Effect of superficial air velocity on the fluidized bed drying performance of stingless bees pot-pollen

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Abstract. Stingless bees or "kelulut" also produce pot-pollen apart from honey. The pot-pollen is mixed with honey and bee secretion before stored in cerumen pots. It has high nutritive value and medicinal benefits. Pot-pollens are often neglected by the beekeepers due to difficulty in storing and preserving them due to high moisture content. Hence, fluidized bed dryer is proposed as a suitable method to dry and enable convenient storage and preservation of the pot-pollen. Pot-pollen sample of initial moisture content 30.5 % is dried at three superficial air velocities, 1.0 m/s, 1.5 m/s, and 2.0 m/s for 30 minutes. Fluidized bed drying has managed to decrease the moisture content down to 23.0 %, 20.5%, and 18.5 %, respectively. Higher superficial air velocity lead to higher drying rate in of pot-pollen. Hence, using a fluidized bed dryer to dry stingless bee pot-pollen is a promising method for preserving them. Subsequently, the dried pot-pollen can be easily commercialized in the future.

Keywords: pot-pollen, stingless bee, fluidized bed dryer

1. Introduction

Stingless bees are native to Malaysia and locally known as "kelulut". They are important pollinator especially in tropical region such as Malaysia [1]. As stingless bee is usually for its honey, meliponiculture or beekeeping tend to neglect other bee products. Similar to honey bees, stingless bee collect pollen from variety of plant species [2]. The pollen is mixed with honey and bee secretion before stored in cerumen pots, coining the term pot-pollen. Although used interchangeably with bee bread, the term pot-pollen exclusively refer to pollen stored in stingless bees nest [3]. Pot-pollen have therapeutic and medicinal value [4]. Pot-pollen are usually neglected or simply thrown away by the bee keepers due to difficulty to preserve them as they contain high moisture content [5]. This can cause excessive fermentation and spoilage, deteriorating the quality of pot-pollen. Hence, preserving pot-pollen requires drying with suitable method. However, conventional methods may lead to loss of nutrient and useful compounds [6].

Currently, studies on engineering application for stingless bee focused either on thermal regulation for hives [7,8], or honey processing [9,10] and engineering economic analysis [11]. Fluidized bed dryer has shown promise as a viable method for drying of pot-pollen owing to its ability to operate at low temperature and short drying time [5]. Fluidized bed dryer employ the concept of fluidization, where the bed material is suspended in a fluidizing gas with air being the typical gas [12]. Fluidized bed dryer has several advantages compared to conventional dryers, as listed in **Table 1.**

Table 1. Advantages of fluidized bed drying [13]

Homogeneous and rapid drying
Suitable for heat sensitive products
Efficient in drying
Simple and low labour cost for operating
Wide range of capacities and sizes designs
Low maintenance cost

In a fluidized bed, drying temperature is the most significant parameter towards drying rate [14–16]. However, it is not recommended to heat pot-pollen above 40 °C as its nutritional properties will be lost [6]. Hence, controlling other parameter such as superficial air velocity while maintaining low temperature is preferable towards drying of pot-pollen. This study aims to explore the effect of superficial air velocity on the fluidized bed drying of stingless bee pot-pollen.

2. Methodology

The drying experiments were conducted at the Meliponini Engineering Laboratory (MePEL), Faculty of Mechanical and Automotive Engineering Technology, Universiti Malaysia Pahang (UMP). A schematic of laboratory scale fluidized bed dryer used in present study is shown in **Figure 1** below. The cylindrical fluidized bed chamber is used to contain the bed material during drying. A ball valve is used to control the superficial air velocity. A perforated air distributor with diameter of 3 mm and 10 mm square pitch was used in this study.

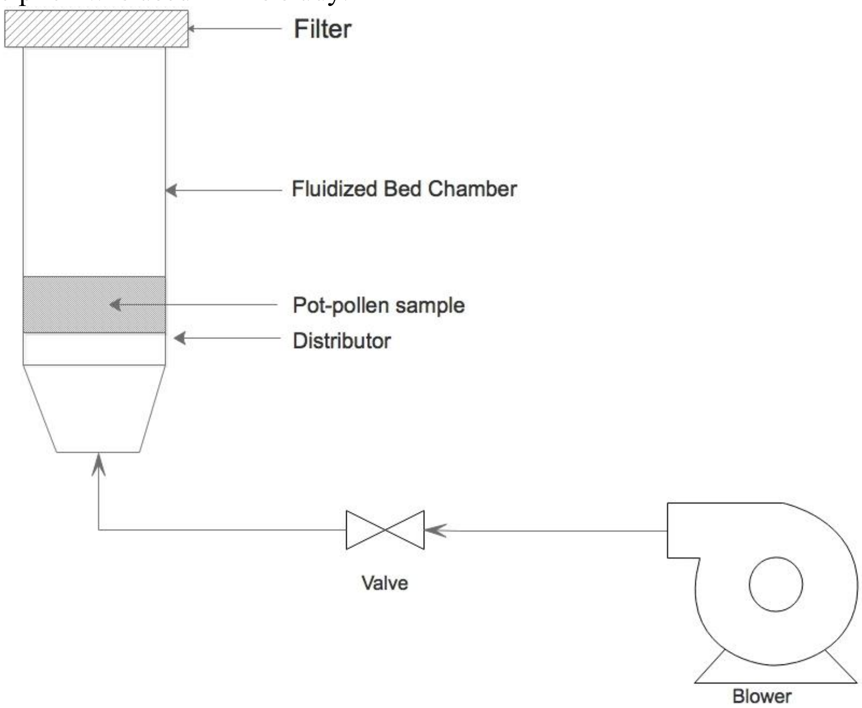

Figure 1. Schematic of laboratory scale fluidized bed dryer

Raw stingless bees pot-pollen sample is sourced from a local farm in Kuantan, Pahang. The pot-pollen sample is cleaned and stored at -10 °C prior to the experiment. For each experiment, 50 g of pot-pollen is dried for 30 minutes in the fluidized bed dryer at ambient temperature conditions. The experiment is conducted at three superficial air velocities, 1.0 m/s, 1.5 m/s, and 2.0 m/s.

The moisture content of raw pot-pollen and dried pot-pollen sample is determined using hot air oven method. Each pot-pollen sample was weighed to 2 g before put in hot air oven at 100 °C for 24 h. The moisture content will be the difference of the initial mass and the dried mass [17]. This is shown in equation (1) below.

$$Moisture\ content, MC\ [\%] = \frac{A - B}{B} \times 100 \quad (1)$$

where A is the initial mass in g of pot-pollen sample before oven drying and B is the final mass of pot-pollen after dried in the oven.

3. Results and discussion

Table 2 shows the moisture content for each pot-pollen sample dried in the fluidized bed dryer. The initial moisture content of pot-pollen sample is recorded at 30.5%. The moisture content level is within the typical range for stingless bee pot-pollen [3,18–20].

Table 2. Moisture content level of pot-pollen sample.

Air velocity [m/s]	Before [g]	After [g]	Moisture Content [%]
Initial	2	1.39	30.5
1.0 m/s	2	1.54	23.0
1.5m/s	2	1.59	20.5
2.0 m/s	2	1.63	18.5

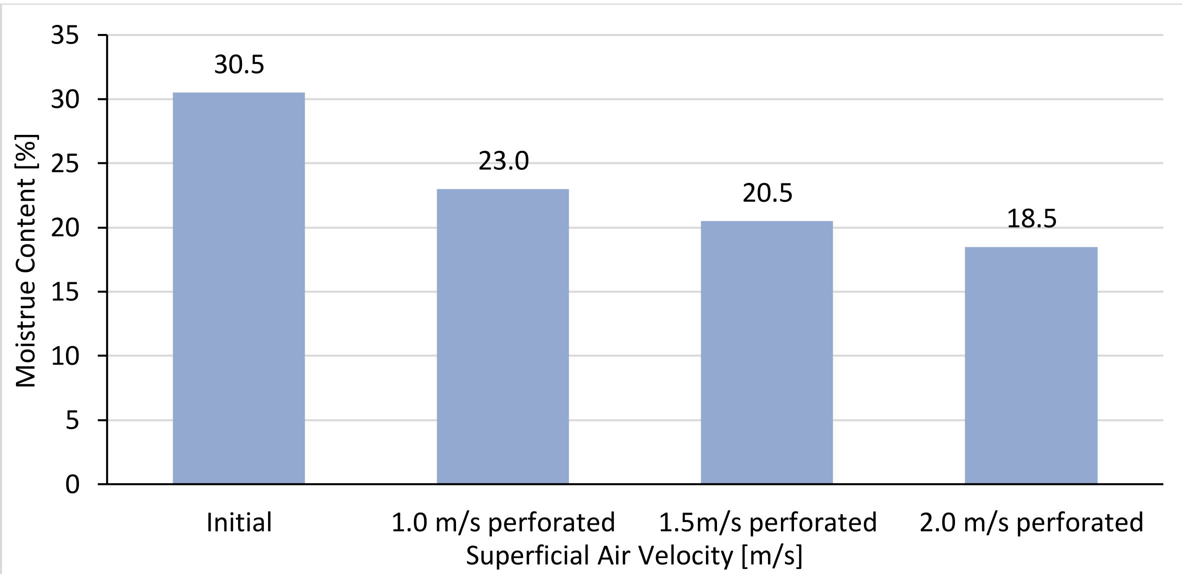

Figure 2. Moisture content for dried pot-pollen at different air velocities

Figure 2 shows the initial and final moisture content of pot-pollen sample dried at each superficial air velocities. The final moisture content level are reduced down to 23.0 %, 20.5 % and 18.5 %, respectively. The trend can be seen that increasing the superficial air velocity will reduce the moisture content further. This indicates that the drying rate is higher for higher superficial air velocity. Such observation can be explained by higher heat and mass transfer between fluidizing air and pot-pollen sample as the air velocity is increased. The best drying performance in this study is at 2.0 m/s air velocity, where the moisture content is reduced by 12.0 %. This is a significant reduction for a short drying time of 30 minutes. Hence, using fluidized bed dryer is a viable and promising technique for pot-pollen drying.

4. Conclusion

Raw stingless bee pot pollen sample is weighed to 50 g, and dried using fluidized bed dryer for 30 minutes at superficial air velocities of 1.0 m/s, 1.5 m/s, and 2.0 m/s. The initial moisture content level of pot-pollen sample is at 30.5%. As the superficial air velocities is increased, the drying rates also increase. The final moisture content at each superficial air velocities are at 23.0 %, 20.5 %, and 18.5 %. The best drying performance from this study is at 2.0 m/s superficial air velocity, where the moisture content level reduced by 12.0 %. In conclusion, fluidized bed dryer is able to dry stingless bee pot-pollen within a short period of time. Hence, dried pot-pollen can be easily stored and may be commercialized in the future.

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