

# Measuring muscle color in meat

## Application note



This application note describes how to make a session recipe that quantifies color on the muscle part of a meat slice. The session is made for pork meat and may later be adapted to beef, lamb or other meat types, and even to other products. Although this example is quite generic there may be a need for other tools if the sample has different properties. The intention of this application note is to illustrate the recipe building for routine analysis using the "General statistics/Statistics" plugin. In this note we only use one image, but this procedure works with multiple images on the same time.

### Step 1: Sample presentation

Pork chops are presented on the blue background plate. Load "pork chop.hips" into the VideometerLab software to see an example. It is shown in sRGB in Figure 1, left.

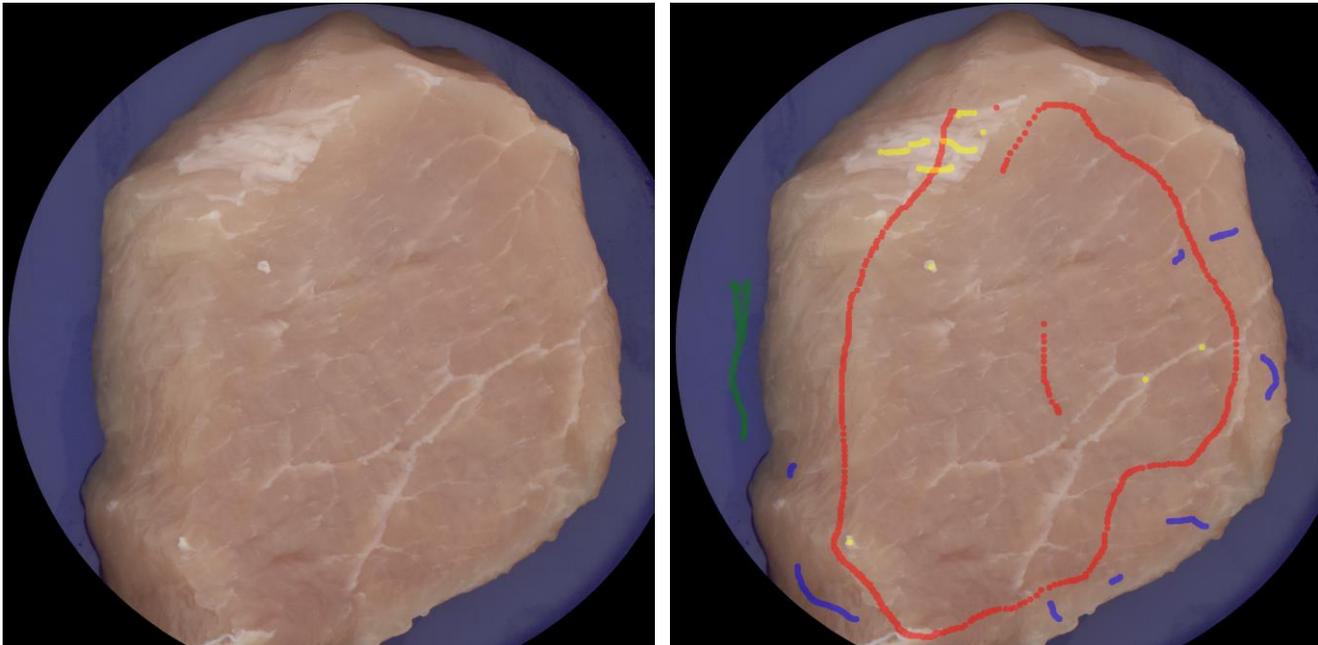


Figure 1 Left: pork chop shown in sRGB. Right: 4 layers have been painted: red layer is meat, green is the blue background plate, blue is muscle, and yellow is fat and connective tissue.

### Step 2: Segmenting the meat from the blue background and shrink the boundaries

In Figure 1 we observe that we need to remove the blue background first and in addition to this we remove the meat pixels which are closest to the blue as it seems like the meat near the cut is shaded and/or partially transparent. This is done through a segmentation. To build a segmentation we first need to create the highest contrast between the colors of the meat and blue background. To do this we paint a red layer for meat colors and a green layer for blue background as seen in Figure 1, right. Then transformation builder is applied using nCDA to separate the red layer from the green layer, Figure 2, left. Figure 2, right, shows the nCDA image. We see a generally good separation.

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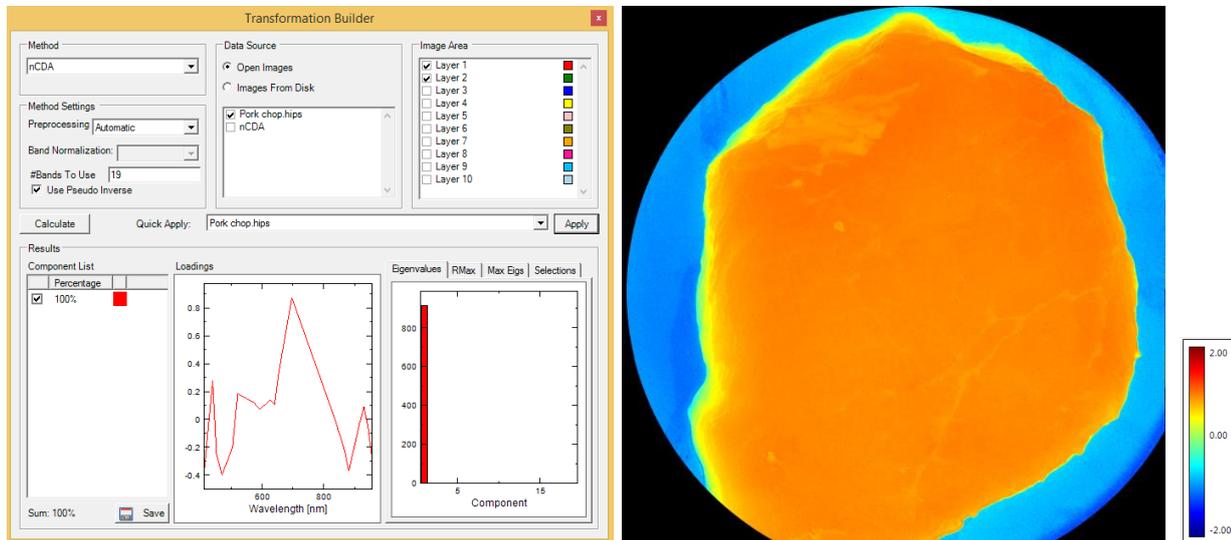


Figure 2 Using transformation builder nCDA to get the best separation between the red and green layers (left). nCDA image showing the separation of the two classes (right).

We save the nCDA transformation as "meat vs blue bg", and then open the segmentation builder. Figure 3, left, shows the segmentation builder window with settings for segmenting the pork chop. We choose the segmentation method "Simple Threshold Morphology". We choose the default Threshold 0. Foreground is "Greater" than this. We use Euclidean erode to remove pixels around the boundary of the meat (radius=9). Figure 3, right, shows the result of the segmentation. Save this segmentation under the same name as the transformation "meat vs blue bg".

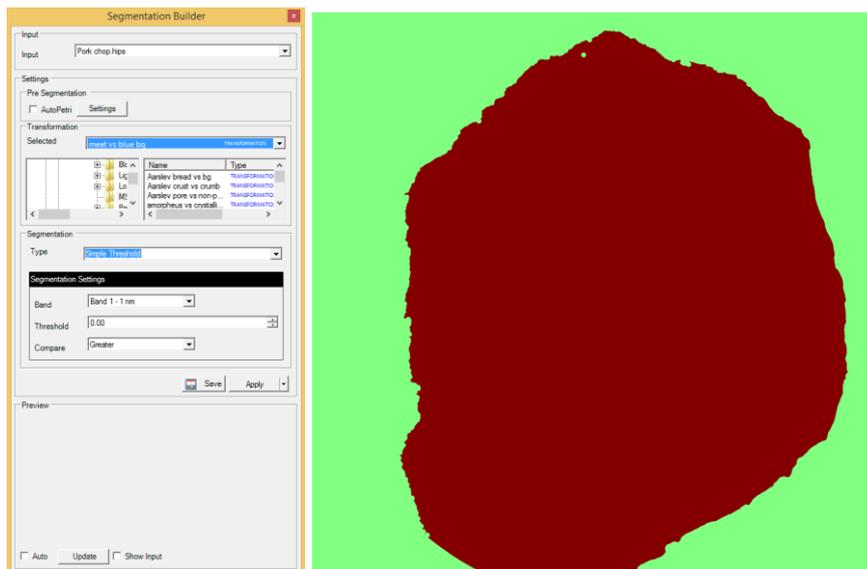


Figure 3 Left: Segmentation builder window with settings for segmenting the yellow pepper. Right: segmented pork chop.

### Step 3: Segmenting the muscle from the non-muscle

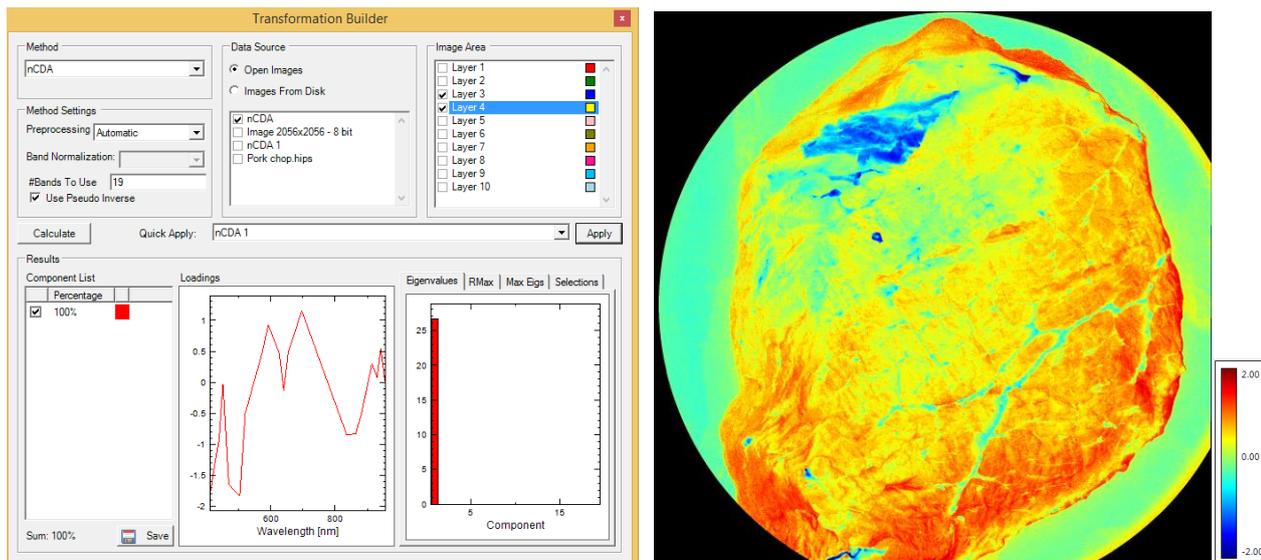
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We now make a similar segmentation between muscle and non-muscle (fat, connective tissue). In Figure 1, right, we have painted muscle with a blue layer and non-muscle with a yellow layer. The segmenting the muscle from the non-muscle is done in a very similar way to the previous step. Use the blue and yellow layers as shown in Figure 4, left. Repeat the procedure of generating a nCDA.



**Figure 4 Using nCDA to create the highest contrast between muscle (blue layer) and non-muscle (yellow layer) (left). nCDA image showing the separation of the two classes (right).**

We save the nCDA transformation as "muscle vs non-muscle", og then open the segmentation builder. Figure 5, left, shows the segmentation builder window with settings for segmenting the yellow pepper. We choose the segmentation method "Simple Threshold Morphology". Again we choose threshold 0. Foreground is "Greater" than this. We use Euclidean erode to fill any holes that may appear on the cracks. (radius=5). Figure 5, right, shows the result of the segmentation. Save this segmentation under the same name as the transformation "muscle vs non-muscle".

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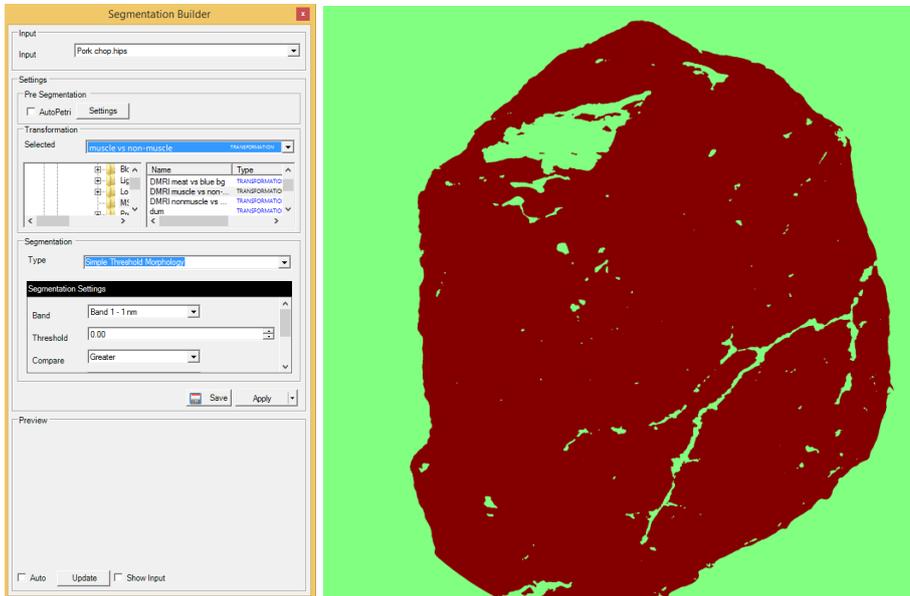


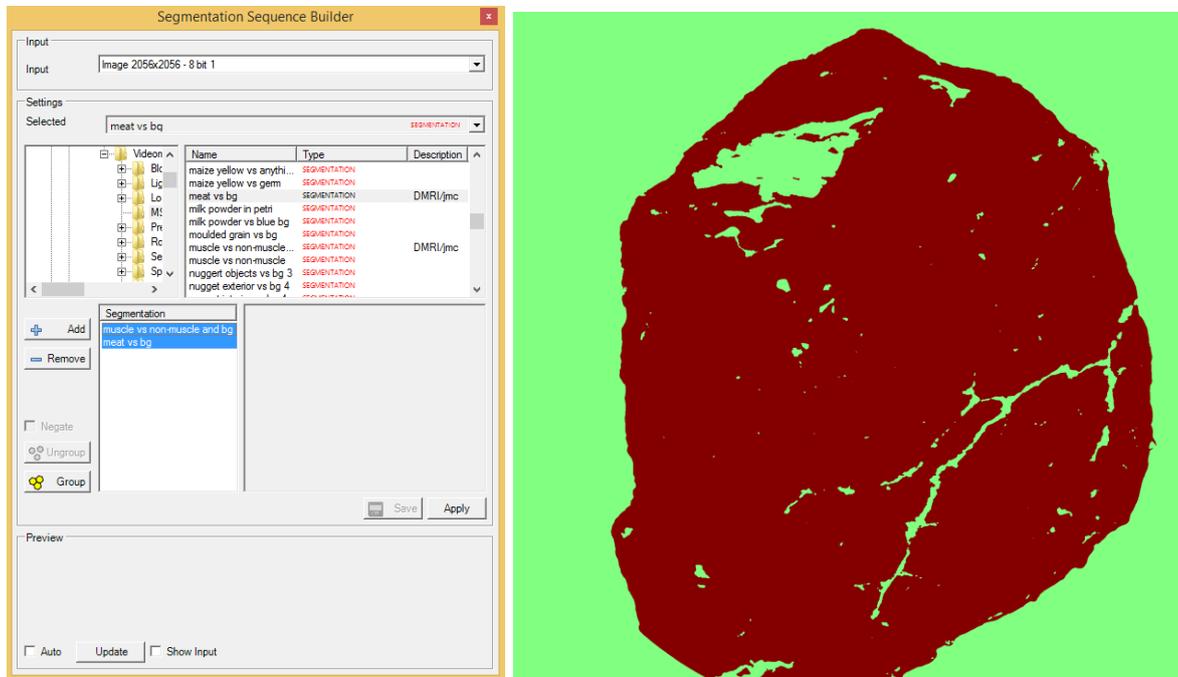
Figure 5 Segmentation builder window with settings for segmenting the muscle from non-muscle.

#### Step 4: Combine the two segmentations to segment the relevant product area

We now want to combine the segmentations from step 2 and step 3 into a segmentation that points out the relevant product of examination. This is done in "MSI->Segmentation->Segmentation Sequence Builder" by making the set intersection of the two segmentations. Figure 6, left, shows the Segmentation Sequence Builder window where two segmentations are added, and then highlighted by holding down the Ctrl key while left-clicking on them. Finally choose Group->Intersection as shown in Figure 6, left. If you click Apply then you should get the image in Figure 6, right. Save the new segmentation as "muscle vs non-muscle and blue bg". The result in Figure 6, right, looks very much like Figure 5, right, but this may not always be the case since the non-muscle and the blue background are very different.

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**Figure 6 Left: Segmentation Sequence Builder makes a combined segmentation by using the intersection of two previously defined segmentation. Right: the result on the pork chop image.**

### Step 5: Make a session recipe that determines the mean muscle color

Go to “Session->Session Manager”, choose the Processing tab, and select “General statistics” as Category and “Statistics” as Name. This is shown in Figure 7, left. Then click “Edit Settings” and you will see the window in Figure 7, right. Choose “muscle vs non-muscle and bg” as the “SegmentationFile”, and choose True for “DoCIELabTransformation”. You will now measure the mean spectrum and the mean CIELab coordinates for the muscle pixels in the image. You may choose another illuminant than the default D50.

When you are done then “OK” everything and save the recipe. Finally run it and you should get a result as shown in Figure 8. You can now save the session and use it on meat pieces in the future. There may be minor adjustments needed if the sample was not completely representative, but it should be able to provide consistent and reproducible results within the representative scope.

Besides the mean muscle spectrum and CIELab color then the standard deviation of each of these are also provided. On the left side you see the part of the meat that is actually measured. The non-muscle part and the background are black.

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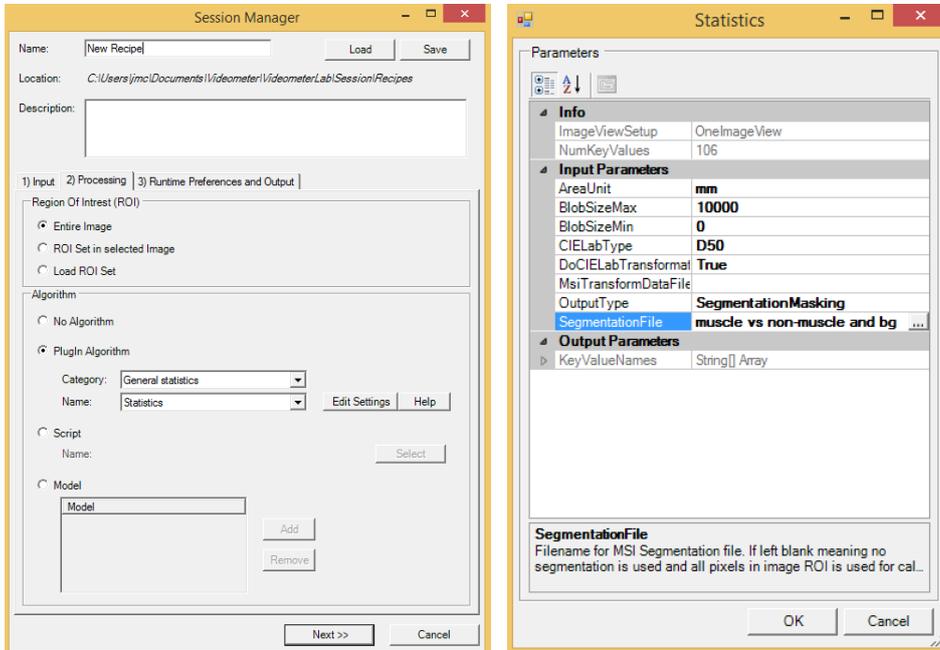


Figure 7 Processing tab in Session Manager (left). Settings for General statistics/Statistics (right).

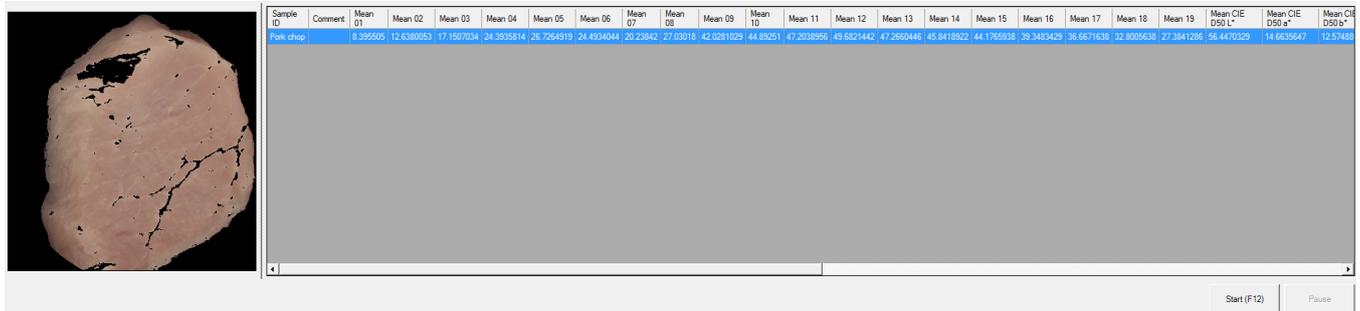


Figure 8 Result from running a session recipe.

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