National Institute of Technology Rourkela

Synopsis Seminar

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| 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 | : 03 Sep 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 shallot peeling and drying. The infrared lamps of ceramic, ruby coated quartz tungsten (RCQT) and transparent quartz tungsten (TQT) were used in peeling and drying studies. Spectral characteristics of the radiation emitted by the lamps were evaluated, and the peak wavelength was found to vary from 2.56 to 7.1 µm. IR dry peeling experiments were carried out by using the Box Behnken design, which varied the type of IR emitter (ceramic, RCQT, and TQT), IR power level (30 to 90%), distance between the IR emitter and product (20 to 60 mm), and exposure time (3 to 15 min). Optimal peeling was achieved using a ceramic lamp at 60% power, 60 mm distance, and 15 min exposure. It resulted in 68.27% peelability, 31.72% unpeeled percentage, 6.99 ease-of-peeling score, 7.89 color change, and 2.27% moisture loss. The optimized 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 ± 15 °C flame of 30 s), and knife peeling. 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%) with a constant distance of 100 mm. The optimized condition was drying using TQT lamp at 60% power. The optimized IR drying condition was combined with hot air at 60 °C and 1.1 m $s^{-1}$ air velocity to enhance drying performance further. The combined IR and hot air drying (HAD) method improved the drying process and preserved bioactive compounds compared to IR and HAD alone. The log reduction of Aspergillus niger was 0.78 during IR peeling and 4.3 during IR-HAD, resulting in a total log reduction of 5.08. Additionally, physicochemical, structural, and sensory analyses, including allicin, pyruvate, total phenolics, total flavonoids, antioxidant activity, ascorbic acid content, SEM, XRD, and FTIR were carried out on the final product. 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 shallot peeling and drying process, enhancing processing efficiency, quality retention, and microbial safety.