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Name of Topic: **Performance Evaluation of Fruit Supply Cold Chain – A case Study**

Keywords:

Cold Supply Chain; FACCC; Temperature Control; Agricultural Crops; Fruits And Vegetables; Shelf Life; Storage; Transportation; Energy Analysis; First Law Efficiency; Second Law Efficiency; Convective Heat Transfer Coefficient; Nusselt Number; Reynolds Number; Stanton Number; Low-Cost Cold Chain.

India is a nation of geographic diversity with various soil-types; habitats, climates, and vegetations. The most crucial thing is to maintain food products at a desirable controlled temperature environment during storage and transportation after harvesting. More than 40% of India's total food production becomes waste from harvesting to the eating plate, mainly because of the weak cold chain

However, the contemporary cold chains of fruit and vegetables are not as per the requirements, leading to a high decay rate and significant constraint for the fruit and vegetable industry. Fruit and vegetables cold chain is a specialised supply chain; must keep the appropriate low temperature during the processing; storage; transportation; distribution and retail to maintain the quality and reduce the loss as far as possible. Temperature management is an essential factor to improve the shelf life of perishable products.

It is observed that temperature control of fruits and vegetables and their heat transfer characteristics are major factors in maintaining potency and increasing shelf life. This study proposed a low-cost design of FACCC for temperature control of fruits and vegetables during transportation and storage with Chillers' help.

The free cooling technique, as used inside the FACCC unit, has a complex system. Moreover, depending on those characteristics, cooling varies with time and is also affected by the surrounding environmental conditions such as air velocity, humidity, outside air temperature, and solar radiations; these all affect the heat transfer rate of FACCC. Under these conditions, all variable conditions such as heat drop are up to 8^0C to 9.5^0C under shading and direct sunlight. So it will affect the shelf life of crops like fruits and vegetables and those that do not require being stored in such a high cold environment as mango; papaya; potato etc.

It is observed that thermodynamics first law efficiencies for the above configuration vary from 23.82% to 34.67% under the shaded surface condition and 15.61% - 31.46% for direct sunlight conditions for FACCC model. However, thermodynamics second law efficiency varies from 52.31% - 80.93% under the shaded surface condition and 33.20% - 72.33% for direct sunlight conditions for the FACCC model.

Accordingly, calculate the Stanton number of different commodities' numerical value for various Reynolds number values, which is obtained by operating four fans fitted in FACCC. Apart from that, calculates heat transfer rate, and Nusselt number for selected fruits and the experimental results show that Nusselt number varies 29.65 to 190 inside the FACCC with varying airflow conditions and different temperatures. The surface heat transfer coefficient inside the FACCC varies from 17 W/m^2K to 278 W/m^2K, supported by the different ambient conditions.

The airflow rate was maintained between 0.2065 m/s - 0.413 m/s inside FACCC. An experimental study reveals that the average Nusselt Number of these vegetables lies in 57.9 - 115.74. The range of surface heat transfer coefficient is 54.48-108.96 W/m^2K. Validation of FACCC performance has been done by comparing the heat transfer rate and Nusselt number from published literature.