Mushrooms contain significant amounts of ergosterol (provitamin D₃), which is converted to previtamin D₃ upon UV exposure and then to vitamin D₃. While ergosterol has been identified in past research, the specific region in the mushroom in which ergosterol is the most abundant has not. Crimini (Agaricus bisporus), Shiitake (Lentinula edodes), and Portobello (Agaricus bisporus) mushrooms were tested in this experiment. Samples were obtained using a core borer, diameter of 12 mm, and split into four parts—top, middle, bottom, and stem. Then, they underwent either methanol extraction or saponification and followed by hexane extraction and were analyzed by straight phased high-performance liquid chromatography (HPLC) to determine the absence of conjugated ergosterol. The results show that Crimini mushrooms had the greatest amount of ergosterol (22.9 ± 1.7 µg/g), followed by Portobello mushrooms (12.5 ± 3.1 µg/g) and Shiitake mushrooms (8.9 ± 5.1 µg/g). These three types of mushrooms differ significantly (p=0.029). After saponification, Crimini, Portobello, and Shiitake mushrooms have 7.1 ± 1.9, 4.4 ± 1.6, and 3.8 ± 1.0 µg/g, respectively, of ergosterol, showing that ergosterol in mushrooms exists in the free form and when converted will be bioavailable. Secondly, it was discovered that the bottom portion of the mushroom has significantly more ergosterol than the top and middle layers. The top, middle, and bottom portion were found to be statistically significantly different with p-values of 0.012, 0.012, and 0.038, respectively. But, the stem was insignificant among the mushrooms. In the future, the bottom portion of the mushroom and the stem could be used for dietary supplements for more concentrated vitamin D₃. This information will also be useful for future research on vitamin D₃ production in mushrooms.

Discussion

The ergosterol levels of different types of mushroom that underwent methanol extraction were quantified. In decreasing order of concentration, Crimini, Portobello, and Shiitake mushrooms had 22.9 ± 1.7, 12.5 ± 3.1, 8.9 ± 5.1 µg/g of ergosterol, respectively. The Kruskal-Wallis Test showed that compared to Crimini and Portobello mushrooms, Shiitake mushrooms had significantly less ergosterol (p=0.029).

The smaller amounts of ergosterol after saponification of Crimini, Portobello, and Shiitake mushrooms (7.1 ± 1.9, 4.4 ± 1.6, and 3.8 ± 1.0 µg/g) revealed that all ergosterol is free, since the saponified samples did not have a much larger concentration. There are no ergosterol that is bound to other molecules. This shows that all converted vitamin D₃ is free and bioavailable to the human body.

The chromatograms reveal that there are greater amounts of ergosterol in the bottom layer in all three mushrooms, contrary to what was previously thought. Portobello mushrooms appear to have an upward trend of ergosterol concentration from the top of the mushroom to the stem. Crimini mushrooms, as well, have an upward trend, but instead their stem has relatively less ergosterol compared to the bottom layer. The top layer, bottom layer, and stem are inversely proportional to the concentration of vitamin D₃ in Shiitake mushrooms. Statistical analysis of the data showed that in each of the three species of mushrooms the bottom and stem had significantly more ergosterol than the top and middle regions. The Kruskal Wallis Test confirmed that the top, middle, and bottom layers of each species of mushroom is different from each other.

Conclusions

Previous studies have found mushrooms to be a good source of vitamin D₃. This study further reinforces the concept of obtaining sufficient amounts of vitamin D from mushrooms. As all converted vitamin D₃ is bioavailable in mushrooms, irradiated mushrooms are a good source of vitamin D. The results reveal that in the future as opposed to the other regions of the mushroom, the bottom layer and stem can be used for dietary supplement and experiments, since the bottom regions of the mushroom are more concentrated in ergosterol.

Future studies can be done to determine the particular regions with the highest vitamin D₃ conversion by irradiating the samples and quantifying the abundance of vitamin D₃ produced. This will further show which regions of mushrooms should be utilized in supplements to ensure the greatest yield of vitamin D₃.

References


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