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Propose suitable model for modeling of moisture ratio and estimation of effective moisture diffusivity of onion slices by hot air dryer

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Abstract
Onion slices were dried under different processing conditions by hot air dryer. Slice thickness, air velocity were constant and inlet air temperature, drying time were varied to study the drying behavior. Thin layer drying of onion slices was carried out at air temperatures of 60, 70, 80 and 90 $^{\circ}C$ and air velocity of $1.5\ m/s$. The drying occurred in the falling rate of drying period. 13 available moisture ratio models were fitted to the drying data. The model proposed in this study had a higher squared correlation coefficient (R^2), and low sum of square error (SSE) and thus predicted drying behaviour of the onion slices more accurately. The average effective moisture diffusivity of onion slices ranged between $0.125821\times10^{-10}\ m^2s^{-1}$ and $0.788957\times10^{-10}\ m^2s^{-1}$. The values for D_{eff} increased with a increase in air temperature and decrease in moisture content under all drying conditions.

Keywords: moisture ratio; Onion; Drying; Modeling; Moisture Diffusivity; Drying rate

1. Introduction
Onion (Allium cepa L.) has been widely used even in ancient times as seasonings, for medical uses and as foods. In current times, onion is an important vegetable to serve as ingredients in dishes, as toppings on burgers, in seasonings, as chip coatings, and in a variety of other food products including ramen noodles and canned foods [1.]. Onion ranks third highest in world vegetable production with an annual production of 47 million tones.
Dehydration of foods is aimed at producing a high density product, when adequately packaged has a long shelf life, after which the food can be rapidly and simply reconstituted without substantial loss of flavour, colour, taste, and aroma. Hot air-drying is the most commonly employed commercial technique for drying of biological products [2.].
Numerous empirical and semi-empirical models have been proposed to describe the drying behavior of agricultural products [3., 4.]. The drying and energy requirements of a specific crop and cost effectiveness are the main considerations while designing a dryer [5.]. Simulation models are needed in the design and operation of a dryer. Several researchers have developed simulation models for natural and forced convection drying systems [6., 7.].
The diffusion coefficient of a food is a material property and its value depends upon the conditions within the material. Effective moisture diffusivity describes all possible mechanisms of moisture movement within the foods, such as liquid diffusion, vapour diffusion, surface diffusion, capillary flow and hydrodynamic flow [8.]. Moisture transport which involves diffusion of moisture in solid foods is a complex process. Very little published literature is available on effective diffusivity data for onion slices during hot air drying. A knowledge of effective moisture diffusivity is necessary for designing and modeling mass transfer processes such as dehydration, adsorption and desorption of moisture during storage. The objective of this study was to examine the effect of different drying temperatures on moisture ratio of onion slices and to propose simple mathematical models to predict the moisture ratio as a function of drying time And determine the effective moisture diffusivity of onion slices during hot air drying process and its dependence on factors such air temperature and moisture content that essentially influence drying rate.

2. Theoretical considerations
In drying, diffusivity is used to indicate the flow of moisture within a material. In the falling rate period of drying, moisture is transferred mainly by molecular diffusion. Moisture diffusivity is influenced mainly by moisture content and temperature of material. Onion slices were considered as an infinite slab because the thickness of the slice (3 mm) was much less than its diameter (about 64 mm). The moisture diffusivity for an infinite slab was therefore calculated by the Eq. (1).considering assumptions mentioned hereunder [9.].
(1) Initial moisture is uniformly distributed throughout the mass of a sample.
(2) Mass transfer is symmetric with respect to the centre.
(3) Surface moisture content of the sample instantaneously reaches equilibrium with the condition of surrounding air.

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