

香榧酶法脱蒲工艺技术的初探

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摘要: 香榧种仁加工前需要去除肉质化假种皮, 目前生产上分批采收成本高、耗时长, 常存在未开裂青果大量采摘的现象。研究酶法去皮的最优工艺参数, 为研发新型香榧酶法脱蒲装置、实现工厂化酶法脱蒲提供技术支撑, 对提高香榧生产效率具有重要的现实意义。选择未开裂的‘细榧’青果, 利用果胶酶、纤维素酶和半纤维素酶对其进行切口酶法和脱蜡酶法处理, 测定相关代谢酶活力的最适 pH、温度以及酶液浓度, 结合香榧假种皮的硬度和感官得分值, 明确香榧脱蒲最优酶解工艺条件; 通过测定细胞壁组分及相关降解酶活性的变化, 结合假种皮微观结构的观察, 分析香榧种实营养物质及香气成分的变化, 揭示香榧酶法脱蒲的内在机制。结果表明: (1) 当渗透方式为纵切或者脱蜡, 酶液 pH、温度、浓度、比例分别为 3.9819、34.8112 °C、27.7103%、 $V_{PME}: V_{CX}: V_{\beta-Gal}=3.5: 3: 1$, 酶解反应时间为 30 min 时, 此时脱蒲效果最优。(2) 从微观结构观察, 酶法处理后的香榧假种皮可以明显看出树脂道塌陷、细胞壁崩塌、细胞层分离以及表面蜡质浮出的现象, 5%蔗糖脂肪酸酯相比 60%乙醇处理下分解蜡质现象更为明显。(3) 酶法处理相比 CK 的假种皮的水溶性果胶 (WSP)、木质素总体上呈增加趋势, 而 CDTA 可溶性果胶 (SSP)、 Na_2CO_3 可溶性果胶 (CSP)、纤维素、4%半纤维素、24%半纤维素则呈降低趋势; 酶法处理与 CK 之间的粗脂肪、可溶性糖、淀粉、可溶性蛋白含量均无显著差异。(4) PCA 和韦恩图分析发现, 酶法去皮与 CK 的香气组分相比, 总化合物含量与萜烯类化合物含量无显著差异, 而差异物质主要体现在醇类和酮类化合物, 在酶法处理下均未检测到 4-萜烯醇物质 (具有胡椒香, 泥土香, 陈腐木材香)、仲辛酮 (具有霉香, 酮香)、2-甲基-5-环己酮物质。生物复合酶法为香榧假种皮的去除提供了重要的技术支撑, 可以大大提高香榧生产效率, 有望实现工厂化酶法脱蒲工艺技术。

Preliminary Study on the Enzymatic Dehydration Technology of *Torreya grandis* cv ‘Merrillii’

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Abstract: Before processing *Torreya grandis* seeds, it is necessary to remove the fleshy false seed coat. Currently, batch harvesting is costly and time-consuming in production, and there is often a phenomenon of picking large quantities of unripe green fruits. Studying the optimal process parameters for enzymatic dehulling of *Torreya grandis* provides technical support for the development of a new enzymatic dehulling device and the implementation of industrialized enzymatic dehulling. It is of great practical significance for improving the production efficiency of *Torreya grandis*. Select the uncracked ‘Xi Fei’ green fruit and use pectinase, cellulase, and hemicellulase to treat it

with incision enzyme method and dewaxing enzyme method. Determine the optimal pH, temperature, and enzyme concentration of related metabolic enzyme activity, combined with the hardness and sensory score of *Torreya grandis* aril, to determine the optimal enzymatic hydrolysis process conditions for *Torreya grandis* aril; By measuring the changes in cell wall components and related degradation enzyme activities, combined with the observation of the microstructure of the aril, the changes in nutritional substances and aroma components of *Torreya grandis* seeds were analyzed to reveal the internal mechanism of enzymatic dehulling of *Torreya grandis*. The results indicate that: (1) When the penetration method is longitudinal cutting or dewaxing, the pH, temperature, concentration, and ratio of the enzyme solution are 3.9819, 34.8112 °C, 27.7103%, $V_{PME}: V_{CX}: V_{\beta-Gal}=3.5:3:1$ is used and the enzymatic hydrolysis reaction time is 30 minutes, the optimal dehulling effect is achieved. (2) From the microstructure observation, the resin channel collapse, cell wall collapse, cell layer separation, and surface wax floating phenomenon can be clearly observed in the enzymatic treated *Torreya grandis* aril. The wax decomposition phenomenon is more pronounced under 5% sucrose fatty acid ester treatment compared to 60% ethanol treatment. (3) Enzymatic treatment showed an overall increase in water-soluble pectin (WSP) and lignin compared to CK's aril, while CDTA soluble pectin (SSP), Na_2CO_3 soluble pectin (CSP), cellulose, 4% hemicellulose, and 24% hemicellulose showed a decreasing trend; There was no significant difference in crude fat, soluble sugar, starch, and soluble protein content between enzymatic treatment and CK. (4) PCA and Venn plot analysis showed that there was no significant difference in total compound content and terpene compound content between enzymatic peeling and CK aroma components, while the differences were mainly reflected in alcohol and ketone compounds. Under enzymatic treatment, no 4-terpene alcohol substances (with pepper aroma, soil aroma, and aged wood aroma), 2-octanone (with mold aroma, ketone aroma), and 2-methyl-5-cyclohexanone substances were detected. The biological composite enzyme method provides important technical support for the removal of the false seed coat of *Torreya grandis*, which can greatly improve the production efficiency of *Torreya grandis*, and is expected to achieve industrialized enzymatic dehulling technology.