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基于**Weibull**分布函数的葡萄干燥过程模拟及应用

Weibull distribution for modeling drying of grapes and its application

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中文摘要:

为了探究Weibull分布函数中各参数的影响因素及其在干燥中的应用，该文以不同干燥方法（气体射流冲击干燥、真空脉动干燥）、干燥温度（50、55、60和65℃）以及烫漂预处理（30、60、90、120 s）的葡萄干燥过程为研究对象，利用Weibull分布函数对其干燥动力学曲线进行模拟并分析。研究结果表明：Weibull分布函数能够很好的模拟葡萄在试验条件下的干燥过程；尺度参数α与干燥温度有关，并且随着干燥温度的升高而降低；形状参数β与干燥方式和物料状态有关，但干燥温度对形状参数β的影响很小。计算了葡萄在干燥过程中的水分扩散系数Dcal在0.2982×10-9~2.7700×10-9 m2/s 之间，并根据阿伦尼乌斯公式计算出热风干燥和真空脉动干燥方法的干燥活化能分别为72.87和61.43 kJ/mol。研究结果为Weibull分布函数在葡萄干燥过程的应用提供参考。

英文摘要:

Abstract: Grapes as a seasonal fruit, have relatively high sugar content and moisture content, and are very sensitive to microbial spoilage during storage. Therefore, grapes once harvested must be consumed or processed into various products within a few weeks in order to reduce economic losses. Drying grapes into raisins is the major processing method in almost all countries where grapes are grown. The knowledge of the drying mechanism is very necessary for heat and moisture transportation efficiency, energy savings and product quality. Several different empirical and semi-empirical drying models were used for describing and predicting drying curves. Some of these models could give a good fit to the drying curves, but the basic idea of process characterization was to consider the process as a "black box"--the drying materials and drying conditions were difficult to be related to the parameters of these models used. In this study, the Weibull distribution model was applied to the drying process under different drying methods (hot air drying, pulsed vacuum drying), drying temperature (50、55、60和65 oC) and blanching pretreatment time (0、30、60、90、120 s). The result demonstrated that the Weibull distribution model could well describe the drying curves, for the moisture ratio vs. drying time profiled of the model showed high correlation coefficient (R2=0.993-1.000), and low root mean squared error (RMSE=2.72×10-3-2.12×10-2) and chi-squared (χ2=8.13×10-6-4.27×10-4). For the drying process, the scale parameter (α) defined the rate constant and represented the time needed to accomplish approximately 63% of the process. It was found that the scale parameter (α) was depending on the drying temperature and the drying method. When the drying temperature increased from 50 to 65 oC, the scale parameter (α) decreased from 2738.946 to 840.846 min for hot air drying and decreased from 813.219 to 294.831 min for pulsed vacuum drying, respectively. The blanching time could also affect the scale parameter (α), the value of α was decreased from 840.846 to 133.754 with the blanching time increased from 0 s to 120 s at drying temperature of 65oC. The shape parameter (β) was related to rate of the mass transfer at the beginning of drying. In this study, it was found that the shape parameter (β) was depending on the drying method and materials status. For the same drying method, drying temperature had little impact on the shape parameter (β=1.214-1.258 for hot air drying, 1.393-1.409 for pulsed vacuum drying). One important application of the Weibull distribution model is to determine the moisture diffusion coefficient (Dcal), whether the whole drying occurs in the falling rate period or not, by the scale parameter (α). So the Dcal of the grape samples were calculated, ranging from 0.2982×10-9 to 2.7700×10-9 m2•s-1, and it was found that increasing drying temperature, increasing blanching treatment time could enhance the Dcal of grape samples. The activation energy for moisture diffusion of grape samples was 72.87 and 61.43 kJ/mol by hot air drying and pulsed vacuum drying, respectively. It was demonstrated that drying method can affect the activation energy, and drying grapes with pulsed vacuum could save energy and increase efficiency. The result will provide a reference for the application of Weibull distribution on grape drying.

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