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Development of a Photovoltaic Driven Ventilation System to Modified Traditional Ethiopian Gombisa for On-Cobs-Maize Drying and Storage

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Abstract

Unsafe moisture content at loading and the climatically uncontrolled nature of traditional storage structure (gombisa) together with ventilation dependent on wind alone, results in mycoflora growth and development on maize in the system. Therefore, this study aimed to develop and test a photovoltaic driven ventilation system fitted to a gombisa for natural air in-bin drying of on-cobs-maize and increased shelf life of the stored product. A modified gombisa was constructed from locally available materials in Germany. An appropriate fan type and size, humidistat set at 70 % and two 20 Wp photovoltaic panels were utilised for ventilation purpose, fan control and to power the fan, respectively. In total 1.76 m^3 of on-cobs-maizes with an average moisture content of 0.22 on d.b. (kg kg^{-1}) were used for the study. Data was collected on solar irradiance, photovoltaic voltage, current, inlet duct air velocity and temperature and relative humidity inside the storage system. Similarly, moisture content of on-cobs-maize, ambient temperature and relative humidity data were also collected for both experiments. The result for the temperature and relative humidity trends revealed higher variability and fluctuation for ambient compared with inside the modified gombisa. Ventilation of on-cobs-maize for 10–12 days resulted in a reduction of moisture content (d.b.) to almost 0.14 (kg kg^{-1}) which generally is considered safe for mould growth conditions. A computational fluid dynamics simulation result revealed the uniformity of the drying of on-cobs-maize using the ventilation system fitted to the modified gombisa. Secondary data of solar irradiance obtained from Jimma area, Ethiopia compared to the current experiment show higher energy availability, demonstrating high potential to apply ventilation and drying system to the region. Storing maize inside modified gombisa played a role in protecting the stored product from outside weather conditions. Also, monitored temperature, relative humidity and energy output showed the system was able to bring the product to safe moisture content for storage without mould development. This promising research result needs to be tested and validated in tropical regions of the world.

Keywords: Maize in cobs, modified gombisa, relative humidity, temperature, ventilation system

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