Tropentag 2008
University of Hohenheim, October 7-9, 2008
Conference on International Research on Food Security, Natural Resource Management and Rural Development

Drying of Lemon Balm *(Melissa Officinalis L.)* using stepwise process control

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Abstract

In this work the method of stepwise drying of medicinal plants is presented as an alternative to the conventional drying that uses a constant temperature during the whole process. The objective of stepwise drying is the decrease of drying time and energy saving. In this process, apart from observing the effects on saving process time and energy, the influence of the different combinations of drying phases on several characteristics of the product is considered. The tests were carried out with *Melissa officinalis L.* variety citronella, sowed in greenhouse. For the stepwise drying process a combination of initial and final temperature 40°C/50°C was considered, with different transition points associated to different moisture contents (20, 30, 40 and 50%) of the product during the process. To determine the color changes a Chroma-meter® device is used that carries out the colorimetric evaluation of color coordinates and color differences by means of the CIELAB color space, in accordance with the norm DIN 6174. As reference for the color change the measurement of the color of the fresh product is used. The CIELAB coordinates of the reference color is compared with the coordinates of the color of the product after being exposed to the stepwise drying process.
Drying curves were obtained to observe the dynamics of the process for different combinations of temperature and points of change, corresponding to different conditions of moisture content of the product. Finally it was found that combinations of temperatures beginning with high temperature are not advisable since they produce severe changes in the color that affect negatively the final quality of the product diminishing their commercial value.

Keywords: Stepwise drying, drying process, medicinal plants, *Melissa officinalis L.*, Lemon Balm.

Introduction

Lemon Balm (*Melissa officinalis L.)* is important due to its medicinal properties and its use as tee. Its essential oil is required mainly in the pharmaceutical, food and cosmetic industries. The properties of the plant extracts include sedative, relaxing, antibacterial, antiviral, and antispasmodic effects [1,7]. The main components of the essential oil are citral, citronellal and linalool. By means of gas chromatography studies of the essential oil, 70 components are known [2,3,4]. The lemon balm has low essential oil content (among 0.05 and 0.12 % vol.) [2].

The development of new drying strategies for medicinal plants that allow reaching the required quality characteristics and at the same time to have short drying times and low energy

consumption is required. The strategies should consider an optimal balance between required quality and production costs.

The objectives of this research were to compare the conventional drying with the proposed stepwise drying, for lemon balm, considering drying time, energy consumption, color change of leaves and essential oil content, and additionally to determine the optimum change point of stepwise drying in terms of energy saving and reduction of drying time considering at the same time obtaining the quality characteristics.

Materials and Methods

The used Lemon Balm (*Melissa officinalis L.*), variety citronella, was planted in a greenhouse at Witzenhausen (Germany). For this research two methods of drying were considered. The standard drying, which is conducted at only one temperature (40°C) and stepwise drying using two temperatures, the first step at a low temperature (40°C) and final step with high temperature (50°C) and having different changes points corresponding to different moisture content of the product as shown in Figure 1.

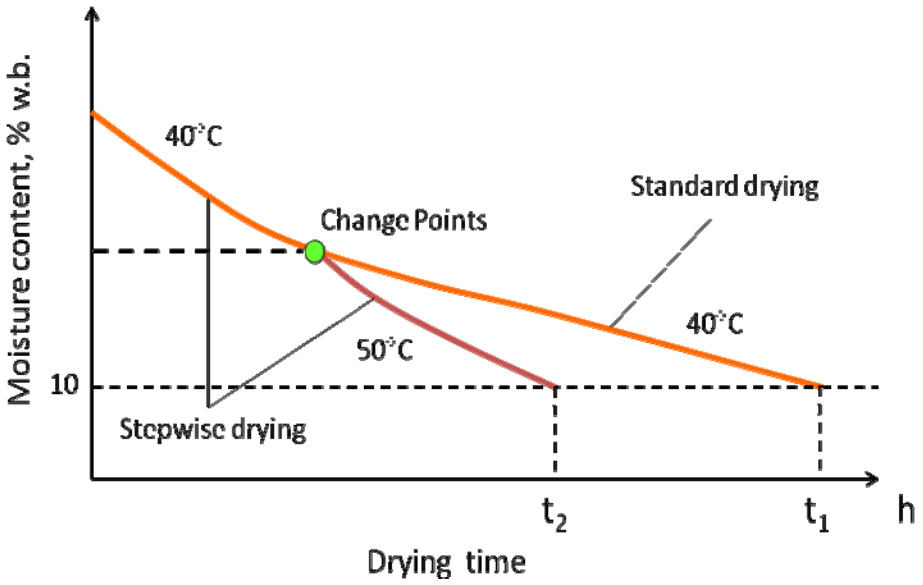

Figure 1: Drying methods considered in the study: standard drying and stepwise drying

In Figure 2, the different change points considered in the research are presented. During the drying process the moisture content loss of the product was measured by monitoring the weight until a moisture content of 10% is reached. Parallel, the consumed energy during the drying process was measured.

After the drying process, the essential oil content and color change were determined. To obtain the color change the norm DIN 6174 [6] was used, which considers the system of coordinates L*a*b*. The measurement of the color of the fresh leaves was taken as reference and is compared with the measurement of the color of dried leaves to get the value of the color difference called ΔE. For the determination of the content of essential oil the method described in DAB 10 [5] was used. This method uses steam distillation with a special distillation device.

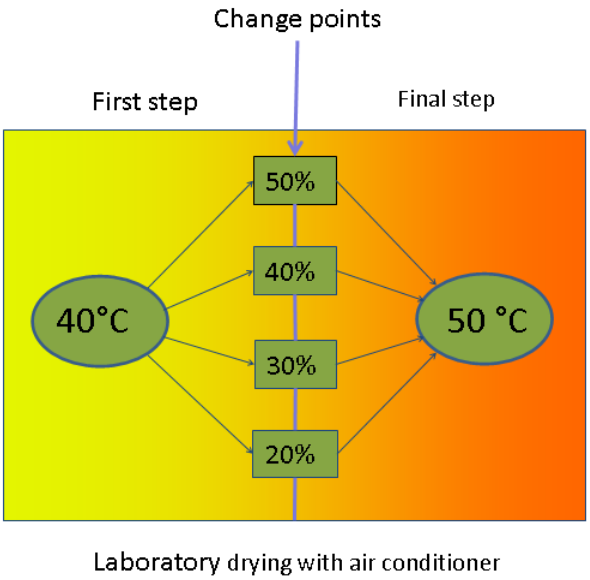

Figure 2: Different change points considering in the study

Results

In Figure 3, the drying curves corresponding to standard drying, for drying air temperature of 40°C, and stepwise drying combination of 40°C/50°C, considering different change points, are presented. A considerable decrease on drying time compare to standard drying is observed.

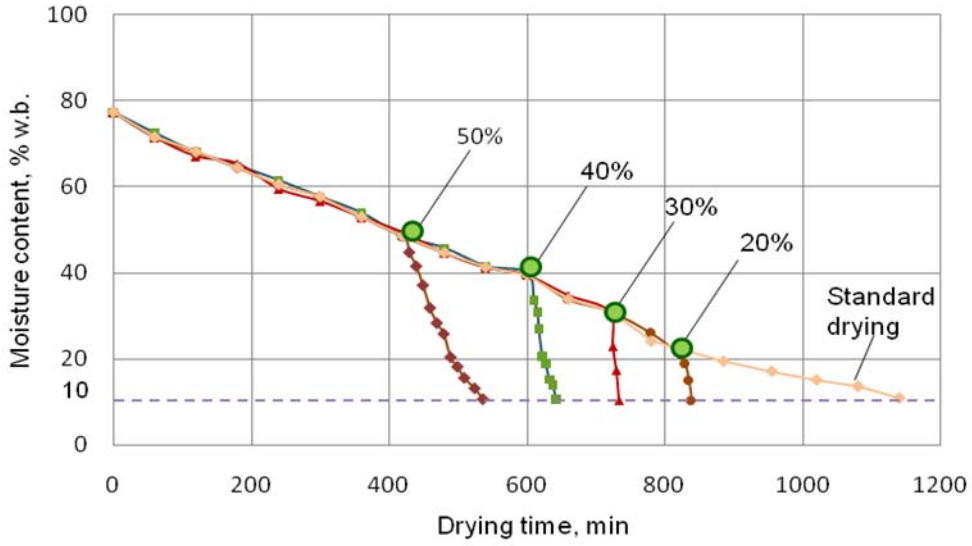

Figure 3: Considered drying methods: standard 40°C and stepwise 40°C/50°C

To analyze the change on color and essential oil content, the values for standard drying were considered as reference. In Figure 4, it can be observed that when the change point is higher, the change on color increases and the essential oil content decreases. For standard drying, the obtained essential oil content was 0.17 ml/100gr dm (dried matter) and the color change was ΔE= 12. In contrast for stepwise drying with change points of 50% the essential oil content was 0.06 ml/100gr dm, which corresponds to the largest loss of essential oil observed (near 65% of the reference value). Regarding the color change, for stepwise drying with change point 50%, ΔE= 22 was obtained, which was the largest color change observed.

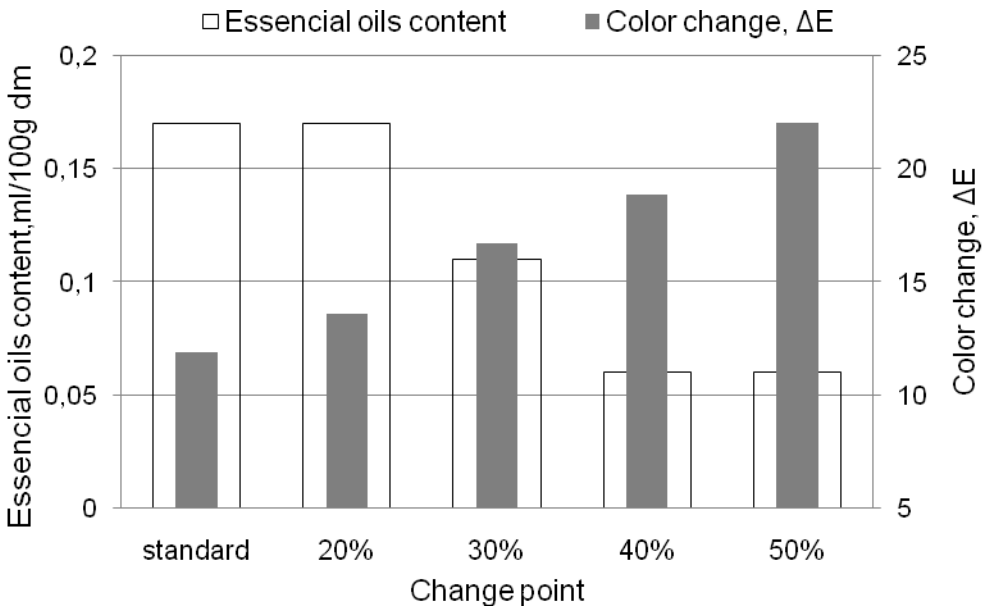

Figure 4: Color change and essentials oil content for different change points of the stepwise drying (40°C/50°C) compared with standard drying (40°C).

To analyze the consumed energy and drying time, the values for standard drying were considered as reference. In Figure 5 shows the behavior of drying time and consumed energy in the process for different change points of the stepwise drying compared with the standard drying. It can observed that if the change points increases, both the drying time and the consume energy decreases. For standard drying, the consumed energy was 4.25 kWh and the drying time was 1140 minutes. In comparison, for stepwise drying with change points of 50% the consumed energy was 3.07 kWh, which corresponds to a reduction of 28.5%. Regarding the drying time, for stepwise drying with change point 50% was 537minutes, corresponding to a decrease of 53% in comparison to standard drying.

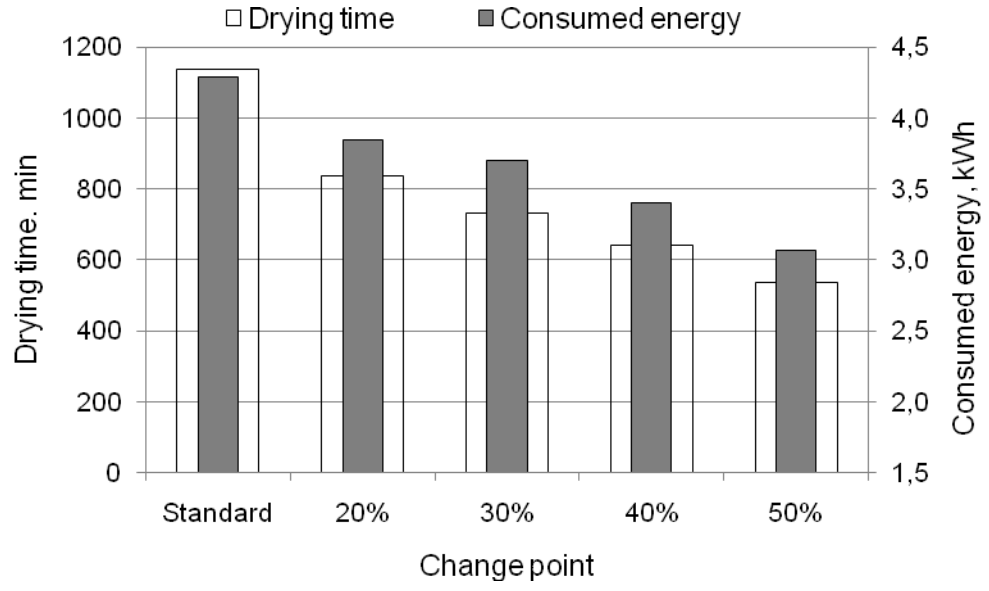

Figure 5: Drying time and consumed energy for different change points of the stepwise drying (40°C/50°C) compared with standard drying (40°C).

Conclusions

A decrease in drying time for all changes points in comparison to standard drying was observed. The lowest energy consumption and shortest drying time was observed for change point 50%. But in terms of quality, the change point 50% shows high color change and the lowest content of essential oil. The combination 40°/50°C, for change point 20%, shows nearly no color change and the same essential oil content of standard drying.

Recommendation

Considering the presented results, the stepwise drying strategy 40°/50°C with change point at moisture content 20% is recommended for lemon balm. A decrease of 27% in drying time can be reached together with a reduction of 11% in consumed energy compared with conventional drying at no changes in quality. Further investigations are done with other temperature combinations (e.g. 30/60, 30/50, 30/40 °C).

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