MORENPBIZ.
More Natural Product Business by Enhanced Quality and Energy Efficiency of Drying

MoreNPBiz – Drying of plant-based materials

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1 Introduction

Polyphenols are secondary metabolites of plants, that are not vital compounds for living, but protect and defend the plant. Polyphenols are composed of several chemical subgroups such as flavonoids, phenolic acids, lignans and stilbenes.[1] It is commonly known that plants have beneficial effects on human health, and can therefore be used as nutraceuticals in diet. There are strong arguments that polyphenols can prevent cancer, cardiovascular diseases, neurodegenerative diseases and osteoporosis.[2] In addition to their potential health effects, polyphenols are also responsible for the quality of fruits and berries, since they affect their color, flavor, bitterness and maturation.[3]

Plants and their fruits and berries can be consumed fresh or as products like powders, jams, sweets, juices, tea etc. However, products require processing of plants such as drying, crushing or extracting depending on the end product. In the worst case, processing can alter the composition of the plant and cause evaporation and decomposition of valuable compounds such as polyphenols. In order to maintain the quality of the end product, the processing parameters must be adapted. Otherwise, the beneficial health effects as well as the flavor and color properties of the plant can be lost.[4,5]

Drying is one of the most common ways to refine plant-based material. Drying gives a higher market value and longer shelf life to the product with a simple process. However, drying consumes a lot of energy as a refining process and heat is usually a very expensive form of energy. But, by studying today´s refining processes, there are many sources of excess energy, where the energy is mostly blown away as heat without utilizing it. Combining this excess energy with a party, that has an interest in drying plant-based materials, a large part of the drying costs can be saved. In case of using excess energy of industry, the need of the drying capacity should be great, since the starting costs of the drying systems are higher.[6,7]

The aim of the MoreNPBiz -project is to study and optimize the drying processes while maintaining the quality and valuable compounds in the plant-based material. The energy efficiency of the drying is also improved and the drying costs reduced by making modifications to the drying systems and finding sources of excess energy.

2 Materials and methods

Stinging nettle (*Urtica dioica*), roseroot (*Rhodiola rosea*) and birch leaves (*Betula pubescens, Betula pendula*) are used in our experiments (Fig. 1) to examine optimal drying conditions and dryers. All the materials are collected as fresh and put into the freezer before drying. End goal of the drying is to achieve moisture content between 10 – 12 m-%. Modified small-scale convective dryer from Orakas Tuotteet (Fig. 2) is compared to a conventional heat oven and vacuum oven. In preliminary tests, temperatures between 20 – 60 ℃ are applied. After the drying, remaining moisture content, total polyphenolic content (Fig. 3) and antioxidant capacity are determined from the materials in order to optimize the drying temperature and evaluate the effects of different dryers.

Figure 1. Fresh stinging nettle, roseroot and birch leaves are used in the drying experiments.

Modifications of Orakas convective dryer are based on better control over temperature distribution and even airflow throughout the dryer. The raw version of the dryer is a simple chamber with a heat source and a fan. As the temperature variation of the original dryer was 10 ºC, it was not possible to determine optimal drying temperature. Therefore, the temperature control was updated to Omron digital temperature controller. As some studies have shown, airflow may be a critical factor in drying, so an airflow control was also added to the dryer.

One of the most important and energy saving ideas in the modification of Orakas convective dryer was installing an air-recycling channel. It routes heated and humid exhaust air from the outlet end of the dryer to the input, where it mixes with the fresh input air. Recycled warm air is thus partly blown back to the oven by the fan. Almost half of the energy is saved by this simple modification.

By exploiting the drying results of small-scale dryers as well as the theory and models of drying, a large-scale mobile trailer dryer will be built during the winter 2019/2020. This trailer dryer can be used as a pre-drying unit at the harvesting place. Harvested crop starts very quickly to warm up due to the continuing enzymatic activity of the plants. Decomposition of valuable compounds due to the warming is prevented by blowing cold air through the harvested material. After the transport to the processing place, trailer dryer is connected with a heat source, and the drying continues as a conventional warm air drying. The trailer dryer and the effects of immediate pre-drying will be tested in the summer of 2020 in a collaboration to special crop farmers and natural product companies.

Figure 2. Modified small-scale convective dryer from Orakas Tuotteet.

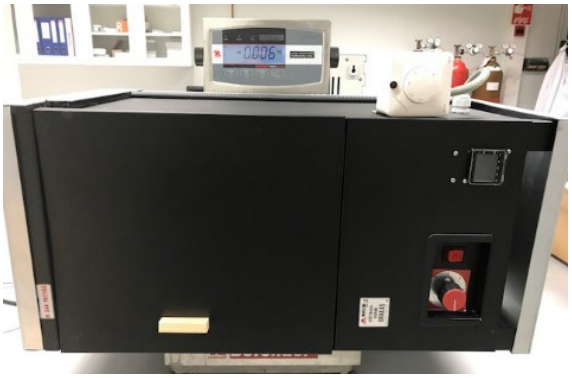
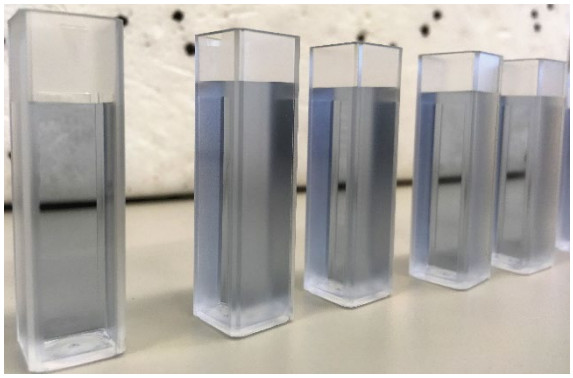


Figure 3. Measurement of total polyphenolic content, where blue color indicates the presence of polyphenols.



3 Results and Discussion

Preliminary drying tests and chemical analyses of nettle, roseroot and birch leaves were completed in the end of July 2019. Based on the total polyphenolic content and antioxidant capacity results, we have selected more narrow drying temperature range for each material to be studied. This temperature range will help to optimize more closely the ideal drying temperature in order to remain the quality of the material.

Besides the temperature, in preliminary tests we also observed that the drying time and remaining moisture content of the material can affect its quality. Therefore, actions have been made to monitor the moisture content and optimal drying time of the material more precisely. In the following drying tests, priority is to find the optimal drying temperature, time and remaining moisture content for the material and maintain the energy efficiency of the dryer. This may require more modification to convective dryer of Orakas Tuotteet.

4 Contact

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5 References

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