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ORIGINAL ARTICLE

Numerical modeling and simulation of temperature profiles in finger millet bed during solid state fermentation

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Abstract

Abstract: The temperature profile (core temperature and temperature gradient) of the finger millets bed affects the efficiency of the solid-state fermentation (SSF) process and quality of the product. Despite its detrimental effect, it is difficult to measure/monitor the temperature profile inside a chamber. Hence, the temperature profiles in the finger millets bed during SSF were predicted and analyzed using numerical modeling. The bed thicknesses (0.075, 0.15, and 0.225 m) and air flow velocities (0.12, 0.24, and 0.36 m/s) were varied to study the temperature profiles in the SSF process. Fermentation was carried out in a fixed bed solid-state fermenter. The results showed that temperature profiles were depending upon both bed thickness and air velocity and the lesser differences in temperature profiles were observed at 0.15 m bed thickness and 0.24 m/s air velocity. The low relative error (−0.335–0.250) and chi-square (0.00–4.09) values indicated that the model could be used for prediction of temperature profiles in finger millet bed and it could be used for online temperature profiling in commercial-scale solid state fermenter.

Practical applications: SSF of finger millet is a promising bioconversion process and it is used for improving the nutritional and functional properties of millets. During the SSF process, continuous metabolic heat emission affects the quality of the end product. Hence, maintaining and controlling the temperature during SSF helps to improve the quality of product formation. However, formation of hard mass or densification of substrate does not enable to measure the temperature variation in the finger millet bed (substrate) and causes difficulty to maintain and control the temperature. Therefore, numerical models were developed to predict the temperature profile in the SSF process. The models could be useful for developing controllers to maintain the temperature in the SSF process that is required for quality product formation. Also, the developed model could be useful to develop the sensors for online measurement of temperature during SSF process and design and development of large-scale solid state fermenter.

