Title Packaging engineering for tropical horticultural products: geometric, structural and thermal optimization of mango and banana packages

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Abstract

Fruit and vegetable production has been growing significantly every year, in Brazil and worldwide. Therefore, the application of appropriate technologies requires constant improvement and technological investment, from harvest to commercialization. Particularly, packages are a significant part of post-harvest losses statistics for fresh fruit and vegetables; only 10 to 50% from the total yield are reported per year, depending on the country's development, climate, cold chain employment, logistical aspects, and others. This study introduces the methodology of a packaging design project and discusses results of its application for design and optimization of mango (*Mangifera indica* L., 'Tommy Atkins') and banana (*Musa cavendishii* 'Nanica') packages, based on computer simulation and experimental validation. It was aimed to minimize material volume (reforestation wood - *Pinnus ellioiti*) by combining structural, thermal, ergonomic and geometric aspects, as effective areas and opening distribution. The Finite Element Method (FEM) was employed for optimization and structural dimensioning, allowing a material volume reduction of 83% for banana package and 67% for mango package. Due to the effective opening area distribution, the cooling time reduction of fruit, which were cooled by forced-air, was on average 50% as for packaging commercially utilized. The results of this study, as well as the methodology applied, may be employed for commercial purposes, such as for reforestation wood packages, provided these are watertight and non-reutilized, even for export markets. The methodology used combined computer and engineering tools, at an appropriate cost-benefit relationship among structural, geometric, thermal and ergonomic aspects.