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FREEZE-DRYING CHARACTERISTICS FOR THE CONSERVATION OF BEE POLLEN

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Abstract: *Bee pollen is very important in the nutrition of bees since it provides them with proteins, lipids, vitamins and minerals. Bee pollen also has a significant nutritive value as a supplement to human nutrition. Fresh bee pollen contains a large quantity of moisture which favors development of various microorganisms. In order to preserve pollen from spoilage its dehydration in controlled conditions is commonly performed. In this paper, freeze-drying was proposed as a conservation method. Results showed increment in the drying rate and improve the product quality compared to traditional hot air drying. The current work provides theoretical and technical reference for applying this type of technology.*

Key words: *Bee pollen, drying, vacuum drying, freeze-drying.*

1. INTRODUCTION

Bees voluntarily collect pollen and nectar from oilseed rape and on this melliferous pasture bee keepers in Serbia prepare bees for a major black locust pasture. Due to abundance of pollen that are bees willing to collect, on this pasture, bee keepers involve the use of pollen traps and thus obtain a significant quantity of pollen. A part of oilseed rape pollen is later placed on the market for human consumption while the rest is used for making the brood food.

In the nutrition of honeybees a pollen represents a principal source of protein, fats, vitamins and minerals (Nedić et al. 2003). The number of broods in beehive and length of life of worker honeybees depend to a large degree on quantity of nutritionally available pollen (Jevtić et al., 2009; Di Pasquale et al., 2016). Pollen chemical composition varies depending on the plant from which it was collected and on the way of its keeping and storing (Campos, 1997; Campos et al., 2010). Oilseed rape pollen has a solid content of

crude protein ranging from 22.8% to 26.1% and it can affect a development of bee colony (Rayner and Langridge, 1985).

Besides its extraordinary benefit for bees pollen is used also in human nutrition and in apitherapy. Due to its valuable nutritive and biological ingredients the oilseed rape pollen is used as a natural diet supplement in China. With oilseed rape pollen supercritical CO2 fluid extract the trials are conducted on its effect on benign prostatic hyperplasia (Yang et al., 2014).

Pollen brought by bees is being collected in a raw state by placing special pollen traps at the entrance of beehive populated with bees. A water content has a crucial effect on the maintenance of its quality which in fresh pollen can vary from 20 to 30 g in 100 g (Bogdanov 2004). In order to preserve valuable properties of this product a good bee keeping practice directs bee keepers to collect pollen every day and then to dry it in the temperature of 40oC. If it is not done, because of a high water content, fresh pollen becomes susceptible to fermentation, mould growth and development of mycotoxins and reduction in vitamin C content due to potential degradation of ascorbic acid in aqueous environment (Petrović et al., 2014; Kostić, 2015). In dry pollen the water content should be in the range of 4 to 8% (Mustaers, 2005; the Official Gazette of the Republic of Serbia, 101/2015).

Freeze drying is a process whereby water or other solvent is removed from frozen material by converting the frozen water directly into vapor without the intermediate formation of liquid water. Of the various methods of dehydration, lyophilization is especially suited for substances that are heat sensitive. Also, freeze drying has been extensively used in the preservation of biologicals, nutrients and food properties due to the nondestructive nature of this process. (Cinkmanis et al., 2019)

2. MATERIAL AND METHOD

For the purpose of pollen drying a fresh sample of pollen was used in the experiments collected with pollen traps placed at the entrance of beehive on oilseed rape melliferous pasture (Brassica napus L.). Up to the moment of drying a fresh oilseed rape pollen has been vacuum packed and stored in a deep-freezer.

This research used oven-dry method as one of the commonest methods of determining sample moisture content. It consists of taking a pollen sample, determining its exact weight, and dry the sample in an oven at a temperature of 105 centigrade for 3 hours, then weighing the sample and determining the moisture loss by subtracting the oven-dry weight from the moist weight. (Shreve et al., 2006) The obtained resultes showed 23.48% of water content at dry basis in fresh pollen sample.

Moisture analyzers (MA) type BTS110D was used for fast and precise moisture determination of a sample based on mass loss during heating process. Drying proces parameters (40°C and 50°C) were set on the basis of law norms and available chemical-physics data of pollen samples. Moisture analyzers are designed to work in food industry, construction materials industry, biotechnology, pharmacy, environment protection and others. Main field of use is quality control. Moisture analyzer use 2x100W halogen radiators for the material heating. Density redout precision was 0.1%.

Labconco FreeZone® 18 freeze dry (FD) system was used for laboratory lyophilization procedures. The pollen samples were kept in deep freezer at -70°C before freeze drying process. During the lyophilization, the collector temperature were maintained at -40°C and the chamber pressure condition was vacuum less than 0.133 mBar.

3. DISCUSSION ON THE RESULTS

Bee pollen samples were dried in thin layer without significant overlapping of the pollen layers (Fig. 1). All experimental measurements were performed with the initial mass of the pollen between 10 and 30 grams for one experiment. The results were obtained as average from several measurements per experimental setup.

Fig. 1 a) Fresh pollen sample; b) freeze-drying of pollen

Moisture content of the material during time (Fig. 2) is shown by various temperatures and drying methods. Moisture analyzer was used for moisture determination of a sample at 40, 50 and 60°C temperatures within approx. 3 hours period. Similar drying parameters were used by other authors (Ayla et al. 2018; Kanar and Mazi, 2019). Freeze dryer was used for the determination of drying characteristics of pollen twice. First sample was frozen at -70°C and then dried within lyophilization process in absolute vacuum. Second sample was exposed fresh to an absolute vacuum at room temperature of 25°C without any thermal pretreatment.

Results showed that moisture content decreased significantly during the first hour (approx. during first 4000 seconds), and decreased slowly afterwards. As expected, the increase in drying air temperature will speed up drying process. Drying temperature of 40°C that is commonly used in commercial bee pollen dryers caused the lowest moisture losses of the material, i.e. longest drying process. Consequently, the temperatures of 50 and 60°C provided significantly higher moisture losses and faster drying, especially during the first hour.

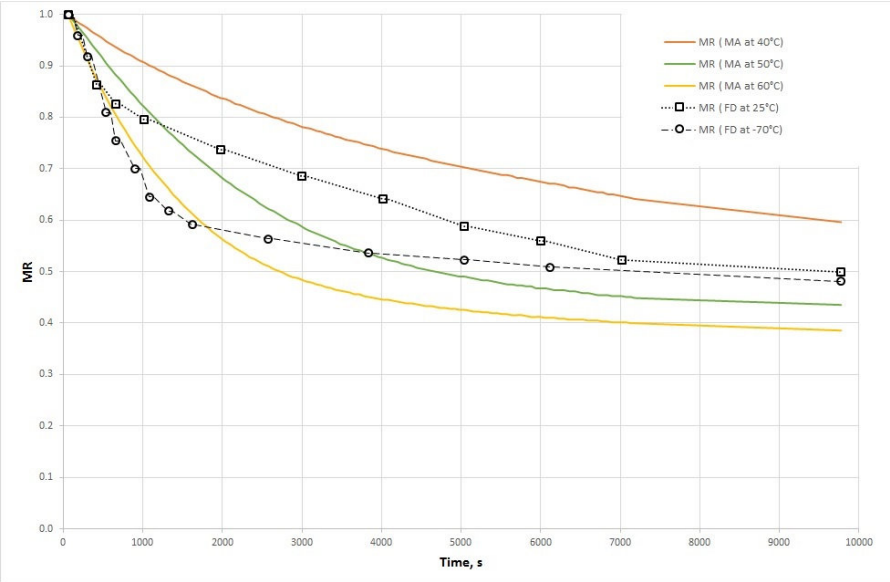

Fig. 2 Experimental moisture ratio (MR) vs. drying time (MA – moisture analyzer, FD – freeze dryer)

However, these temperatures cannot be applied commercially because of the negative effect on bee pollen chemistry. Vacuum regimes showed that initial moisture losses were significantly higher than losses from conventional drying regimes. The best drying kinetics was achieved in lyophilization processes with almost 50% moisture losses within first half an hour of drying process. This effect was almost concurrence with conventional 60°C regime during this period.

4. CONCLUSION

Moisture content of the material during time by various temperatures and drying methods were analyzed in this paper. Three types of drying procedures were analyzed: conventional sample heating (drying temperatures (40, 50 and 60°C), vacuum drying at room temperature and freeze-drying of samples at -70°C temperature (lyophilization). The higher moisture loss was achieved with lyophilization process, especially at the beginning of the drying process, i.e. first hour period. The conventional drying off bee pollen at 60°C showed similar drying rate at initial stages of the drying period. Pollen lyophilization can be recommended from the point of view of the efficiency of the drying process.

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