THE INFLUENCE OF DRYING PROCESS ON CARROT AND CELERY REHYDRATION*

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INTRODUCTION

The course of many technological processes and consumer acceptance of ready product depend on physical properties of food. These physical properties are: shape, size and dimensions porosity, mechanical and rheological properties, water binding capacity, moisture retaining capability etc. Physical properties of materials change during the processing and storage. In general, these changes are irreversible and their degree depends on the technology applied and raw material used. Drying is one of the processes that have significant influence on properties of the material, including physical properties. However, the knowledge of the effect of drying on physical properties of the material has been, up to now, incomplete.

The research on physical properties of dried products has been limited hitherto to examining raw material and ready product only, whereas the research on changes of these properties during the dehydration process has been very rare. The knowledge concerning these changes might be useful in finding out new, better technologies and improving traditional

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processes.

The aim of this work is to investigate changes of water absorption capability of dried carrot and celery as a function of temperature and time of drying process and the air flow velocity.

MATERIAL AND METHODS

The variety Nantejska carrot, cut into 1 cm cubes, and celery cut into cylinders 5 cm long and 1 cm in diameter have been used in this study. Before drying the material was blanched in the temperature of 96-98°C for 3 minutes. Drying has been carried out in a laboratory convective dryer at three temperature levels (60, 80, 100°C for carrot, and 40, 60, 80°C for celery) and three levels of air flow velocity (0.96; 1.34 and 1.76 m/s). The analysis of properties of the material taken out from the dryer when the critical moisture content was reached, at the point of second critical moisture content and at the end of the drying process was done.

<u>Rehydration capacity</u> . 10 g of dry material has been placed in a beaker in 140 cm^3 of water at 20°C and was kept for 0.5; 1; 2; 3 and 5 hours. Hydrated material was weighed and the rehydration capacity was calculated from the formula:

$$R = (100\ m' - m\ s_o)/m\ s_o$$

where: m' - initial weight of the dry material, kg

m - weight of the material after the rehydration process has been completed, kg

s_o - the average content of dry substance in dry material, kg d.s./kg

R - rehydration capacity.

Measurement of the average volume of the material . The known number of cubes or cylinders was placed in a 50 cm^3 cylinder. Then, from a 50 cm^3 burette hexan was filled to the cylinder until the mark of 50 cm^3 was reached. The volume of hexane left in the burette corresponded with the volume of the material in the cylinder.

Measurement of the content of dry substance . The measurement of the content of dry substance in the investigated material was done with the cabinet drying method.

RESULTS AND THEIR INTERPRETATION

Kinetics of the drying process . Analysis of the drying process kinetics has shown that the course of drying curves and curves of drying rate depends on temperature and velocity of air and kind of material used (Fig. 1, 2). The temperature increase by 40°C results in an average increase of the drying rate of carrot in the constant rate period by 0.042 $gH_2O/(g$ d.s.min.) and drying rate of celery by 0.110 $gH_2O/(g$ d.s.min.). On the other hand the air velocity increase by 0.80 m/s results in an increase of drying rate in the constant rate period on an average by 0.036 $gH_2O/(g$ d.s.min.) for carrot and 0.071 g $H_2O/(g$ d.s.min.) for celery. For both materials about 50% of water evaporates during the constant rate period and this takes about 20% of the drying time. In the falling rate period the influence of temperature and air velocity on the kinetics of the process is less pronounced. The influence of the properties of the material, its structure and the relation between free and bound water on the course of the process become more importent than process parameters.

The influence of drying parameters on the rehydration capacity of the material . The rehydration capacity informs about the advance of changes of the material induced by the drying process. It could be expected that carrot and celery should absorb the same amount of water during the rehydration process as that evaporated if there were no changes due to the drying process at all.

It was determined that the relationship between the amount of water absorbed and the time of rehydration is parabolic in nature and asymptotically approaches the state of equilibrium (Fig. 3). In addition it has been observed that between the 3rd and 5th hour of rehydration there is no substantial difference in the amount of water absorbed, however intensive diffusion of the dry substance to the surrending water takes place (Fig. 4).

Carrot and celery dried at lower temperatures in the constant rate period reach the moisture content close to the initial value in the 3rd hour of rehydration process. It is 8 kg H_2O/kg d.s. for carrot and 7 kg H_2O/kg d.s. for celery and it means that the structure changes due to drying process are not substantial and do not influence strongly the volume of water absorbed. In the falling rate period changes of the structure of the material take place, what is reflected in the lesser uptake of water during the rehydration process. At lower drying temperatures carrot and celery show smaller, by approximately 30-40%,ability to absorb water as that for the constant rate period. Carrot dried at 100°C and celery dried at 80°C show lower, by approximately 50%, ability to absorb water as compared with that of the constant rate period.

The effect of temperature of drying air on the changes of structure of the material during the falling rate period is also manifested by larger diffusion of solubles to the surrending water as compared with that of the constant rate period.

The increase of drying air velocity in the range 0.96-1.76 m/s do not significantly affect the ability of the material to absorb water during the rehydration process.

The influence of drying parameters on the reversibility of shrinkage of the material . One should expect that the material with undestoyed structure would, in the process of rehydration, assume the same shape and dimensions as that before drying. However, it has been found that the material does not regain its initial volume during the rehydration process, and the shrinkage in most cases is irreversible. In the case of carrot and celery, for which the drying process has been stopped at the critical water content, it was found that the shape and volume are almost completely regained during the rehydration process. However, the longer the drying time the more visible is the irreversibility of the shrinkage. For example, carrot completely dried at 100°C reaches 55-60% of the initial volume during the rehydration process, while celery dried completely at 80°C reaches 70-75% of it's initial volume (Fig. 5). The differences in the irreversibility of shrinkage observed for both investigated materials are probably due to different tissue structure and different shape of the dried samples.

SUMMARY

This work is concerned with changes of rehydration capacity and shrinkage of carrot and celery dried in a laboratory convective dryer. Samples of dried material were analysed at critical moisture content, at second critical moisture content and at the end of the drying process. It has been shown that rehydration capacity and shrinkage change during the dehydration process. These changes are slight in a constant drying rate period, but they increase significantly in a falling rate period. The effect of drying temperature and air velocity on these changes is also described.

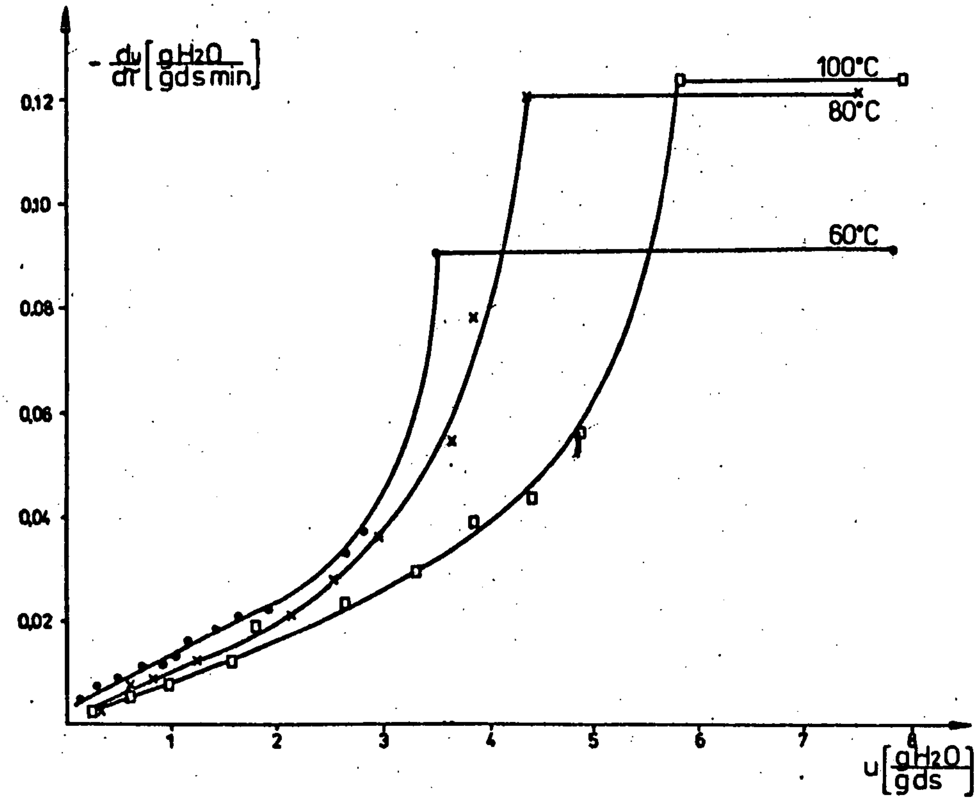

Fig. 1. Influence of the drying temperature on rate drying curves of carrot (V = 1,34 m/s)

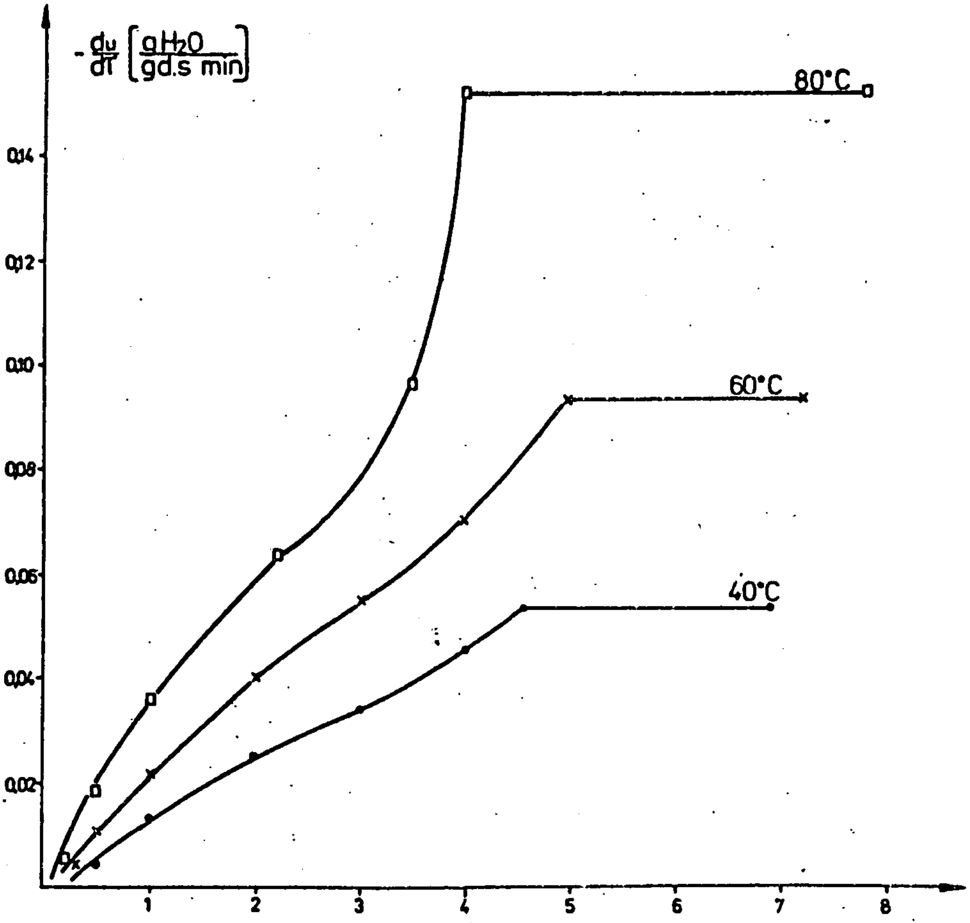

Fig. 2. Influence of the drying temperature on rate drying curves of celery (v= 1,34 m/s)

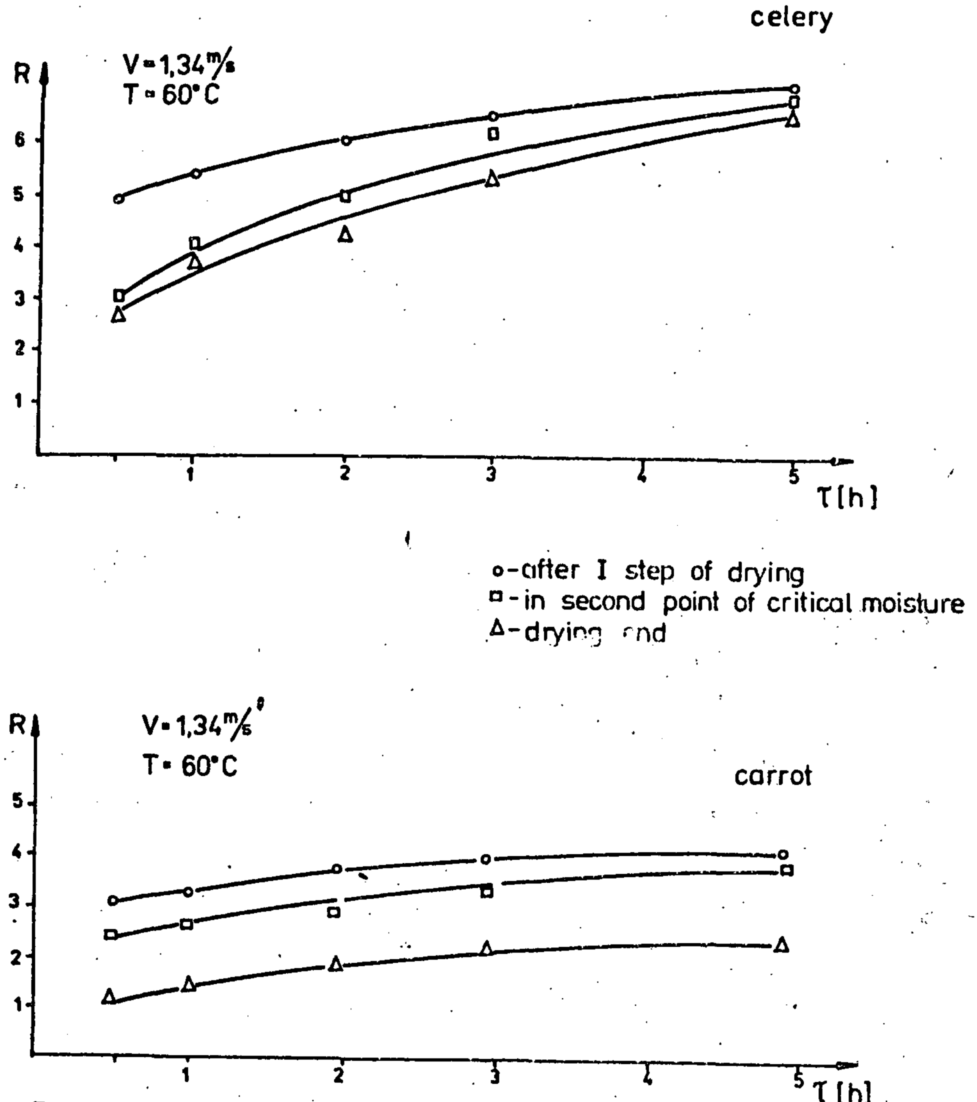

Fig. 3. Kinetics of rehydration

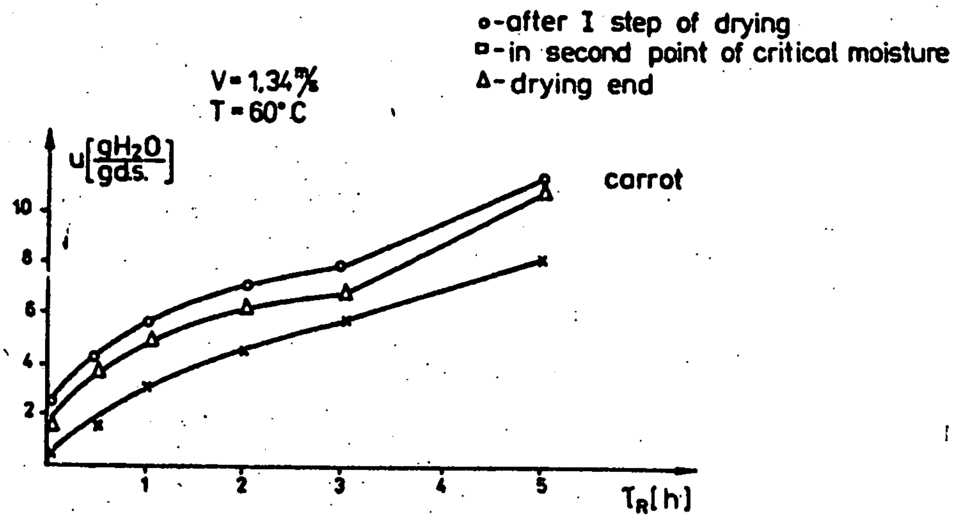

Fig.4. Influence of drying time on water content in rehydration time

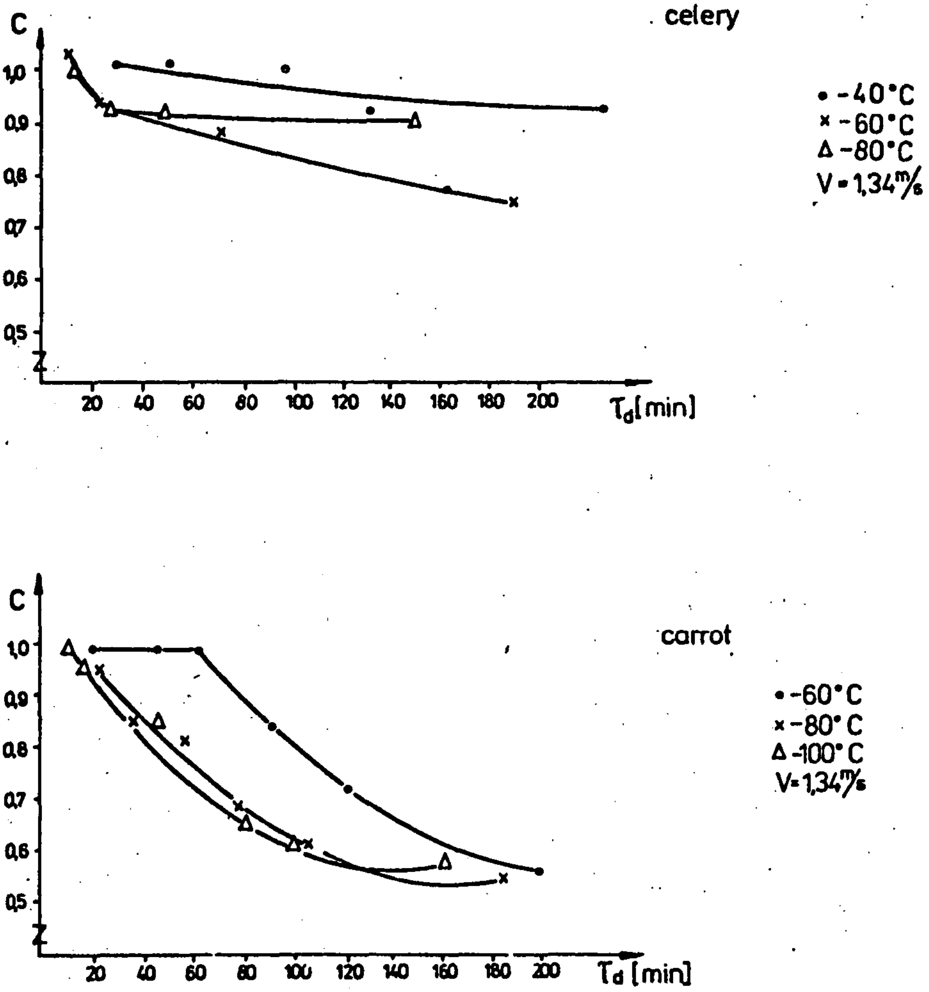

Fig. 5. Influence of drying temperature on maximum dimensions of carrot and celery after rehydration

Készült: A Szegedi Magas-és Mélyépitőipari
Vállalat Sokszorositójában.
Felelős vezető: Mazán Jánosné