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Research Paper :

Thermal modeling and its experimental validation for drying of Prawn (*Macrobrachium lamarrei)* (H.Milne Edwards) in a greenhouse under natural convection

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ABSTRACT

An experimental study was carried out to develop a thermal model to predict the prawn (*Macrobrachium lamarrei)* (H.Milne Edwards) temperature, the greenhouse air temperature and the amount of moisture evaporated (prawn mass during drying) under natural convection mode. The prawn having initial weight 162.9g (250 numbers) was dried in a roof-type even span greenhouse with floor area of 1.20×0.78 m^2. Experiment was carried out during July 3–4, 2006 at IIT Delhi (Latitude 28^0 35'N and Longitude 72^0 12' E) between 10 am to 5 pm for two consecutive days. A computer program was developed in MATLAB 7.0 software to calculate the prawn temperature, the greenhouse air temperature, the amount of moisture evaporated and also used to predict the thermal performance of the greenhouse on the basis of solar intensity and ambient air temperature. The model developed was validated with the experimental data and exhibited fair agreement.

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Key words : Thermal modeling, Drying of prawn, Greenhouse, Natural convection

In many rural areas of developing and under developed countries, the availability of electricity and other non-renewable sources of energy are not only irregular and unreliable for many fish farmers but also expensive. Thus, in such locations, electrical heating for fish drying is not a dependable option. The small fish farmers rarely adopt the dryers powered by fossil fuels due to their high cost. The traditional open sun drying method has some limitations like inadequate drying, fungal attacks, insects and birds catching, unexpected downpour of rain and other adverse weather effects. In such conditions, solar dryers appear to be attractive and cost effective for fish drying. The prawn drying can be done by several methods namely open sun drying, cabinet drying and greenhouse drying. In open sun drying humidity cannot be controlled and hence, it takes considerably a longer time for drying due to the hygroscopic nature of prawn. The drying can also be done with the help of a solar cabinet dryer but the high temperature inside cabinet dryer may burn the products, which is also not desirable. However, the greenhouse dryer provides a controlled environment in terms of moderate temperature and humidity, which is beneficial for the drying of prawn more effectively thus reducing the drying time (Prakash, 2006; Kumar *et al.*, 2006). Mathematical modeling of greenhouse prawn dryer is rarely available in the literature. The principles for drying of prawn are similar to any crop drying inside greenhouse (Bal *et al.*, 2003; Jain and Tiwari, 2004). The present work focuses on the development of a thermal model for prediction of hourly prawn temperature, greenhouse air temperature and the quantity of moisture evaporated under natural convection mode for required drying of prawn inside a solar greenhouse.

METHODOLOGY

Experimental set-up:

Wire mesh tray of 0.4x0.24 m^2 was used to accommodate 162.9 g samples of prawn, *Macrobrachium lamarri* (H.Milne Edwards). A roof type even span greenhouse with an effective floor covering 1.2´0.78m^2 has been made of PVC pipe and UV polythene film. The central height and height of walls were 0.60 and 0.40m, respectively. The inclination of the north and the south roof were 25.90^0 and 25.90^0, respectively from