

Abstract

This study presents a comparative evaluation of two drying methods: conventional convective drying (hot-air) and freeze-drying (lyophilization) applied to selected Mediterranean fruits, namely dates (*Phoenix dactylifera*), tomatoes (*Solanum lycopersicum*), and zucchini (*Cucurbita pepo*). The objective was to assess the impact of these methods on key quality parameters, including moisture reduction efficiency, total phenolic content, antioxidant activity (DPPH assay), vitamin C content (HPLC), color stability (L^* , a^* , b^*), and texture characteristics (hardness and chewiness). Freeze-drying demonstrated superior performance in preserving sensitive bioactive compounds, with vitamin C retention exceeding $85\% \pm 1.5\%$, total phenolic content reaching 93.4 ± 2.1 mg GAE/100 g dry weight, and antioxidant activity reaching $79.2 \pm 1.8\%$ inhibition. In contrast, hot-air drying, while more energy-efficient (approximately 0.8 kWh/kg), led to greater nutrient degradation, with vitamin C retention around 55% and antioxidant activity at 58.6%. Sensory evaluation by a trained panel revealed that freeze-dried products received the highest overall acceptability scores (8.2/9), particularly in terms of appearance, aroma, and texture, whereas hot-air-dried samples showed noticeable declines in visual appeal and mouthfeel. This study highlights the trade-offs between nutritional preservation, sensory quality, and energy efficiency. These findings provide valuable guidance for selecting appropriate drying technologies in the context of sustainable food processing and the valorization of Mediterranean plant-based resources. Overall, freeze-drying remains the preferred technique when product quality is the priority, while hot-air drying offers a viable option where cost and energy are the priority.