Quantification of Textural Properties of Composite Milk Gels Using Laser-Scanning Fluorescence Confocal Microscopy and Image Texture Analysis

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Current techniques of food texture analysis require destruction of the sample, ignore the spatial relationship between principal constituents, or require subjective data that depends on the skill of human subjects. A two-dimensional, non-destructive, objective measurement technique is needed to quantify the spatial relationship between the principal constituents of dairy products. The purpose of the present study was to investigate whether textural properties can be measured using laser-scanning fluorescence confocal microscopy (LSFCM) by quantifying the spatial relationship between the principal constituents of dairy products.

In this study, 2 different types of composite milk gels were created, one formed by freeze drying and the other by baking. The milk gels were stained with the fluorescent markers Nile red, which stains lipids, and fast green FCF, which stains for protein. LSFCM was used to image the stained composite milk gels. For each sample, a stack of 30 images, each 5μm apart, were captured to create a 3-dimension set of data. Maximum intensity projection (MIP) was then performed on the stack of images to create a single image where the entire field of view contains pixels that are in focus. Using the MIP image, the following parameters were calculated: 1) fat/protein ratio (FP), 2) fat and protein overlap (OL), and 3) the image texture (T). All three parameters were calculated using an algorithm written in MATLAB. FP was calculated by counting the number of pixels labeled as fat and divides that number by the number of pixels labeled as protein, OL was calculated by counting the number of pixels labeled as both fat and protein and dividing that number by the total number of pixels in the image, and T was calculated using the gray level co-occurrence matrix of the image. OL was found to be the best parameter for distinguishing between baked and freeze dried gels, with OL = 0.67 ± 0.12 for baked gels, and OL = 0.23 ± 0.09 for freeze dried gels. A high OL was found to indicate a chewy texture, while a low OL was found to indicate a more brittle texture that commonly occurs from freeze drying.