Image Processing to Enhance the Visibility of Curcumin Conjugated Nanoparticles in Cell Nuclei

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Abstract

Here we discuss a method based on GIMP software for enhancing the visibility of the curcumin conjugated nanoparticles in an image showing glioma cells.

The Nanotechnology Image Library is a remarkable source of images that we can use for the development of image processing methods, suitable for some studies concerning medical imaging. Let us consider one of the images. It is showing nanoparticles in glioma cell (Figure 1). In particular the description given at page visuals.nci.nih.gov/details.cfm?imageid=11261 allows us to understand the role of the different colours in the image. Since water-insoluble compounds, like curcumin, can be difficult to deliver to the cells because they cannot move in a watery environment, nanoparticles are used to transport them (some references about curcumin nanoparticles are given [1-6]). The nanoparticles become carriers of water-insoluble compounds to reach the cancer cells. In the description at the page of the Library it is also told that the nanoparticles can transport the compounds across the blood-brain barrier, the protective shield around blood vessels of the brain. Image 11261 shows that the curcumin-conjugated nanoparticles, which are green colored in the image, were able to reach the nuclei (blue colored) of brain tumor cells in mice. The creator of the image is Doctor Meser M. Ali, National Cancer Institute, Henry Ford Hospital, who is studying glioma and glioma imaging [7-11].

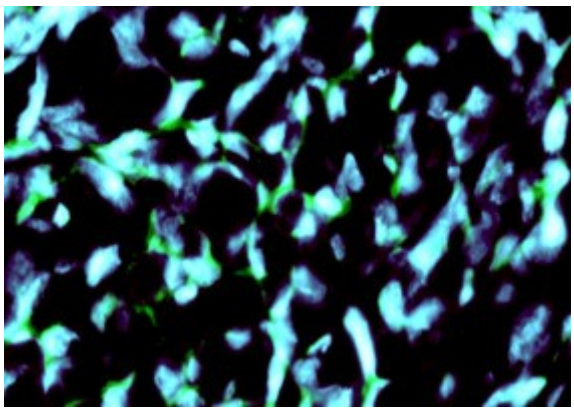

Figure 1: The image shows that curcumin-conjugated nanoparticles (green) have reached the nuclei (blue) of brain tumor cells, as given in https://visuals.nci.nih.gov/details.cfm?imageid=11261

Let us consider the image and investigate a method to enhance the visibility of the green colored

particles in the image. This can be obtained using GIMP, in the manner similar to those already proposed in [12-14]. Actually, in the given references, we used the method to enhance differences between images to study the motion of sand dunes and clouds. GIMP is the GNU Image Manipulation Program, a cross-platform image editor available for GNU/Linux, OS X, Windows and more operating systems. It is a free software. Other features of GIMP are useful too [15-19], in particular its Retinex tool. We will use the Retinex tool to evidence the curcumin nanoparticles.

First, we use GIMP and its Channel Dialog interface to manage the RGB colours. We have three channels (Red, Green, and Blue) as primary colors. If we select only the Blue channel, we see the image A in the Figure 2. If we use only the Green channel, we obtain the image B in the same Figure. Using the Desaturate Command of GIMP, we obtain images A' and B'. The Desaturate Command has three options - Lightness, Luminosity, and Average - which are illustrated by the tutorial www.gimp.org/tutorials/Digital_Black_and_White_Conversion/ . Here we used the Luminosity option.

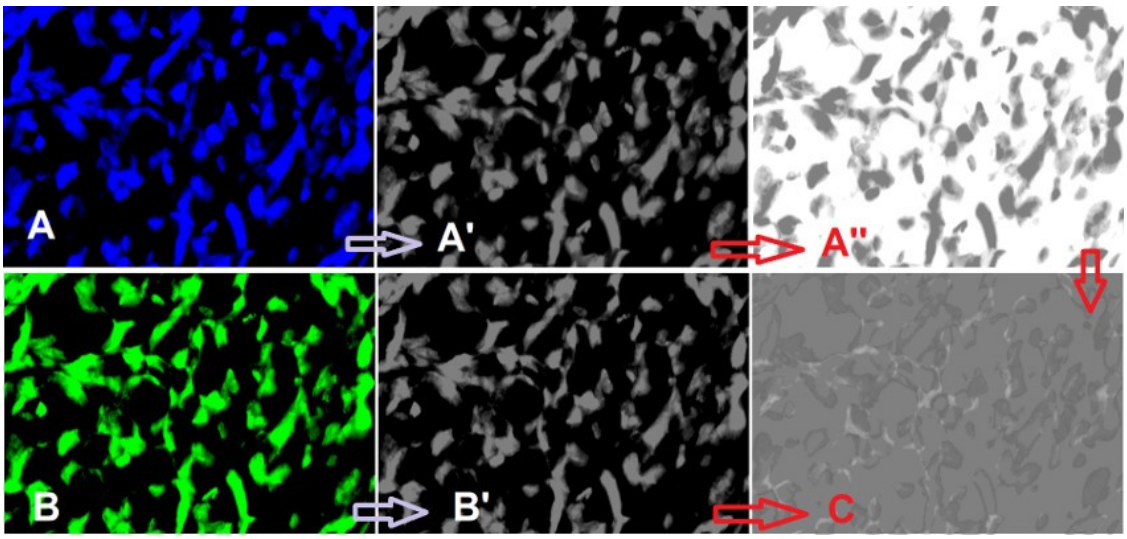

Figure 2: Using GIMP we obtain from the Figure 1 two images. A corresponds to the Blu channel, B to the Green channel. A' and B' are the corresponding grey-tone maps. A' is inverted to have A''. Using A'' and B' we have map C.

A' and B' look as the same image, but it is not so. They are giving different information. To evidence the difference, we use the approach proposed in [12-14]. A' in converted into A'', by means of the inversion of the grey tones. The layer of the image A'' is placed on image B'. Opacity of A'' is reduced of 50%. The result is given in the image C. We see bright and dark domains in the grey background. This background is composed by the pixels of the two images which are giving the same information. The bright pixels are those where green is predominant, the dark pixels where blue is prevalent. To have a better appreciation of differences, we can filter C by means of GIMP Retinex. The result is given in the right panel of the Figure 3. On the left, we see the original image.

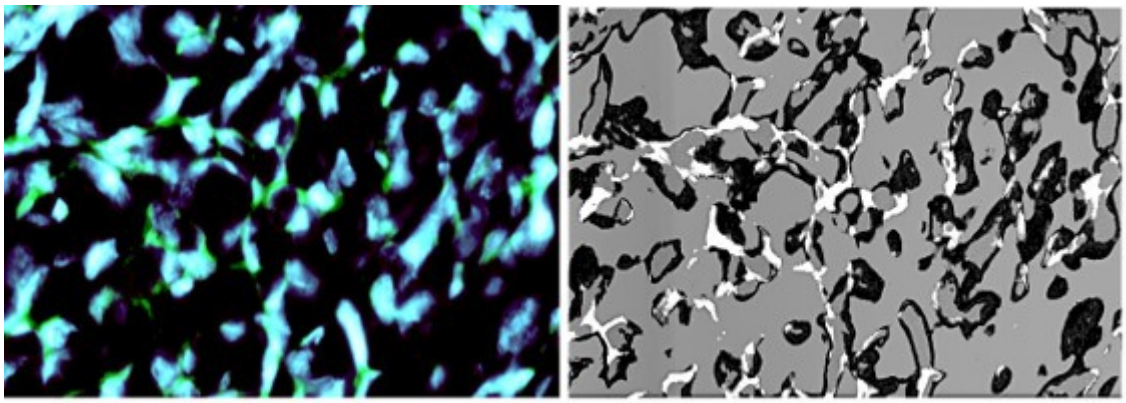

Figure 3: The original image (left) can be compared to the map which is revealing the different information coming from Blue and Green channels.

The map shows that the presence of curcumin seems larger than that we can appreciate from the original image. Further studies are necessary to test the method and for its use for quantitative measurements.

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