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RESEARCH ARTICLE

ANALYSIS RESULTS OF VITAMIN D (D2, D3) IN DOMESTICALLY PRODUCED WOOD EAR MUSHROOMS- CHANGES DUE TO UV IRRADIATION TIME

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ABSTRACT

Mushrooms often contain ergosterol, which is converted to vitamin D2 by ultraviolet irradiation. It has been reported that ingesting ergosterol may help prevent dementia and depression by preventing osteoporosis, protecting the brain, and promoting the secretion of the neurotransmitter serotonin. Therefore, this study focused on wood ear mushrooms, which have a high vitamin D content according to the Japanese Food Analysis Table, and investigated whether the vitamin D2 content of dried wood mushroom ears can be increased by irradiating them with ultraviolet light (UV253.7nm). Using domestically produced wood ear mushrooms (manufactured by Kikurage Farm Inazawa Co., Ltd.), the vitamin D (vitamin D2 and vitamin D3) content of fresh, dried, dried (1 hour UV irradiation), dried (2 hours UV irradiation), and dried (3 hours UV irradiation) samples was analyzed by the Japan Food Analysis Center The results showed no significant difference between 1-hour and 2-hour UV irradiation, but 3-hour UV irradiation resulted in a vitamin D content approximately 1.5 times higher (127 μg) than the vitamin D value (84 μg) listed in the Japanese Food Analysis Table for wood ear mushrooms. In the future, considering the potential application of domestically cultivated wood ear mushrooms as disaster food and space food, we aim to enhance their value as a food ingredient by managing "moisture content," "particle size," and "UV irradiation conditions" to maximize their vitamin D2 nutritional value.

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INTRODUCTION

Currently in Japan, the government's nutritional intake surveys have reported deficiencies in calcium, vitamin D, and dietary fiber. Many researchers have also reported that vitamin D deficiency may increase the risk of developing a weakened immune system. A meta-analysis of COVID-19 positive patients also reported that decreased vitamin D levels were significantly associated with worsening patient outcomes and prognosis. Therefore, it has become necessary to raise awareness about vitamin D intake, not only for the prevention of osteoporosis, rickets, and osteomalacia, but also as an even more important vitamin. The 2025 edition of the Dietary Reference Intakes for Japanese recommends a daily intake of 9μg of vitamin D, and if it is difficult to obtain sufficient amounts from food, the use of supplements should be considered. However, since vitamin D is a fat-soluble vitamin, there are concerns about excessive intake through the use of supplements. Therefore, this study aimed to investigate the vitamin D content (vitamin D2, vitamin D3) of domestically produced wood ear mushrooms, with the goal of increasing D intake from diet, and vitamin further investigating the possibility of increasing vitamin D levels through UV irradiation.

METHODS

Using domestically produced wood ear mushrooms (manufactured by Kikurage Farm Inazawa Co., Ltd.), 1 kg of freshly harvested similarly harvested wood ear mushrooms were dried in a steam convection oven (manufactured by Fujimac Co., Ltd.) at 60 degrees Celsius and 0% humidity for 2 hours to obtain 140 g of dried wood ear mushrooms., 140 g of dried wood ear mushrooms were irradiated with ultraviolet light (UV 253.7 nm) in a sterilization cabinet (manufactured by Fujimac Co., Ltd.) for 1 hour, 2 hours, and 3 hours to obtain samples of wood ear mushrooms. The vitamin D (vitamin D2 and vitamin D3) content of all five samples was measured by the Japan Food Research Laboratories.

RESULTS

Analysis conducted by the Japan Food Research Laboratories revealed that while calcium was present in both fresh, domestically produced wood ear mushrooms and those dried in

a dehydrator, vitamin D (both vitamin D2 and vitamin D3) was not present. (See Tables 1 and 2). On the other hand, when raw, domestically produced wood ear mushrooms were dried in a dryer and then irradiated with 253.7 nm ultraviolet light for 1, 2, and 3 hours using a sterilization chamber, the vitamin D levels of the mushrooms were below the detection limit for vitamin D3 (less than 0.7 µg), but vitamin D2 was present. (See Table 1). Vitamin D2 levels were almost the same after 1 hour and 2 hours of UV exposure, but after 3 hours of exposure, the amount was 1.5 times higher than after 1 hour or 2 hours of exposure.

Table 1. Analysis results of vitamin D (vitamin D2 and vitamin D3) in domestically produced wood ear mushrooms by the Japan Food Research Laboratories

sample name	vitamin D	vitamin D2	vitamin D3	Analysis method
Fresh wood ear mushrooms 1 kg	Not detected	Not detected	Less than 0.7 µg/100g	high performance liquid chromatography
Dried wood ear mushrooms 140g	Not detected	Not detected	Less than 0.7 µg/100g	high performance liquid chromatography
Dried wood ear mushrooms (140g) - UV irradiation for 1 hour	85.7 µg/100g	85.7 µg/100g	Less than 0.7 µg/100g	high performance liquid chromatography
Dried wood ear mushrooms(140g) -UV irradiation for 2 hours	83.4 µg/100g	83.4 µg/100g	Less than 0.7 µg/100g	high performance liquid chromatography
Dried wood ear mushrooms(140g) -UV irradiation for 3 hours	127 µg/100g	127 µg/100g	Less than 0.7 µg/100g	high performance liquid chromatography

Table 2. Calcium analysis results of domestically produced wood ear mushrooms by the Japan Food Research Laboratories

sample name	Calcium amount	Analysis method
Fresh wood ear mushrooms 1 kg	12.9mg/100g	IPC emission spectrometry
Dried wood ear mushrooms 140g	98.1mg/100g	IPC emission spectrometry
Dried wood ear mushrooms (140g) - UV irradiation for 1 hour	102mg/100g	IPC emission spectrometry
Dried wood ear mushrooms(140g) -UV irradiation for 2 hours	88.8mg/100g	IPC emission spectrometry
Dried wood ear mushrooms(140g) -UV irradiation for 3 hours	94.7mg/100g	IPC emission spectrometry

DISCUSSION

We commissioned the Japan Food Research Laboratories to measure the calcium content and vitamin D2 content of domestically produced wood ear mushrooms. The results showed that vitamin D2 was not detected in fresh wood ear mushrooms or fresh wood ear mushrooms dried using a drying device (this is the limit of the detection limit). However, when fresh wood ear mushrooms dried using a drying device were irradiated with ultraviolet light (253.7 nm) in a sterilization chamber, the amount of vitamin D2 measured was 85.7 µg/100g after 1 hour of irradiation, 83.4 µg/100g after 2 hours of irradiation, and 127 µg/100g after 3 hours of irradiation. Since ergosterol, which is abundant in mushrooms, is converted to vitamin D2 by ultraviolet irradiation, the design of the post-harvest processing of mushrooms significantly affects their vitamin D2 content. Furthermore, it has been reported that conversion efficiency changes not so much with the drying process itself, but with the management of UV irradiation, the form of pulverization, and the irradiation conditions. It should be understood that mushrooms are not foods that "contain large amounts of vitamin D2 from the start," but rather foods that "contain ergosterol, which has a large potential to be converted to vitamin D2 by light (ultraviolet rays)." Mushrooms are usually sun-dried, but the effect varies depending on the amount of irradiation, the irradiation time, and the surface being irradiated. Based on the analysis of vitamin D2 in domestically produced wood ear mushrooms conducted in this study, it can be concluded that ultraviolet irradiation is important rather than the drying process itself. It has become clear that sun-drying is not an increase in vitamin D2 content itself, but rather a result of the drying process taking place outdoors, which allows for easier production of vitamin D2 due to exposure to ultraviolet rays from the sun. These results suggest that when drying Mushrooms using machine drying or indoor drying methods with little or no UV exposure, the amount of vitamin D2 obtained is negligible. In order to expect the vitamin D2 effect of wood ear mushrooms as a "nutritional value," it is necessary to clearly define the purpose of UV irradiation (vitamin D2 production), determine the irradiation time and irradiation surface (front and back), and set up UV irradiation equipment, in order to improve and guarantee quality. Another method already in use involves "grinding" a sample containing ergosterol and then irradiating it with ultraviolet light under conditions such as stirring and vibration to efficiently convert it to vitamin D2. This method can be considered a way to increase the surface area exposed to ultraviolet light, thereby enabling more efficient conversion of ergosterol to vitamin D2. In the future, if we expect vitamin D2 to be a valuable nutrient for disaster relief food or space food, we believe that by controlling the "moisture content" using a drying machine after harvesting the wood ear mushrooms, further controlling the "particle size" using a pulverizer, and finally controlling the "ultraviolet irradiation conditions" using an ultraviolet irradiation device, we can reduce variations between batches and ensure the supply of wood ear mushrooms of consistent quality.

CONCLUSION

Domestically produced wood ear mushrooms made by Inazawa, Inc. Japan were dried using a steam convection oven (manufactured by Fujimac Co., Ltd.: temperature 60 degrees, humidity 0%, 2 hours) and exposed to ultraviolet light for one hour, 2 hours, and 3 hours using an indoor ultraviolet irradiation device (sterilization cabinet: manufactured by Fujimac Co., Ltd.: 253.7 nm). The vitamin D2 content of the wood ear mushrooms was then measured by the Japan Food Research Laboratories (IPC emission analysis). As a result, vitamin D2 was undetectable in both domestically produced fresh wood ear mushrooms and dried domestically produced fresh wood ear mushrooms, but vitamin D2 was found in dried domestically produced fresh wood ear mushrooms irradiated with ultraviolet light (85.7 µg/100g after 1 hour, 83.4 µg/100g after 2 hours, and 127 µg/100g after 3 hours). When seeking vitamin D2 as a nutritional value for mushrooms such as wood ear mushrooms, it is possible to reduce variations between lots and ensure a consistent quality supply by controlling the "moisture content" using a drying machine after harvesting, further controlling the "particle size" using a pulverizer, and finally controlling the "ultraviolet irradiation conditions" using an ultraviolet irradiation device.

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