Chapter 25
Multifractal Characterization of Apple Pore and Ham Fat-Connective Tissue Size Distributions Using Image Analysis

Fernando Mendoza, Nektarios Valous, Adriana Delgado, and Da-Wen Sun

25.1 Application of Fractal and Multifractal Analysis to Biological Material

Fractal and multifractal concepts have been increasingly applied in various fields of science to describe the complexity and self-similarity of nature. A fractal describes a rough or fragmented geometric shape that can be subdivided into parts, each of which is at least approximately a reduced-size copy of the whole. Fractal dimensions offer a systematic approach to quantifying irregular patterns that contain an internal structure repeated over a range of scales (Mandelbrot 1992). Estimations of fractal dimension are based on the box-counting technique, which allows obtaining the scaling properties of 2-D fractal objects (e.g., from binary images) by covering the images with boxes size ε and counting the number of boxes containing at least one pixel representing the object or structure under study. However, the disadvantage of the box-counting technique is that the process does not consider the amount of mass inside a box and therefore is not able to resolve regions with high or low density of mass. Biological materials are frequently complex in the distribution of their components or structures, which could be of interest to characterize and to quantify, and therefore, simple fractal dimension estimations may not be enough to appropriately characterize these materials.

By contrast, multifractal methods are suitable for characterizing a complex spatial arrangement of mass because they can resolve local densities (Vicsek 1992). Multifractal formalisms involve decomposing self-similar measures into intertwined fractal sets, which are characterized by their singularity strength and fractal dimension. Multifractal characterization does not require a single dimension, but rather a sequence of generalized fractal dimensions. Thus, a combination of all the fractal sets produces a multifractal spectrum that can characterize variability and heterogeneity of the studied variables (Kravchenko et al. 1999). The advantage of

F. Mendoza (✉), N. Valous, A. Delgado, and D.-W. Sun
FRCFT Group, Biosystems Engineering, UCD Agriculture & Food Science Centre, University College Dublin, Belfield D4, Ireland
e-mail: fmendoza@ing.puc.cl; dawen.sun@ucd.ie

J.M. Aguilera et al. (eds.), *Food Engineering Interfaces*, Food Engineering Series,
DOI 10.1007/978-1-4419-7475-4_25,