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# Apply image processing to measure the moisture content of rice kernel

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**Abstract**

The moisture content of rice is importance before storage, because the water content has directed affect to rice damage (when store in high moisture content) and the piece is decease. The sample of this study was used Thai Hom Mali 105 long grain rough rice, were condition moisture content six levels 11-21 MC% (wet basis). For measurement the moisture content of rice, which is direct and indirect method, the standard method is hot air oven but time consuming. In this study aims to apply the image processing to determine the moisture content of rice kernel, the image processing is nondestructive and fast methods for measuring. The color extracting of rice kernel by RGB, HSV and L*a*b* color, then calculate color, classify with correlation between color and MC%. The result shows that L* and G color were high correlation with $R^2 = 0.95$, and 0.94, that mean the image processing method can apply to measure the moisture content of rice kernel.

**Keywords:** Rice kernel, Image processing, Moisture content, Rough rice

## 1. Introduction

Rice (Oryza Sativa L.) is among the oldest of cultivated crops and ranks as the most widely grown food grain crop, serving as the staple food for about half of the world's population [1].

Moisture content of rough rice is the most important in drying process, handling and storage. Tests on storage of high moisture content of rice [2] provide data from which safe storage time can be predicted; at the high moisture content can be kept in short time. Moisture content can be measured by direct methods and indirect methods [3]. In terms of indirect method, electrical properties of grain included capacitance and conductance, were measured by electrical instruments [4-5]. While with direct method, air-oven process still is the standard method for its consistence and accuracy [3]. Romano[6] has studies for combination of digital image and laser light to predict moisture content and color of bell pepper simultaneously during drying and [1] using multispectral imaging and chemometric methods to determination of transgenic Bacillus thuringiensis rice seeds (Oryza sativa L.).

In this study aims to apply the image processing to determine the moisture content of rice kernel, the image processing is nondestructive and fast methods for measuring.

## 2. Materials and methods

The methodology of this study involves several tasks such as data acquisition, image processing and image analysis illustrate in Figure 1.

### *2.1 Samples preparation*

The species of rice was used Hom Mali 105 Thai long grain grown in Northern Thailand. The initial moisture content of rough rice was 25.3±0.53% measuring by oven method (ECOCELL-55 (220v) 33kw) with hot air at 105 °C for 72 h [3]. Rough rice samples randomly collected from field were clean by fan sorted with a blower, after that conditioned for difference moisture content six levels (11.3, 13.2, 15.6, 17.8,19.2 and 21.1 MC%) and sealed in a plastic bag. The sealed samples were put in a cooler at 2 °C for 4 weeks. Before capture image the sample, the sample was put in the room temperature (23±2°C) with 24 h ahead. The moisture content of each sample was separated into two portions, first was used to reconfirm the moisture content value by standard method (15 g for MC level below 25% and 100 g for MC level over 25%) [3, 7] and second portions the samples were used for capture image about 600 kernels (100 kernel x 6 groups) for rough rice and 600 kernels for brown rice, after they were pre-processed into single kernel rough rice and single kernel brown rice with size of image 160x120 pixel (width="160" height="120") illustrate in Figure 2.

### *2.2 Box chamber*

The box chamber was applies from electrics control box with size wind *x* long *x* tall (16.5x29.5x35 cm.) webcam and a block smooth fur-like drapery was used as a background and the illumination was move controllable. After finish making a box chamber, then integrate with the laptop (computer hardware software) to build low-cost computer vision system (Figure 3), that it has own monitored, so that it

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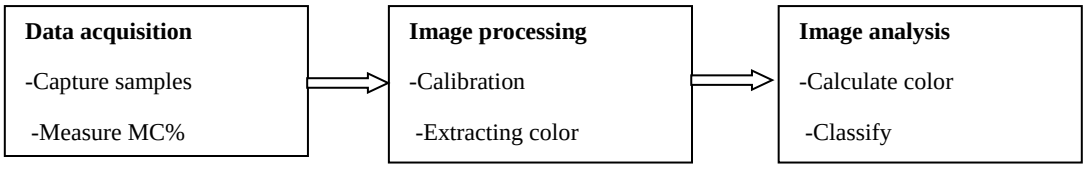


**Figure 1** Flowchart of this study

(a) (b)

**Figure 2** Image of the samples (a) rough rice and (b) brown rice


**Figure 3** Digital image processing box chamber of this study

will save more space and money. For capture the samples of rough rice and brown rice, the image of rough rice and brown rice were capture at the center orientation from perpendicular views using webcam camera (Genius is brand of webcam, the specification are 720p HD resolution (1280x720 pixel) with recommended system, lens type: manual focus, interface USB 2.0). Images were taking with LED desk (light in box chamber about 800 lumens and in the sample 30 lumens determine by lux meter) and the light source has been calibrating before. LED have a lot of advantages over traditional lightning, such as long lifetime, low power consumption, low heat generation, small size, fast response and insensitivity to vibration. The webcam was set up in a fixed position for get an appropriate and best image.

*2.3 Image processing*

For camera calibration significantly helps to overcome the fundamental correspondence problem, which arises as a result of the necessity to match, and classify potential objects within and across cameras and the following parameters are critical when selecting a suitable camera: solution, minimum illumination required [8]. Then it is using extracting color with RGB, HSV and L*a*b* after that invert them and calculate average, R-squared of each color. The inverse transformation is easily obtained by inverting the matrix. The matrices given are not fixed; other matrices can be defined according to the definition of the color white. To discuss color independent of brightness, the tristimulus values can be normalized by dividing by X + Y + Z: and so x + y + z =1[9].

## 3. Results

*3.1 Extracting color*

In Figure 4 illustrate value of color RGB, SHV, L*a*b* Found that color R, G, and B was difference that mean, B and V had similar with G and S. However, L* color could identify the moisture content level show in Table 1.

Result of color value of rough rice show in Table 1, the color R was different R-squared at $R^2$=0.74 and B color with $R^2$=0.60 respectively. However, image processing method color applies to measure rough rice single kernel but it was very difficult because the color has quiet similar to each the moisture content.

In Table 2 shows the result of brown rice single kernel color value, the color L* was higher R-squared about $R^2$=0.95 (show in Figure 5) and G color with 0.94 so that, image processing could determine moisture content of brown rice single kernel.

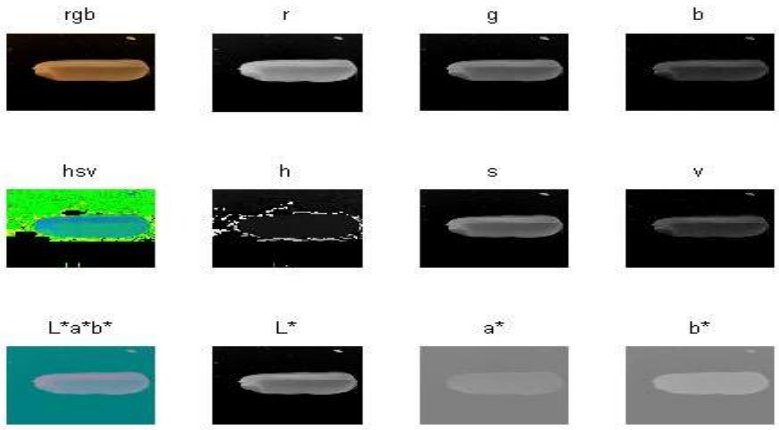


**Figure 4** Brown rice of difference color (RGB, HSV and L*a*b*)

*3.2 Calculate color*

**Table 1** Rough rice mean

| | R | G | B | H | S | V | L* | a* | b* |
|---|---|---|---|---|---|---|---|---|---|
| 11.3% | 27.91 | 11.85 | 3.23 | 0.071 | 11.85 | 3.23 | 16.99 | 134.31 | 135.81 |
| 13.2% | 27.45 | 12.22 | 3.53 | 0.072 | 12.22 | 3.53 | 17.07 | 133.97 | 135.69 |
| 15.6% | 28.40 | 12.33 | 3.54 | 0.070 | 12.33 | 3.54 | 17.48 | 134.30 | 135.90 |
| 17.8% | 28.65 | 12.12 | 2.76 | 0.071 | 12.12 | 2.76 | 17.46 | 134.37 | 136.15 |
| 19.2% | 28.47 | 12.48 | 3.03 | 0.071 | 12.48 | 3.03 | 17.67 | 134.16 | 136.15 |
| 21.1% | 29.33 | 10.26 | 2.07 | 0.394 | 10.26 | 2.07 | 16.62 | 134.47 | 135.07 |

**Table 2** Brown rice mean

| | R | G | B | H | S | V | L* | a* | b* |
|---|---|---|---|---|---|---|---|---|---|
| 11.3% | 25.32 | 13.00 | 4.60 | 0.076 | 13.01 | 4.77 | 16.73 | 132.42 | 134.53 |
| 13.2% | 24.63 | 13.22 | 5.23 | 0.079 | 13.23 | 5.21 | 16.70 | 132.07 | 134.28 |
| 15.6% | 26.76 | 14.42 | 5.69 | 0.078 | 14.44 | 5.68 | 18.17 | 132.35 | 134.78 |
| 17.8% | 26.65 | 16.78 | 8.44 | 0.075 | 16.70 | 8.43 | 19.58 | 131.15 | 133.99 |
| 19.2% | 26.45 | 16.35 | 7.85 | 0.078 | 16.45 | 7.81 | 19.41 | 131.32 | 134.27 |
| 21.1% | 27.58 | 18.13 | 9.55 | 0.096 | 18.16 | 9.50 | 20.91 | 130.97 | 134.14 |

*3.3 Classify of the moisture content with correlation color*

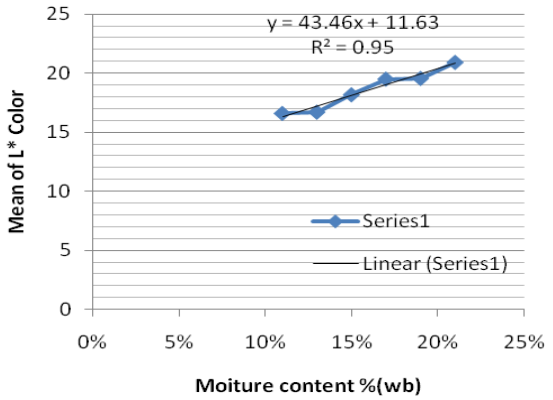


**Figure 5** Correlations between %MC and color of brown rice L* color

## 4. Discussion

Shei and Lin [10] have studied of an optical automatic measurement method for the moisture content of rough rice using image processing techniques , the image processing could be applies to measure automatic of drying process. In this study for the rough rice single kernel was quite difference because, the level of moisture content close to each group. However, for brown rice sample was higher R-squared, because brown rice has the cell and color was difference.

## 5. Conclusions

Image processing applies to measure rice kernel. Rough rice and brown rice were used for the samples. The result show that, color L* was higher R-squared about $R^2$=0.95 that mean the image processing techniques could be used to measure the moisture content of brown rice.

## 6. Acknowledgements

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## 7. References

[1] Changhong L, Wei L, Xuzhong L, Wei C, Jianbo Y, Lei Z. Nondestructive determination of transgenic Bacillus thuringiensis rice seed (Oryza sativa L.) using multispectral imaging and chemometric methods. Food Chemistry 2014;153:87-93.

[2] Calderwood DL. Use of aeration to aid rice drying. Transaction of ASAE 1966;9(6):893-895.

[3] Chen C. Evaluation of air oven moisture content determination methods for rough rice. Biosystems Engineering 2003;86(4):447-457.
[4] Henry ZA, Zoerb GC, Birth GS. Instrumentation and Measurement for Environmental Sciences. 3rd ed. Michigan: St. Joseph American Society of Agricultural Engineers; 1991.
[5] Chen C. Uncertainty evaluation of conductance moisture meters for rough grain. Biosystems Engineering 2008;99(4):508-514.
[6] Romano G, Argyropoulos D, NagleM, Khan MT, Muller J. Combination of digital images and laser light to predict moisture content and color of bell pepper simultaneously during drying. Journal of food engineering 2012;109:438-448
[7] ASABE. Standard ASABE S352.2: Moisture Measurement-Unground Grain and Seeds. St joseph, MI, USA: American Society of Agricultural and Biological Engineers; 2008.
[8] Plugfelder R, Micusik B. Chapter 9 Self-Calibretiong Cameras in Video Surveillance. In: Ahmed Nabil Belbachir, editor. Smart Cameras. New York: Springer; 2010. p. 161-180.
[9] McAndrew A, Wang JH, Tsang CS. Introduction To Digital Image Processing With MATLAB, Asia ed. Taiwan: Cengage Learning Asia Pte ltd; 2010.
[10] Hung-Jung S, Chern-sheng L. An optical automatic measurement method for the moisture content of rough rice using image processing techniques. Computers and Electronics in Agriculture 2012;85:134-139.