Chapter 1
Introduction

1.1 Background

Porosity is defined as the ratio of free spaces occupied within a material to the total volume of the material. What defines a material as porous or a nonporous remains to be determined, although a few studies suggest that a nonporous material is one that has a porosity of less than 0.25, with a porous material having a porosity greater than 0.4 (Karathanos et al. 1996; Goedeken and Tong 1993; Waananen and Okos 1996; Lozano et al. 1983; Zogzas et al. 1994; Krokida and Maroulis 1997).

Knowledge of pore formation in food during the drying process can be useful in predicting transport properties, such as thermal conductivity, thermal diffusivity, and mass diffusivity (Rahman 2001), as well as dried-food quality (Xiong et al. 1992; Mayor and Sereno 2004; Mavroudis et al. 1998). This is because most of the factors that contribute to transport properties are significantly affected by the structure of the food material.

Drying methods and drying conditions affect the porosity of the final dried product. Thus, the same raw material may possess different pore characteristics at the conclusion of the drying process, depending on the drying method and conditions (Sablani et al. 2007). There is a scarcity of thorough research in the literature concerning the characteristics of pores in food products. Depending on the end use of the dried food materials, high porosity may be either desirable or undesirable. For example, if a long bowl life is required for a cereal product, a crust (lower porosity) product that prevents moisture absorption may be preferred. On the other hand, dehydrated foods, such as fruits, vegetables, and instant noodles, should possess high porosity to facilitate their fast rehydration.

In addition, porosity also gives an indication of the extent of shrinkage that a food material undergoes during drying, which in turn determines the size and shape of the finished product (Ayrosa and Pitombo 2003). Furthermore, it is well established that a more porous structure of the final product is an indication that less

M.U.H. Joardder et al., *Porosity*, SpringerBriefs in Food, Health, and Nutrition, DOI 10.1007/978-3-319-23045-0_1

structural damage took place over the time of drying. Finally, knowledge of the porous structure of dehydrated materials may help in the accurate modeling of mass and heat transfer processes, including the prediction of water diffusivity in various foods (Datta 2007).

It has also been found that porosity has a direct effect on other physical properties, such as the mass diffusion coefficient, thermal conductivity, and thermal diffusivity. The mechanical and textural properties of food are also correlated to porosity. Vincent (1989) found that torsional stiffness (0.5–7 MPa) varied with porosity (0.83–0.54) in the case of fresh apples. In addition to these, porosity plays a significant role in the agglomeration of cell strength in dried foods. Furthermore, variations in pore characteristics have a significant effect on the textural and sensory properties of foods (Vickers and Bourne 1976; Christensen 1984). Despite the importance of the effects of porosity on food properties, little work has been done to establish a relationship between porosity and dried-food qualities.

In brief, the prediction and control of porosity are complex tasks faced by food scientists and engineers. Porosity is one of those physical parameters that is required to build food behavior models; it is particularly relevant in the case of porous solid materials and as such plays a paramount role in the modeling and understanding of drying operations, cold and controlled-atmosphere storage, and other food-treatment processes (Lozano et al. 1983).

The outline of this book is as follows. The pore formation mechanism is described first, followed by a discussion of the factors that affect porosity during drying and a description of heat and mass transfer mechanisms through porous media. Pore development in various drying processes is then discussed. The effects of porosity on the other physicochemical properties of dried food materials are then reviewed. Finally, a hypothesis is proposed concerning the relationship between process parameters and product quality through an examination of pore characteristics.

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