

## Lyophilisation of fresh banana slices

*Lyovapor™ L-200 Pro: Lyophilisation of fresh banana slices*

### 1. Introduction

Freeze drying is a gentle form of drying and may be used to preserve foods without changing their appearance or taste.

The freeze drying process includes the freezing of the food sample and subsequent applying a fine vacuum to the frozen sample. Under these conditions, the water in the food will sublimate, hence, the sample dries.

In food applications, freeze drying is commonly used to make instant coffee and to dry and conserve fruits, vegetables or herbs [1].

### 2. Experimental

The banana was cut into pieces of approximately 5 mm width. Eleven banana slices were placed on the stainless steel tray (Figure 1) and then, frozen overnight in a deep freezer at -40°C.

After 24 hours of deep freezing the banana slices were transferred with the tray into the Lyovapor™ L-200 for freeze drying. The shelf temperature itself was chosen such that it does not exceed 25°C at the end of the primary and secondary drying (temperature set point). For more information about the drying sequence, please see reference [2].

After drying of the banana (see Figure 2), the residual moisture content of three banana slices were analyzed using a halogen moisture balance heated to 110°C. Therefore, the samples were ground in a mortar and transferred to the moisture analyzer within 30 seconds. The switch-off criterion refers to a change of no more than 1 mg / 140 s.

### 3. Results and Discussion

Figure 1 and 2 show the steel tray with the banana slices before and after freeze drying process, respectively. All eleven banana slices showed a homogenous freeze dried structure and appearance. No change of their size and morphology could be observed during the drying.



Figure 1: Tray with fresh cut banana slices.



Figure 2: Tray with banana slices after freeze drying.

To determine the drying efficiency of the Lyovapor™ L-200, the residual moisture content of three banana slices was analyzed using a halogen moisture analyzer. The results of the measured moisture contents and drying efficiencies are shown in Table 1.

Table 1: Results of the residual moisture analysis after freeze drying with the Lyovapor™ L-200.

Banana slice	Weight of freeze-dried sample [g]	Weight of halogen dried sample [g]	Moisture content [%]
1	0.606	0.587	<b>3.14</b>
2	0.843	0.818	<b>2.97</b>
3	0.794	0.770	<b>3.02</b>

The initial water content of the banana was  $76.97 \pm 1.24\%$  (n=3). Hence, applying the described freeze drying method on the Lyovapor™ lead to a water removal of  $\geq 95.92\%$ .

In general, applying the freeze drying process to foods such as banana slices, has the following advantages and disadvantages [3]:

#### Advantages

- The process at low temperature and low pressure makes freeze drying an effective way to keep color, smell, flavor and heat-sensitive nutrients of food.
- Eliminates the surface hardening of the food.
- Freeze dried food is porous and easy to rehydrate and/or dissolve. It can be consumed directly or after rehydration.
- Since freeze dried food contains very low moisture, it has relatively small density and is easy to be transported. The freeze dried food can be preserved at room temperature for a long time, while the cost of transportation is much lower than that of frozen food.
- No additives are added into the food during freeze drying process.

#### Disadvantage

- If exposed directly to air, freeze dried food will be rehydrated quickly, resulting in deterioration of food.
- The freeze dried products have to be vacuum- or vacuum-nitrogen packed and the packaging material must not be permeable to water vapor.
- During transportation and sale process, freeze dried food is easy to be powdered or cracked for its loose porous structure.
- Freeze drying is a time- and energy-consuming process, which leads to higher production costs.

### 4. Conclusion

With the Lyovapor™ L-200, a high drying efficiency was achieved for the water removal of a banana. In summary, the Lyovapor™ L-200 allows freeze drying of fruits such as banana slices.

### 5. References

- [1] G. W. Oetjen; Freeze-Drying; Ullmann's Encyclopedia of Industrial Chemistry (2004).
- [2] Application Note, 254/2016 Lyophilisation of fresh banana slices.
- [3] H. Tse-Chao Hua, L. Bao-Lin, Z. Hua; Freeze-Drying of Pharmaceutical and Food Products, (2010).