# Color Image Analysis Method for Prediction of Turkey Breast Meat Transformation Yield

*P. Marty-Mahé(1), P. Loisel(1), D. Brossard(1), G. Monin(2), V. Santé(2)*
*(1) Cemagref, Unité de Recherche Technologie des Équipements Agro-alimentaires*
*Cedex, France*
*E-mail: pascale.marty-mahe@cemagref.fr, phone: (+33) 2 23 48 21 21, Fax: (+33) 2 23 48 21 15*
*(2)INRA, Station de recherche sur la viande*
*St-Genés-Champanelle, France*

## Abstract

The Trade Union of turkey in France (CIDEF) and National Institute of Agronomical Research (Research Meat station of INRA) study the turkey breast meat color to predict meat transformation yield and the consumers' acceptability of fresh fillets. They have asked to Cemagref to develop a new tool based on color numerical vision to determine the relevant objective color measurements which could give prediction of the breast transformation yield to minimize economic loss of the production of turkey ham. In this research project we devised a vision system to research and measure turkey breast meat visual features. A color vision system was developed and calibrated to grab color images and segmentation methods were applied to locate tissues of breast and to measure their color. To find efficient aspect variables, the color results were studied, in relation to breast transformation yield and other measurements included meat pH.

## 1. Introduction

The Trade Union of turkey in France (CIDEF) and National Institute of Agronomical Research (Research Meat station of INRA) study the turkey breast meat color to predict meat transformation yield and the consumers' acceptability of fresh fillets.[1] They want to know the relation between the meat color and the yield of transformation of breast in turkey ham and to find efficient color features to predict this transformation yield. They have asked to Cemagref to develop a new tool based on color numerical vision to determine the relevant objective color measurements which could give prediction of the breast transformation yield to minimize economic loss of the production of turkey ham.

A color vision system was developed and calibrated to grab color image and segmentation methods were applied to locate various tissues of the breasts and to measure their color. The results obtained on turkey breasts by the image analysis were compared to measurements of transformation yield and we can test efficiency of various aspect variables.

## 2. Material and Methods

### 2.1. Color Vision System

We devised and calibrated a color vision system to study turkey breasts sets following a specific experimental protocol. In order to get high quality images, a diffuse and uniform lighting was devised to avoid specular reflection on meat images. A tri CCD DXC 930 P SONY camera and an Magic Matrox acquisition and digitization board were used to obtain *RGB* images on 3 * 8 bits (Figure 1 and Figure 2).

### 2.2. Image Processing

A uniform grey background, on which we applied a filter to minimize the noise of the system, was used. We divided each image of breasts and image of Macbeth patches by this image to minimize the effect of the uniformity defect of lighting and of the camera with its lens. Then we normalized to obtain stable images which are comparable between various acquisitions and experimentations: we multiplied the level of the *R,G,B* componentes of the images by *R,G,B* level of a grey reference patch divided by *R,G,B* level of a grey patch included in each image. Then a color calibration treatement was apllied to compute *L*,a*b** images (Figure 3: *XYZ* images were computed and a *XYZ-L*a*b** transformation was made with help of Macbeth color patches image: a matrix was computed to transform *R,G,B* components into *X,Y,Z* components by a multi-linear regression model between *X,Y,Z* values of Macbeth color patches and their *R,G,B* components. A classical *XYZ-L*a*b** transformation was applied.

A constant threshold treatement on hue ($H = \tan^{-1}(b^*/a^*)$) component extracted the breast from the grey background. A constant threshold on the $C^* = \sqrt{a^{*2} + b^{*2}}$ component extracted the adipose tissues in the breast to obtain the image of the flesh of the breast (Figure 4).

### 2.3. Data Analysis

A set of turkey breasts were studied to obtain *L*, a*, b*, H, C** measurements of the flesh. *pHu = pHfinal* of the meat was measured. Before the cooking process, each

breast underwent injection of a brine. The breast were weighed before and after injection of the brine and also after cooking to measure the cooking yield. To find the efficient color features to predict yield of transformation, various data analysis: Matrix of correlation coefficients and linear and polynomial regression models were studied.

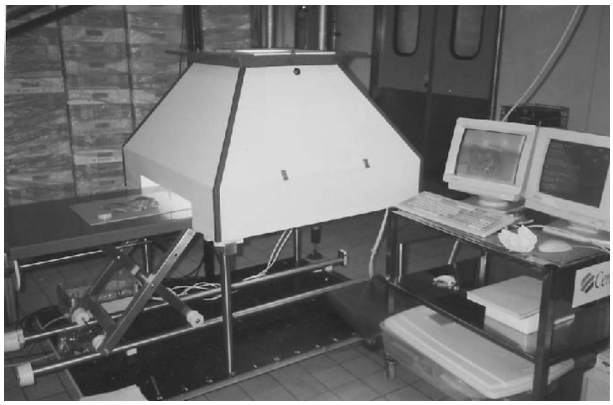

*Figure 1. Color vision system for study of turkey breasts*

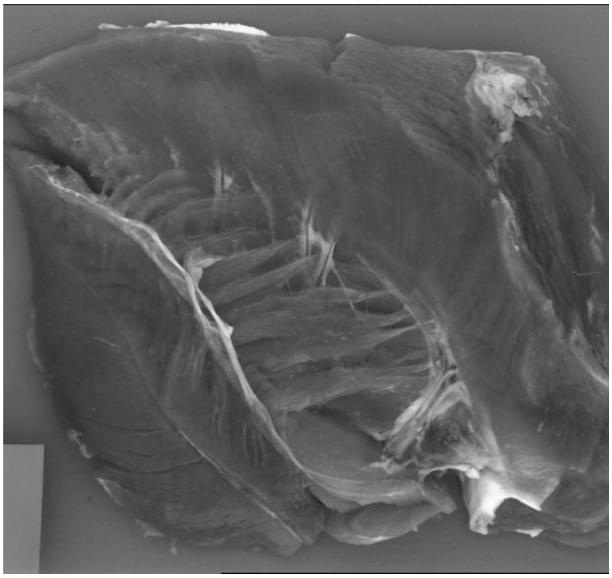

*Figure 2. Color image of a turkey breast*

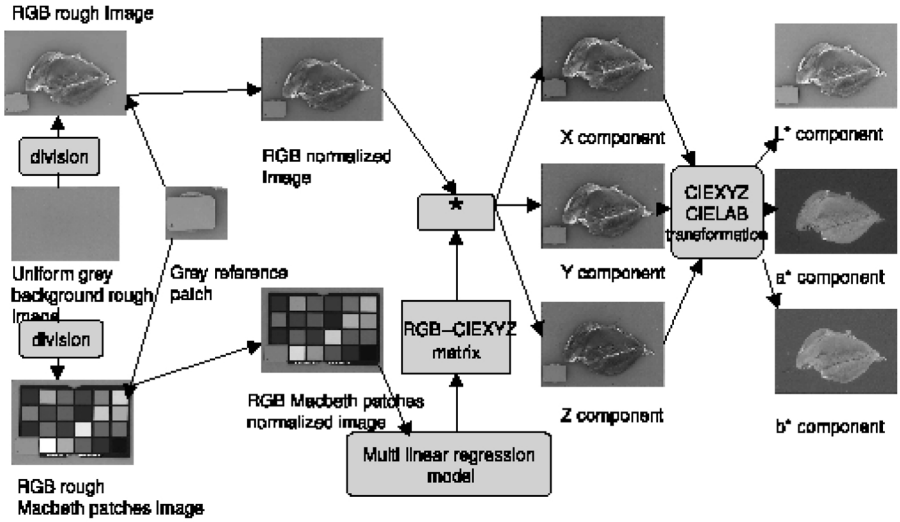


*Figure 3. Color images calibration processing*

**Table 1. Correlation Matrix of Flesh Color Image Features and Transformation Yield of Breast**

| | *pHu* | $L^*_{flesh}$ | $a^*_{flesh}$ | $b^*_{flesh}$ | $C_{flesh}$ | $H_{flesh}$ | *Yield* |
|---|---|---|---|---|---|---|---|
| *pHu* | 1 | -0.70 | -0.47 | 0.63 | 0.42 | -0.58 | 0.49 |
| $L^*_{flesh}$ | -0.70 | 1 | 0.75 | -0.89 | -0.52 | 0.89 | -0.57 |
| $a^*_{flesh}$ | -0.47 | 0.75 | 1 | -0.55 | 0.08 | 0.95 | -0.59 |
| $b^*_{flesh}$ | 0.63 | -0.89 | -0.55 | 1 | 0.79 | -0.78 | 0.56 |
| $C_{flesh}$ | 0.42 | -0.52 | 0.08 | 0.79 | 1 | -0.23 | 0.21 |
| $H_{flesh}$ | -0.58 | 0.89 | 0.95 | -0.78 | -0.23 | 1 | -0.64 |
| *Yield* | 0.49 | -0.57 | -0.59 | 0.56 | 0.21 | -0.64 | 1 |

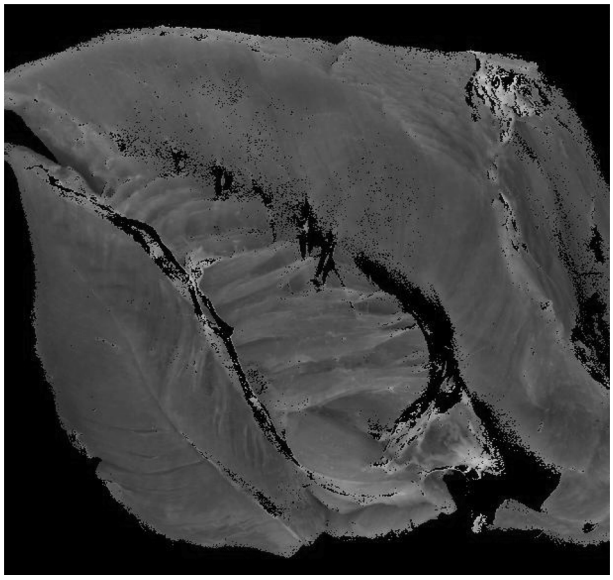

*Figure 4. Flesh image after segmentation of the background and adipose tissues*

## 3. Results

A data base of 42 breasts color images was treated. After images treatmemts to extract colour *L*, a*, b*, H, C** features, data analysis was made on images features and on yield. The correlation matrix was computed on *L*, a*, b*, H, C** measurements, on *pHu* of the meat and on *yield* (Table 1). *H* gave better correlation with the yield (correlation cooefficient = -0.64) than *pHu* usually used to predict meat yield of transform. We studied linear regression models (Tables 2 and 4) and polynomial regression models (Tables 3 and 5) to predict yield of turkey breasts with various color image analysis features. *H* gave also the best linear and polynomial regressions ($R^2$ = 41.51, $R^2$ = 45.16). The regression models were improve by the other color features ($R^2ajusted$ = 44.76, $R^2ajusted$ = 51.94) and with the *pHu* ($R^2ajustsed$ = 45.42).

The relation betwen *H* and the yield of breast needs to be confirmed by others measurements, so new trials will be maded in the next months. We will take care to take new samples with low *yield* because in this trial the number of samples with low *yield* is too small in comparison with the other samples.

## 4. Conclusion

Color images treatments and measurements give, for the Cidef and INRA, interesting results on the prediction of transformation yield of turkey breasts. Color image analysis gives interesting results on the tissues segmentation and on meat color measurement. This study shows that a vision system can give interesting features to sort breasts for their transformation in turkey ham, although, this system vision and color images analysis will be tested on other industrial sets to confirm relation between color features and the transform yield of turkey breasts.

**Table 2. Results of Linear Regression Models of Flesh Color Image Features and Transformation Yield of Breast**

| | | | | | | |
|---|---|---|---|---|---|---|
| $a^*_{flesh}$ | x | | | | | |
| $b^*_{flesh}$ | | x | | | | |
| $C_{flesh}$ | | | | | x | |
| $H_{flesh}$ | | | | x | | |
| $L^*_{flesh}$ | | | x | | | |
| *pHu* | | | | | | x |
| $R^2$ | 30.96 | 34.84 | 32.3 | 41.51 | 4.5 | 24.05 |

**Table 3. Results of Polynomial Regression Models of Flesh Color Image Features and Transformation Yield of Breast**

| | | | | | |
|---|---|---|---|---|---|
| $a^*_{flesh}$ | x | | | | |
| $b^*_{flesh}$ | | x | | | |
| $C_{flesh}$ | | | | | x |
| $H_{flesh}$ | | | | x | |
| $L^*_{flesh}$ | | | x | | |
| $R^2$ | 34.8 | 39.54 | 40.56 | 45.16 | 8.43 |
| $R^2ajusted$ | 31.54 | 36.44 | 37.52 | 42.35 | 3.74 |

**Table 4. Results of Multi Regression Models of Flesh Color Image Features and Transformation Yield of Breast**

| | | | | |
|---|---|---|---|---|
| $a^*_{flesh}$ | x | x | x | |
| $b^*_{flesh}$ | x | x | x | |
| $C_{flesh}$ | x | | | x |
| $H_{flesh}$ | x | | | x |
| $L^*_{flesh}$ | x | | x | x |
| $R^2$ | 51.59 | 42.54 | 43.41 | 42.44 |
| $R^2ajusted$ | 44.86 | 39.59 | 38.94 | 37.9 |

**Table 5. Results of Multi-Polynomial Regression Models of Flesh Color Image Features and Transformation Yield of Breast**

| | | |
|---|---|---|
| $a^*_{flesh}$ | x | x |
| $b^*_{flesh}$ | x | x |
| $C_{flesh}$ | | x |
| $H_{flesh}$ | x | x |
| $L^*_{flesh}$ | x | x |
| $R^2$ | 49.15 | 62.49 |
| $R^2ajusted$ | 42.09 | 51.94 |

## References

1. V. Sante, A. Lebert, G. Le Pottier, and A. Ouali. Comparaison between two statistical models for prediction of turkey breast meat colour. *Meat Science*, 43:283–290, 1996.