Quantitative Analysis of Sodium Butyrate Induced Differentiation of Colon Cancer Cells by FTIR Microspectroscopic and Computational Methods

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Colon cancer is the fourth most common cause of death from cancer in the world and it is commonly seen inboth men and women. It has been proposed that the pathogenesis of this cancer is related to loss of differentiation ability of colon epithelial cells. Although many molecular and biochemical studies have been performed to understand the loss of differentiation mechanisms in the formation of colon cancer cells, the global mechanisms in terms of macromolecular structural and contextual alterations in these processes has not been clearly clarified yet. The purpose of this study is to quantitatively determine sodium butyrate (NaB)-induced structural and functional alterations in the molecules of colon cancer cell viaFourier Transform Infrared (FTIR) microspectroscopy and using image analysis techniques. In the current study, NaB was used to differentiate colon cancer cells. Therefore, 3mM NaB was applied to CaCo-2 cells and these cells were then cultured for 48h. The quantitative contextual alterations in the control (non-differentiated) and NaB-treated (differentiated) cells were obtained from the spectral and quantitative image analysis of chemical maps of the studied groups. Total absorbance maps were used to segment the cells in our study where watershed segmentation method is employed to identify the cells within the images. Within each cell, we then determined the average nucleic acid, protein, lipid, and total absorbance densities. Small size cells are not included in our analysis to eliminate contributions from underdeveloped cells. Both methods indicated a decrease in protein and nucleic acid content and an increase in the triglyceride, saturated and unsaturated lipid concentrations of the differentiated CaCo-2 cells. Moreover, an increase in membrane fluidity was observed in the treated cells. Computational and spectrochemical analysis confirmed that the significant variations in the structure and function of biomolecules occur in the loss differentiation of colon epithelial cells during colon cancer cell formation.