National Institute of Technology Rourkela

Progress Seminar

Seminar Title	: Peeling, Drying and Decontamination of Shallots (Allium cepa L. Aggregatum) using Infrared Radiation
Speaker	: Deepika S (Rollno : 517fp1001)
Supervisor	: Parag Prakash Sutar
Venue	: CH 113
Date and Time	: 14 Jul 2025 (05:00 PM)
Abstract	: Shallots (Allium cepa L. Aggregatum) are known for their distinctive flavor and medicinal properties, but conventional peeling and drying are often inefficient and can lead to quality degradation of the final product. This study explores infrared (IR) heating as a sustainable alternative for peeling and drying of shallots. Different wavelength emitting IR lamps (transparent quartz tungsten (TQT), ruby coated quartz tungsten (RCQT) and ceramic) were used for IR peeling and drying studies. Spectral characteristics of the emitted radiation were evaluated. The peak wavelength determined by Wien&rsquos law was between 2.56 and 7.1 µm. Comparatively, longer wavelength was emitted by ceramic lamp. The spectral emissive power determined by Stefan-Boltzmann&rsquos law ranged between 1.14 and 37.49 kW m^{-2} . IR dry peeling experiments were carried out by using the Box Behnken design, which varied the distance between the IR emitter and product (20 to 60 mm), IR power level (30 to 90%), exposure time (3 to 15 min), and type of IR emitter (ceramic, RCQT, and TQT). Optimal peeling was achieved using a ceramic lamp at 60% power, 60 mm distance, and 15 min exposure, resulting in 68.27% peelability, 31.72% unpeeled percentage, ease-of-peeling score of 6.99, color change of 7.89, and 2.27% moisture loss. The optimised IR peeling was compared with the traditional peeling methods like hot water (dipped in water of 60 °C for 5 min), steam (5 min), lye (2% caustic soda for 5 min), flame (600 °C flame of 30 s), and knife peeling (control). Among all treatments, IR dry peeling maintained better quality and flame peeling caused the most quality deterioration. Further, IR peeled shallot bulbs were sliced to a uniform thickness of 5 mm for subsequent drying experiments. IR drying was conducted by varying the type of IR lamp (ceramic, RCQT, TQT) and power level (40 to 80%). The optimized condition was drying using TQT lamp at 60% power with a constant distance of 100 mm. To further enhance drying performance, the optimized IR drying condition was combined with hot air (HA) at 60 °C and 1.1 m s -1 air velocity. The combined IR and hot air drying (HAD) method improved drying process and preserved bioactive compounds compared to IR or HAD alone. Drying kinetics were significantly influenced by IR power level and drying time, and Page model was found to be the best fit for all drying conditions. Physicochemical, structural, and sensory analyses, including allicin, pyruvate, total phenolics, total flavonoids, antioxidant activity, ascorbic acid content, SEM, XRD, and FTIR were carried out for both peeling and drying experiments. Further, numerical simulation was conducted using COMSOL Multiphysics to model coupled heat and mass transfer phenomena during the IR convective drying of shallot slices. Simulated temperature and moisture profiles closely aligned with experimental results, validating the model. Sorption isotherms of dried shallots were determined using static gravimetric methods, and the Guggenheim-Anderson-deBoer (GAB) model was the best fit for sorption data. This study developed a sustainable IR-based peeling and drying process for shallots, enhancing processing efficiency, quality retention, and microbial safety.