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Short Communication: Enhancing the Drying Process of Microbial-Based Products with a Dehumidifier

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Abstract

The development of microbial-based products requires certain criteria for them to be successfully commercialized. The product must meet the following desirable criteria: effectiveness, contamination free, stability, cost-effectiveness, and a prolonged shelf life. Controlling the drying process is crucial for ensuring the stability and durability of the product. The traditional approach, which involved mechanical and natural drying, led to decreased productivity and quality. The objective of this research endeavour was to achieve a dry process enhancement while preserving the microbial quality of *Trichoderma asperellum* (M103). The temperature and relative humidity during the drying period were monitored under two conditions: with and without a dehumidifier. The results demonstrate that the dehumidifier increases drying period efficiency by up to 63%.

Keywords

Dehumidifier, Drying, Relative Humidity, Microbial-Based Product

1. Introduction

Microbial-based products can be produced either in solid or liquid form, depending on their target and mode of application. One of the common microbial-based products that have been marketed around the world is a product containing *Trichoderma* sp. This fungus has been proven to function as a biocontrol agent and biostimulant for plants [1] [2]. The use of *Trichoderma*-based products in oil palm plantations has emerged as a promising strategy to mitigate the severity of *Ganoderma* infection [3] [4]. The consequential yield losses in oil palm due to *Ganoderma* disease have led to substantial economic setbacks in the industry [5]. Most of the *Trichoderma*-based products are typically formulated in dry powder form, employing various production methods. The preference for dry formulation was due to its simple manufacturing process, cost-effectiveness, easy handling, reduced susceptibility to contamination, and easy of store at room temperature [6].

In a way to produce dried powder *Trichoderma*-based products, proper drying process is essential. The dried powder formulation serves to prevent microbial contamination and ensure an extended product shelf-life [7]. Even though drying process is a crucial step in the production of microbial-based products, the reduction of water content might cause a negative effect such as cell damaged and loss of cell viability [8]. The cell viability might be affected at elevated temperature during the drying process [9] [10]. Therefore, the selection of suitable drying methods for microbial-based products is important. Commonly, freeze-drying, spray-drying and fluidized bed drying are selected as the dehydration method in the production of microbial based products [7] [11]. However, the use of these three drying methods may require some new machinery with the high investment cost [9] [12].

In this study, considering the limitations in production costs, it is crucial to adopt an economical and practical approach to improve the drying process without incurring higher additional costs. The use of dehumidifier is a common practice in various industries for managing moisture and providing a straightforward solution to excess humidity [13] [14]. The dehumidifier works by absorbing the excess moisture and changing the moisture from its vapors state to liquid state. The water vapor in the airstream condenses and is gathered in a reservoir. The dehumidified air then passes through the condenser, where it is warmed and recirculated back into the room as dry air [15] [16]. The application of dehumidifier-based drying technology was subsequently incorporated to enhance the drying process of microbial-based products.

The microbial product containing *Trichoderma asperellum* M103 was mass cultivated and formulated in powder form through a simple and straightforward production process involving submerged fermentation and clay-mixing procedure. Mass-scale production took place in an open-area plant, posing the potential risk of bacterial contamination. The product was air-dried at a room temperature by spreading the product on a polyethylene (PE) tarpaulin. However, this drying method was time-consuming and susceptible to weather conditions. To address these challenges, the study aimed to assess the use of a dehumidifier to enhance the drying process of the microbial-based product in powder formulation without affecting cell viability or increasing the risk of product contamination.

2. Materials and Methods

2.1. Preparation of Microbial Culture and Submerged Fermentation

The *Trichoderma asperellum* M103 was acquired from the Microbial Culture

Collection of the Beneficial Microbes Laboratory at FGV R&D Sdn. Bhd., Malaysia. The isolate was grown on the potato dextrose agar (PDA) plate and incubated at 28˚C for 5 to 6 days. A 5 mm of M103 agar plug was transferred into Erlenmeyer flask (1 L) contains 300 mL Potato Dextrose Broth (PDB). Then the inoculated flask was incubated at orbital shaker at 100rpm and temperature of 28 ± 2˚C for 3 days. Next, the prepared M103 inoculum was transferred into a 30L bioreactor for mass production. The fermentation in the bioreactor took 3 to 4 days in the room temperature of 28 ± 2˚C.

2.2. Clay-Mixing Process

Ready M103 culture broth was mixed with clay powder thoroughly to ensure homogeneity. The mixed product was spread on Polyethene (PE) tarpaulin for drying process (**Figure 1**). The initial moisture content after mixing process was measured by using moisture analyzer (MA160-Sartorius).

2.3. Drying Process

The drying process was conducted in a drying room with the dimensions of 6 m (length) × 6 m (width) × 5 m (height) (**Figure 2**). The room temperature was maintained at a temperature of 28 ± 2˚C according to the optimum temperature of M103. One standing and rotating fan was used to circulate the moisture in the drying room. The microbial-based product (M103), with a capacity of 1000 kg, is spread on PE tarpaulin in the drying room with an initial moisture content of 10 to 11%. The product is left to dry until the moisture content reaches below 8% [17].

During the drying process, the products were mixed three times a day to ensure that all products are dried evenly. For the experiment without a dehumidifier, the drying process was solely dependent on the fan. While, for the experiment with a dehumidifier, the relative humidity (RH) was set at 50% with the

Figure 1. The product spreading on the PE tarpaulin.

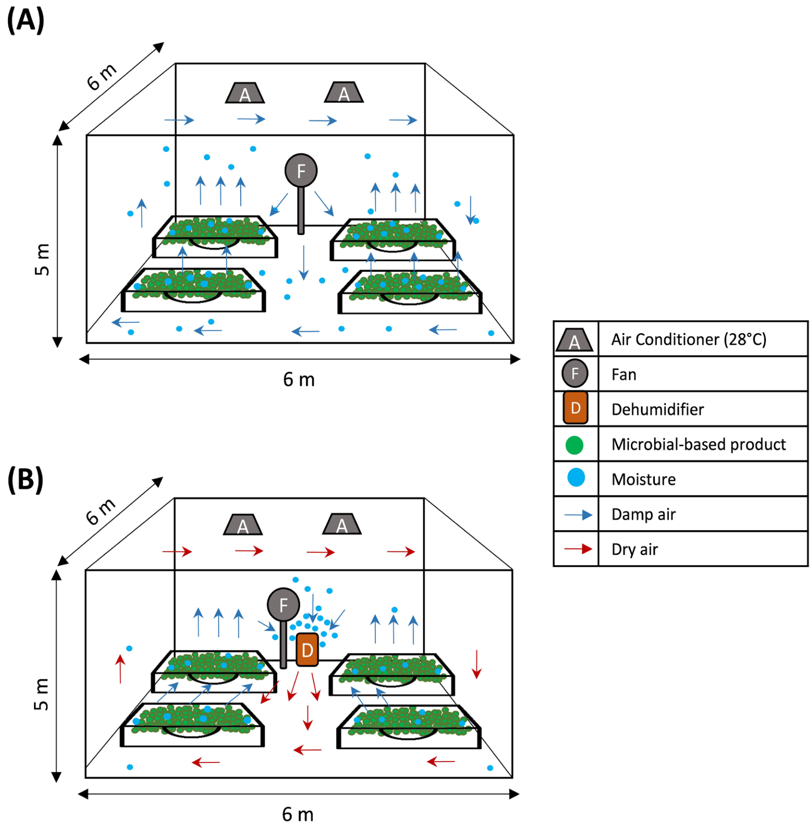

Figure 2. Drying room dimension with the microbial based product's drying area. (A) Without dehumidifier; (B) with dehumidifier.

machine running continuously. A relative humidity of 50% was selected, as many types of bacteria may not find a favorable environment for their survival under these conditions [18] [19]. This dehumidifier operates with a rotary compressor with a capacity of 50 L per day. The room temperature and relative humidity were recorded everyday by using a data logger.

3. Results and Discussion

The drying process of a microbial-based product cannot involve high temperatures as the microbial cell or spores might lose viability, except for thermophile bacteria or fungi. In this study, the microbial-based product (M103) was left to dry without using any heating elements. The moisture inside the product will evaporate to become water vapors, and the fan used helps to circulate the moisture inside the drying room.

In normal conditions without a dehumidifier, the drying process takes a long time to achieve the targeted moisture content of the final product. In addition, the drying process is also affected by the current weather. Sometimes, if the drying process was delayed for too long to achieve the targeted moisture content, bacterial contamination might take place. Table 1 shows the RH and temperature readings in the drying room with and without the dehumidifier. The RH value decreased upon using a dehumidifier, reducing the product's moisture content.

Table 1. Drying room condition and product moisture content during drying process.

Drying Day	Without Dehumidifier			With Dehumidifier (RH 50%)		
	Drying Room, Temp (˚C)	Drying Room, RH (%)	Product Moisture Content (%)	Drying Room, Temp (˚C)	Drying Room, RH (%)	Product Moisture Content (%)
Initial	27.20	78.50	12.54	27.33	71.77	12.63
1	27.00	83.10	11.00	27.53	61.30	10.30
2	26.53	82.17	10.50	27.57	59.03	8.30
3	26.67	86.57	9.80	27.43	61.57	6.60
4	26.50	88.13	9.00	-	-	-
5	26.80	87.30	8.60	-	-	-
6	27.20	86.77	8.10	-	-	-
7	27.33	87.50	7.30	-	-	-
8	26.63	82.40	6.40	-	-	-

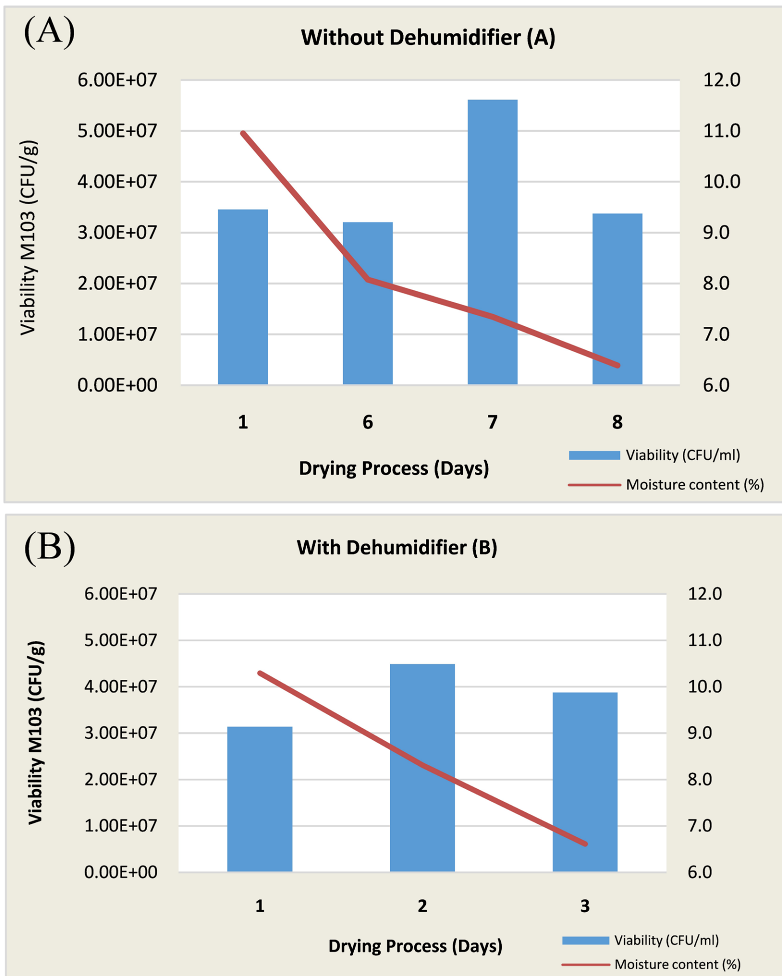

Figure 3. Viability of M103 and moisture content of final product during drying process. (A) Without Dehumidifier; (B) with Dehumidifier.

According to **Figure 3**, without a dehumidifier, the drying process takes around 8 days to achieve targeted moisture content, while with a dehumidifier, it requires only 3 days. The excess moisture from the microbial-based product and surrounding area of the room were removed efficiently. In general, humidity refers to the amount of moisture or water vapor in the air [20]. Without a dehumidifier, the relative humidity was around 82 to 88% in the drying room. Compared to the addition of a dehumidifier, the relative humidity of the drying room can be reduced to 50 to 60% (**Table 1**). The dehumidifier works by removing excess moisture from the air through the condensation process.

4. Conclusion

As a conclusion, the dehumidifier proves to be a useful, straightforward, and cost-effective tool for the drying process of microbial-based products, ensuring no adverse effects on their viability. Utilizing a dehumidifier enhances manufacturing efficiency by reducing the required drying time, thereby increasing the overall productivity of microbial-based products.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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