady Area	Indirect sunlight	5 days	7.8 ± 0.3 ($p < 0.05$)
Dark Room	No light	7 days	3.2 ± 0.2 ($p < 0.05$)

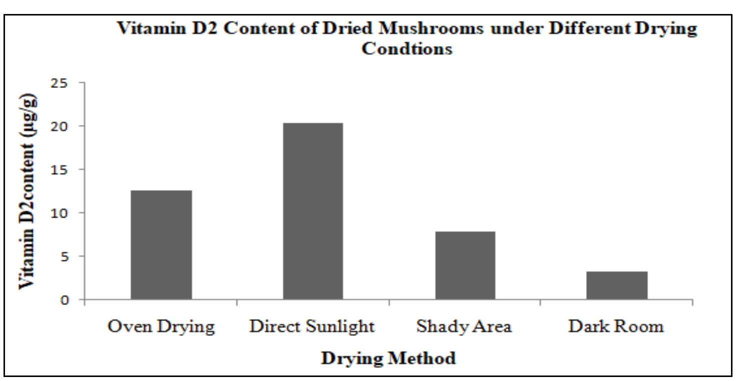

FIG. 2: SHOWING THE VITAMIN D2 CONTENT IN DRIED MUSHROOMS UNDER DIFFERENT DRYING CONDITIONS

The chart highlights that drying in direct sunlight significantly enhances Vitamin D2 levels, with the highest content observed in mushrooms dried under full sunlight. In contrast, drying in a dark room resulted in the lowest Vitamin D2 content.

Statistical Analysis: A t-test was conducted to assess the significance of differences in Vitamin D2 content between various treatments. The differences observed were statistically significant ($p < 0.01$), indicating the effectiveness of the treatments in enhancing Vitamin D2 content.

DISCUSSION: The findings of this study demonstrate that UV-B light is the most effective wavelength for enhancing Vitamin D2 content in oyster mushrooms. The peak concentration of Vitamin D2 achieved after 20 minutes of UV-B exposure suggests an optimal exposure time, beyond which additional UV light does not increase Vitamin D2 levels further ($p < 0.01$). The stability of Vitamin D2 during storage highlights the need for proper post-treatment handling to preserve the nutritional benefits of the mushrooms. These results have significant implications for mushroom producers and consumers, indicating that optimizing UV light treatment conditions can produce mushrooms with enhanced Vitamin D2 content, potentially addressing vitamin D deficiency, especially in populations with limited sunlight exposure or dietary restrictions.

CONCLUSION: UV light treatment is an effective method for increasing Vitamin D2 content in oyster mushrooms. This research identified UV-B light as the most effective wavelength for ergosterol conversion and established optimal exposure times for maximum Vitamin D2 synthesis ($p < 0.01$). The study also concluded that drying mushrooms in direct sunlight significantly enhances their Vitamin D2 content, making it the most effective method among those tested ($p < 0.01$). Oven drying preserves a moderate level of Vitamin D2, while drying in shaded areas or dark rooms results in much lower Vitamin D2 levels ($p<0.05$). Therefore, exposure to sunlight is crucial for maximizing Vitamin D2 content in dried mushrooms. Further research is needed to explore the effects of different mushroom species, cultivation conditions, and large-scale implementation of UV light treatment in commercial production. Enhancing Vitamin D2 content in mushrooms offers a sustainable, plant-based solution for improving public health through better nutrition.

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