猕猴桃片真空冷冻干燥工艺及其效率研究 *

彭润玲,韦 妍,王 鹏,杨 杰,吴亚梅

(西安工业大学机电工程学院,陕西 西安 710021)

摘 要:为了提高猕猴桃片冻干效率和质量,本文通过单因素实验研究了猕猴桃片冻干过程中切片厚度、预冻方式和干燥时间等因素对其干燥率及质量的影响;通过响应曲面方法分析了各因素之间的交互作用,得到其对干燥率的回归模型。结果表明:影响干燥率的次序依次为干燥时间、切片厚度、预冻方式;在实验型冻干设备上利用传统单面干燥方法时,猕猴桃片冻干工艺为:切片厚度 5mm、-20℃预冻、干燥10h,优化为双面干燥后,在其余条件不变的情况下切片厚度可增加到 7mm,干燥效率最高可增加约 11%。

关 键 词:猕猴桃片;冻干;工艺参数;优化

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Study on Vacuum Freeze Drying Technology and Efficiency of Kiwifruit Slices

PENG Run-ling, WEI Yan, WANG Peng, YANG Jie, WU Ya-mei

(*School of Mechanical and Electrical Engineering, Xi'an Technological University, Xi'an 710021, China*)

Abstract: In order to improve the freeze-drying efficiency and quality of kiwifruit slices, the effect of slice thickness, pre-freezing method and drying time on the drying rate and quality of kiwifruit slices during freeze-drying process was studied by single factor experiment. The interaction between various factors was analyzed and the regression model of the drying rate of kiwifruit slices is obtained by the response surface method. The results show that the influencing order on the drying rate is drying time, slice thickness, and pre-freezing method. Among them, there was significant interaction between slice thickness and drying time, while there was no significant interaction between slice thickness and freezing mode, freezing mode and drying time. When the traditional single side drying method is used in the experimental freeze-drying equipment, the freeze-drying process of kiwifruit slices is as follows: slice thickness of 5mm, pre-freezing at -20℃, drying for 10h. After the optimization of double-sided drying, the slice thickness can be increased to 7mm, and the drying efficiency can be increased by about 11% at most.

Key words: kiwi slice; vacuum freeze drying; processing parameter; optimization

近年来我国猕猴桃产量持续增长,尤其陕西省是猕猴桃生产大省。猕猴桃属呼吸跃变型水果,水分易流失、易霉烂,不易保存,从而造成经济损失[1-2]。现阶段通过加工猕猴桃为果脯、果酱、果汁等产品对其进行保存[3-5];但由于工艺需要,上述深加工产品在加工时需要添加各类化学添加剂,造成营养物质及色香味的损失,且存在化学添加剂超标的风险。冻干技术由于可实现无化学添加果蔬产品的加工,且营养物质保存率较高,结构组织保存完整,近年来广受关注[6-12]。但冻干过程的能耗较高,时间较长,干燥效率低,限制了冻干技术在果蔬行业的推广应用。一些学者研究了具体工艺参数对猕猴桃品质的影响[13-15],发现预冻速率以及预冻方式对猕猴桃片的干燥速率、品质以及微观结构影响显著,降低预冻温度、提升预冻速率确实能够起到提升猕猴桃片品质的作用,但是预冻温度越低,冻干猕猴桃片形成的孔隙越小且多,平均孔隙面积、孔隙率也越小,这些孔隙结构规则且分布均匀,从而使干燥速率降低,干燥时间延长,能耗也随之增加[16-18]。

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作者简介:彭润玲(1974-),女,甘肃省天水市人,副教授。

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