

Influence of process setting in convective apple drying on selected parameters

Master Thesis

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Witzenhausen, November 2017

Conclusion and Summary

In this work, the effect of two drying temperatures, three slice thicknesses and two apple varieties on the quality of apple slices dried in a convective dryer was studied. Selected quality parameters were evaluated. The results revealed that the three factors temperature, thickness and variety influence the individual quality parameters significantly to a different extent. Additional monitoring of an uncontrollable parameter, drying air humidity, allowed to investigate its effect on the drying process and the quality characteristics. The required drying time for apple slices to reach the target moisture $0.13 \text{ g}_w/\text{g}_{ds}$ is strongly influenced by the relative air humidity in the dryer (0) followed by the initial moisture content dry basis (E) and the thickness (B). The study of total colour difference (ΔE) from apple slices was challenging nevertheless an impact of variety (C) and thickness (B) was determined. Those two variables affected the rehydration ratio noticeably as well. The investigation of relative volume (shrinkage) was also demanding and showed that again the relative air humidity in the dryer (D) and the initial IVIDI3 (E) have an influence on the shrinkage of apple slices. Water activity was found to be influenced mainly by the relative air humidity in the dryer (D), the drying temperature (A) and the interaction of those (AD). A small influence of the variety (C) was identified as well. Then again, statistical investigation of RR and aw should be viewed with caution as the collection of those data was done at different moisture contents at the respective

ends of different drying times. The nature of these destructive measurements requires additional sampling or online moisture determination for future investigations.

The analysis of variance indicated that the models of responses are significant.

By establishing regression models the drying time, colour difference and relative volume can be predicted. Optimal conditions for minimum drying time, minimum AE, and maximum relative volume at a moisture content of 0.13 g_w/g_{ds} correspond to a slice thickness of 2 mm, a drying temperature of 70 °C with a relative air humidity in the dryer of 5.3 %, Elstar variety with an initial moisture content of 5.88 g_w/g_{ds} , in order to get a drying time of 77 min, total colour difference of 13.6 and relative volume of 0.28 mm^3/mm^3 . According to the model a maximum rehydration ratio of 61.6 % (rehydration for 10 min at 65 °C) is expected for the same combination of slice thickness, drying temperature and variety.

A higher drying temperature only led to a shorter drying time but did not significantly influence the studied quality properties. The temperature influence on a_w , found at the water activity assessment ignores the non-uniform drying time, hence has little informative value. The sample geometry (slice thickness) notably influenced drying time (thinner slice leads to shorter drying time) and colour change (thinner slices had less colour change). Thinner apple slices rehydrated faster due to the increased ratio of surface area to volume and smaller penetration depth for the water. Albeit a correlation between variety and the quality factors colour change, rehydration ability and water activity as well as with drying time was found, this relationship is more likely linked to the remarkably higher initial moisture content of Golden Delicious slices. Additional trials comparing apple slices with the same fresh moisture content of both varieties have to be done to confirm or refute the findings. The slice thickness of 2 mm which was found to be the best out of the tested range in terms of selected quality parameters is seldom found in previous studies focusing on apple slices. This is despite the fact that also the required drying time is positively influenced overproportionate: To dry a certain quantity of 2 mm apple slices twice the drying area is required when compared with 4 mm slices (as a 4 mm slice weighs approximately twice as much as a 2 mm slices). But as the 2 mm slices require less than half of the drying time at 70 °C, the number of possible drying batches is more than twice. Thus, the total drying capacity at a given drying area is higher for 2 mm slices compared to 4 mm slices dried at 70 °C. As a non-destructive way of analysing moisture content and CIELAB chromaticity of apple slices during the drying process, hyperspectral imaging was utilised. Even though it was possible to develop prediction models from gathered hyperspectral images, it was not achieved to

identify specific and unified wavelengths which can be used to predict those parameters. There is no apparent reason for the obvious difference in the individual loading functions of the reduced wavelengths sets. Nevertheless, numerous studies proved the potential of this modern non-destructive measurement technology and additional effort should be put into further developing this technique to establish automated optical systems for real-time online monitoring.