ABSTRACT

Development of Experimental and Simulation Techniques
For Optimal Design and Operation
Of Packed Bed Driers

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There is a wide range of tropical, high moisture crops which need to be dried prior to storage. Because of the inherent problems associated with sun drying, the use of batch-operated, packed bed driers using artificially heated air is becoming increasingly widespread. Inspite of this, however, there is little or no quantitative description of the drying characteristics of single layer and packed beds of tropical crops.

Against this background, the work described in this thesis sets out to develop an approach which can be used to study the drying behaviour of both single layer and packed beds of tropical crops by:-

(i) Designing, constructing and testing an apparatus capable of drying different crops under a wide range of drying conditions,

(ii) Modelling the single layer drying characteristics of the material using,
   (a) Lumped Models, and
   (b) Distributive Diffusion and Conduction Model,

(iii) Modelling drying in packed beds of using a curve-fit approach, as well as a rigorous simulation, and

(iv) Studying the optimisation of drier operation and design.

The material used in the study was pigeon pea (Cajanus Cajan), the most important pulse in the Caribbean Region, a material for which no previous drying work has been reported.

It was found that:-

(a) The performance of the apparatus proved to be quite satisfactory over a wide range of drying conditions and crop materials,

(b) A semi-empirical model involving three drying regions described the single layer drying characteristics of the pigeon peas very well,

(c) The distributive diffusion and conduction model did not fit the experimental results adequately for reasons enumerated in the text,

(d) Both the curve-fit and the rigorous simulation of the packed bed of material gave good fits with the experimental data,

(e) A previously unreported technique which was used to study the optimisation of drier operation and design showed that for both cases, the best operating conditions for the drying of pigeon peas were at a temperature of 35°C, a velocity of 0.23 ms^{-1} and a bed depth of 7 cm.

It is projected that the approaches enumerated in this work, in conjunction with the apparatus developed can be used to study the drying behaviour of crops previously unstudied. The results obtained would then be used to ensure that the correct drying procedures are used commercially and also in the optimal design of new driers.