

## Model Based Design and Development of Horticultural Produce Crate from Bamboo

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**Abstract :** It is common to observe quality deterioration and mechanical injury of horticulture products as a result of suboptimal design and handling of the packaging systems. Society uses the old and primitive way of handling horticulture products, which is produced through trial and error. This method is known to have many limitations on quality, environmental pollution, labor and cost. Ethiopia stands first in bamboo resources in Africa, which is 67 % of the African and 7 % of the world's bamboo resources. The purpose of this project was to design and develop bamboo-based ventilated horticultural produce crates using validated computational fluid dynamics (CFD). The model was used to predict the airflow and temperature distribution inside the loaded crate. The study included: sizing, collection of the thermo-physical properties, and designing and developing a CFD model of the bamboo-based ventilated horticultural crate. The designed crate (40×30×25cm) had a capacity of about 18 kg, and cold air temperature (13°C) was used for cooling the fruit. Airflow in the loaded crate is far from uniform. There is a relatively high-velocity flow at the top, near inlet and near outlet sections, and a relatively low airflow near the center of the loaded crate. The predicted velocity variation within the bulk of the produce was relatively large, it was in the range of 0.04-7m/s. The vented produce package contributed the highest cooling airflow resistance. Similar to the airflow, the cooling characteristics of the product were not uniform. There was a difference in the cooling rate of the produce in the airflow direction and from the top to the bottom section of the loaded crate. The products that were located near the inlet side and top of the bulk showed a faster cooling rate than the rest of the bulk. The result showed that the produced volume average temperature was 17.9°C after a cooling period of 3 hr. It was reduced by 12.05°C. The result showed the potential of the CFD modeling approach in developing the bamboo-based design of horticultural produce crates in terms of airflow and heat transfer characteristics.

**Keywords :** bamboo, modeling, cooling, horticultural, packaging

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