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Exploring the biochemical impact of dehydration on the antioxidant capacity of *Pleurotus florida*

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Abstract
Mushrooms, particularly *Pleurotus florida*, are recognized for their high nutritional value and bioactive properties. These properties are largely attributed to their phenolic compounds, flavonoids, ergothioneine, and beta-glucans, which act as antioxidants to combat oxidative stress and support cellular health. Dehydration, one of the most common preservation techniques for mushrooms, has been found to impact the biochemical composition and antioxidant efficacy of *P. florida*. Methods such as freeze-drying, oven-drying, and air-drying have varying effects on nutrient retention, with significant implications for their therapeutic potential. This review aims to provide a comprehensive analysis of how different dehydration techniques influence the antioxidant profile of *P. florida*, focusing on nutrient stability, mechanisms of degradation, and potential strategies to optimize processing methods for functional food applications.

Keywords: *Pleurotus florida*, mushrooms, nutritional value, bioactive properties, phenolic compounds

Introduction
Mushrooms have long been valued not only as a dietary staple but also for their health-promoting properties. Among the most commonly cultivated and consumed species, *Pleurotus florida* (oyster mushroom) stands out for its impressive antioxidant potential. This antioxidant activity is primarily attributed to bioactive compounds such as phenolics, flavonoids, ergothioneine, and beta-glucans, which collectively protect cells from oxidative damage and support overall health. However, fresh mushrooms are highly perishable due to their high moisture content, which necessitates preservation techniques like dehydration to extend their shelf life.

Dehydration is an effective preservation strategy, offering the dual benefits of longevity and nutrient concentration. Yet, the process also alters the biochemical composition of mushrooms, potentially affecting their therapeutic value. For example, heat-sensitive compounds like phenolics and flavonoids are susceptible to degradation during high-temperature drying, while structural changes in beta-glucans can reduce their ferment ability and subsequent health benefits. Despite these challenges, dehydration remains a preferred method due to its practicality and ability to make mushrooms available in various forms for functional food and nutraceutical applications.

Recent studies have explored the effects of different dehydration methods on the antioxidant properties of *P. florida*. Freeze-drying, for instance, has been shown to preserve nearly 95% of phenolic compounds, while oven-drying and air-drying result in more substantial nutrient loss [1-3]. Ergothioneine, a sulfur-containing antioxidant unique to mushrooms, demonstrates remarkable stability across various dehydration techniques, maintaining its bioactivity even under high heat [4]. By analyzing the impact of these methods, this paper aims to provide insights into preserving the antioxidant efficacy of *P. florida* during dehydration, thereby enhancing its potential as a functional food ingredient.

Study Objective
The primary objective of this study is to evaluate the biochemical impact of dehydration on the antioxidant capacity of *Pleurotus florida*. Specifically, the study aims to:

1. Analyze the effects of different dehydration techniques, including freeze-drying, oven-drying, and air-drying, on the retention and degradation of key antioxidant compounds such as phenolics, flavonoids, ergothioneine, and beta-glucans.

2. Investigate the mechanisms of nutrient degradation during dehydration, including thermal breakdown, oxidative stress, and structural alterations.
3. Identify optimal preservation strategies to maximize the retention of antioxidant properties in dehydrated *Pleurotus florida*.
4. Explore the implications of these findings for the development of functional food ingredients, dietary supplements, and nutraceutical applications.

Biochemical Impact of Dehydration

Dehydration is a widely used preservation technique for mushrooms, but its effects on the antioxidant capacity of *Pleurotus florida* vary depending on the method used. Freeze-drying, oven-drying, and air-drying are the most commonly employed techniques, each with distinct advantages and drawbacks in terms of nutrient retention.

Freeze-drying involves sublimating water from the mushroom at low temperatures, which helps preserve the structural and biochemical integrity of antioxidants. Studies have reported that freeze-dried *P. florida* retains up to 95% of its phenolic compounds and 100% of ergothioneine, making it the most effective method for preserving antioxidant activity [1-3]. This technique also maintains the fermentability of beta-glucans, ensuring that they continue to support gut health and immune modulation.

In contrast, oven-drying uses high temperatures to remove moisture, often leading to significant nutrient degradation. Phenolic compounds and flavonoids, which are sensitive to heat, can lose up to 30% of their activity during oven-drying[5]. Furthermore, the oxidative stress induced by high heat accelerates lipid peroxidation, reducing the efficacy of lipophilic antioxidants such as terpenoids.

Air-drying, a more cost-effective method, involves exposing mushrooms to ambient or slightly elevated temperatures over an extended period. While this technique preserves some bioactive compounds, the prolonged exposure to oxygen and moderate heat can result in oxidative degradation of phenolics and structural alterations in polysaccharides [4].

These variations in nutrient retention are critical when considering the therapeutic applications of dehydrated *P. florida*. Freeze-drying, despite its higher cost, emerges as the superior method for retaining antioxidant efficacy, while oven-drying and air-drying offer practical alternatives with some compromises in nutrient preservation.

Mechanisms of Antioxidant Degradation

The degradation of antioxidants during dehydration is driven by several biochemical mechanisms, including thermal breakdown, oxidative stress, and structural alterations. High temperatures, as used in oven-drying, can denature heat-sensitive compounds like phenolics and flavonoids, rendering them less effective as antioxidants[1]. Thermal degradation occurs when the molecular structure of these compounds is disrupted, leading to a loss of their ability to neutralize free radicals.

Oxidative stress is another significant factor. During drying, exposure to oxygen promotes the peroxidation of lipids and other biomolecules, reducing the efficacy of lipophilic antioxidants such as terpenoids [2]. This process not only diminishes the antioxidant capacity of the mushroom but also generates harmful byproducts that can affect the overall quality of the dehydrated product.

Structural alterations in polysaccharides, particularly beta-glucans, also play a role in reducing antioxidant activity. High-temperature drying methods can cause these compounds to lose their fermentability, limiting their ability to produce short-chain fatty acids in the gut [3]. These changes highlight the importance of using gentle drying techniques to preserve the bioactivity of *P. florida*.

Preservation Strategies

To mitigate the loss of antioxidants during dehydration, several strategies can be employed. Pre-treatment methods, such as blanching or soaking mushrooms in antioxidant solutions, can deactivate oxidative enzymes and reduce nutrient degradation during drying [4]. These treatments help preserve the structural integrity of bioactive compounds, ensuring their efficacy in the final product.

Optimizing drying conditions is another critical factor. Freeze-drying, while more expensive, offers the best results in terms of nutrient preservation and antioxidant retention. Combining this method with protective storage practices, such as vacuum-sealing and shielding from light and oxygen, can further enhance the shelf life and therapeutic potential of dehydrated *P. florida* [5].

Applications and Future Directions

Dehydrated *P. florida* has numerous applications in the food and nutraceutical industries. Its concentrated antioxidant properties make it an ideal ingredient for functional foods, dietary supplements, and even cosmeceuticals. However, further research is needed to validate these applications through clinical trials and to explore innovative dehydration techniques, such as vacuum microwave drying, for improved nutrient retention.

Sustainability is another critical area for future exploration. Developing energy-efficient drying methods that minimize environmental impact while preserving bioactive compounds will be essential for large-scale production [5].

Conclusion

Dehydration is a practical and effective method for preserving *Pleurotus florida*, but it has significant implications for its antioxidant capacity. While freeze-drying is the most effective technique for preserving bioactive compounds, oven-drying and air-drying remain viable alternatives for cost-conscious applications. By understanding the biochemical mechanisms of nutrient degradation and adopting optimized drying techniques, it is possible to retain the therapeutic potential of *P. florida*. Future advancements in processing technologies and clinical validation will further solidify its role as a functional food ingredient, bridging the gap between traditional nutrition and modern nutraceutical science.

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