A PORTABLE MATCHA IDENTIFICATION DEVICE BASED ON COLOR

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²- similar to 1.

ABSTRACT – Researched and developed a portable device to identify matcha based on color. Matcha is abundant in nutrition, while green tea powder usually exists as an alternative. Color and chlorophyll contents of matcha and green tea powder were measured and their photos in two forms were taken. Then, RGB values of matcha and green tea powder were acquired and based on it, color cards, colorimetric cards and portable matcha identification device were designed. Compared to green tea powder, matcha contained more chlorophyll and lower ratio of chlorophyll a and b thanks to the covering step during its growth period and using steam for enzyme-deactivation. Thus, matcha looked more green than green tea powder. It’s feasible to employ color for matcha identification.

KEYWORDS: matcha; green tea powder; identification; portable device; color.

1. INTRODUCTION

Matcha, called powdered tea in the ancient, was originated in China and spread to Japan in the Southern Song Dynasty (1127-1279, AD) by monks. From Ming Dynasty (1368-1644, AD), powdered tea began to disappear in China because of the rise of bulk tea; while in Japan, after the long-time improvement and innovation, powdered tea gradually became matcha we know today and has been widely applied in a lot of areas such as food processing.

The predecessor of matcha defined by Anhui Agricultural College (2008) is plate-like and dark green grinding tea picked from covered tea gardens and enzyme-deactivated by steam and then roasted. After that, grinding tea is milling into jade powder (matcha) by chausu according to ZHANG (1995). However, green tea powder is powdered from steaming, pan-fired or roasted green tea directly. In contrast with green tea powder, matcha is various in tea cultivars, cultivation management, growth time and processing technology along with contents of proteins, amino acids, trace elements and other nutrients, which make matcha much more expensive than green tea powder.

China has not established national standards about matcha and its levels, thus, it gives some sellers opportunities to sell green tea powder as matcha which is not conducive to the healthy development of matcha’s market, but also harmful to the interests of customers. Color is one of the most important quality parameters when customers consider buying fresh products like fruits, vegetables and meat. Matcha and green tea powder are not an exception. Due to its unique cultivation management, covering before picking along with the measure for enzyme-deactivated, matcha looks more green than green tea powder in our eyes. Though there is no research aims at differentiating matcha and green tea powder by color, Tapp III et al. (2011) used colorimeters such as Minolta Chroma meter and Hunter Lab MiniScan colorimeter to evaluate the color of meat. Pork quality standards card produced by NPPC
U.S.A) is also applied to evaluate the quality of meat for consumers and researchers rapidly. These make it possible to research and develop portable matcha identification device based on color.

This research aims at acquiring the color of matcha and green tea powder in the form of pile and smeared by the colorimeter and analyzing the reasons for their color difference. Meanwhile, getting RGB values of matcha and green tea powder respectively to design and make color cards and portable matcha identification device.

2. MATERIALS AND METHODS

2.1 Materials

In this research, matcha was manufactured by two companies, Hangzhou Jiasheng tea limited company (matcha1) and Hangzhou Yuchacun tea limited company (matcha2). Green tea powder was enzyme-deactivated by two methods, pan-fired (green tea powder1) and steaming (green tea powder2), bought in Hangzhou Jiasheng tea limited company and Hangzhou Efuton tea limited company.

2.2 Color Measurement

A spectrophotometer (CM-600d, Konica Minolta, Inc. Japan) with the illumination of di: 8°, de: 8° (diffused illumination, 8° viewing angle) and the viewing system of SCI (specular component include) was applied to measure the L* (lightness), a* (redness), and b* (yellowness) values in CIELAB color space of samples. As León et al. (2006) reported, L’a*b’ color space is the most used color space in the measuring of color in food due to its uniform distribution of colors is very close to human perception of color. In this research, ΔE’ab was employed as the index to detect the relative perception difference between two colors according to Li et al. (2015). The computational formula of ΔE’ab is shown as equation (1).

\[
\Delta E^{*ab} = \sqrt{\Delta L^{*2} + \Delta a^{*2} + \Delta b^{*2}}
\]  

Paired sample t test of matcha and green tea powder’s ΔL*, Δa*, Δb* and ΔE’ab values in different forms along with independent sample t test of ΔL*, Δa*, Δb* and ΔE’ab values in matcha and green tea powder was conducted in SAS University Edition (SAS Institute Inc. U.S.A.) respectively.

2.3 Chlorophyll Contents Measurement

An optimization of the mixture extraction method for chlorophyll from tea proposed by ZHAO et al. (2011) was used to collect chlorophyll of matcha and green tea powder. The mixture extraction method is the improvement of the acetone grinding method, and the solvent match, extraction temperature, extraction time along with solvent dosage are variables need to be adjusted. In this research, conditions of the mixture extraction method were: 0.2g sample, room temperature, no light, 30mL miscible liquids with the ratio of 3: 6: 1 (acetone: ethanol: water) and extraction time of 1 h. The computational formula of chlorophyll a, chlorophyll b and total chlorophyll are shown from equation (2) to equation (4) derived by Arnon (1949).

\[
\text{chlorophyll a (mg/g)} = (12.7D_{663} - 2.69D_{645}) \times \frac{V}{W \times 1000}
\]  

\[
\text{chlorophyll b (mg/g)} = (12.7D_{663} - 2.69D_{645}) \times \frac{V}{W \times 1000}
\]  

\[
\text{total chlorophyll (mg/g)} = \text{chlorophyll a (mg/g)} + \text{chlorophyll b (mg/g)}
\]
chlorophyll b \( (mg/g) = (22.9D_{645} - 4.68D_{663}) \times \frac{V}{W \times 1000} \) 

(3)

total chlorophyll \( (mg/g) = (20.2D_{645} + 8.02D_{663}) \times \frac{V}{W \times 1000} \) 

(4)

From equation (2) to equation (4), \( D_{645} \) and \( D_{663} \) were measured on the absorption of light in a 10mm cell by an ultraviolet-visible spectrophotometer (752, Shanghai spectrum instrument Co., Ltd.) at 645 and 663nm. \( V \) was the dosage of solvent used in this research (mL) and \( W \) was the weight of the sample measured by an electronic balance (BSA224S, Sartorius scientific instruments (Beijing) Co., Ltd.). All reagents used were AR and brought from Sinopharm Chemical Reagent Co., Ltd., China.

Independent sample t test of chlorophyll a, chlorophyll b and total chlorophyll contents in matcha and green tea powder was conducted in SAS University Edition (SAS Institute Inc. U.S.A.).

2.4 RGB Values Measurement and Device Design

The photo of matcha and green tea powder in the form of pile and smeared was taken by a smart phone (P9, Huawei Technologies Co., Ltd, China) with dual lens of Leica SUMMARIT series in the natural light. RGB values of matcha and green tea powder were acquired by the color picker in Microsoft Office.

Blueprints of color cards and portable matcha identification device were made by PowerPoint 2016. One portable matcha identification device was made in order to illustrate.

3. RESULTS AND DISCUSSION

3.1 Detection of Color

As shown in Figure 1 and Figure 2, it was clear that though \( \Delta L^* \), \( \Delta a^* \), \( \Delta b^* \) and \( \Delta E^{*ab} \) values of matcha and green tea powder in different forms were diverse and paired sample t test showed significant difference (\( \alpha=0.05 \)), their trends were consistent. Matcha had higher values of \( \Delta L^* \) and \( \Delta a^* \) in negative as well as higher \( \Delta E^{*ab} \) values (significant both in pile and smeared, \( \alpha=0.05 \)), however, \( \Delta b^* \) values of matcha and green tea powder were similar. Higher values of \( \Delta L^* \) and \( \Delta a^* \) in negative indicated that matcha was more black and more green than green tea powder. According to Sun et al. (1996), a \( \Delta E^{*ab} \) value above 1.5 between matcha and green tea powder represented naked eyes could distinguish their color difference and all differences between matcha and green tea powder’s \( \Delta E^{*ab} \) values were above 1.5.

Figure 1 – Color differences of matcha and green tea powder in the form of pile

Type

<table>
<thead>
<tr>
<th>Type</th>
<th>matcha1</th>
<th>matcha2</th>
<th>green tea powder1</th>
<th>green tea powder2</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \Delta L^* )</td>
<td>H</td>
<td>H</td>
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<td>( \Delta a^* )</td>
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<tr>
<td>( \Delta b^* )</td>
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<td>H</td>
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<tr>
<td>( \Delta E^{*ab} )</td>
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</tbody>
</table>
3.2 Determination of Chlorophyll Contents

Results of color detection showed that matcha was more green than green tea powder. Contents of chlorophyll a, chlorophyll b and total chlorophyll in matcha and green tea powder, as shown in Figure 3, verified this point.

Matcha had higher contents of total chlorophyll than green tea powder (significant, \( \alpha=0.05 \)), while the ratio of chlorophyll a and chlorophyll b in matcha was lower than in green tea powder with the values of 1.51 and 2.70.

As WAN (2011) reported, after covering, the ratio of chlorophyll contents in tea leaves rises and at the same time, contents of chlorophyll b will increase and contents of chlorophyll a will decrease under shade condition according to JIANG (2011).

One of the characteristics of matcha was the covering step before its picking and covering step usually lasts 30 days. This made matcha accumulate a higher level of chlorophyll contents besides a lower ratio of chlorophyll a and chlorophyll b. Therefore, matcha had a dark green color when compared with green tea powder.

The work of NI (1996) has shown that more chlorophyll reserved in famous green tea when the method for enzyme-deactivating is steaming instead of pan-fired which means matcha and steaming green tea will have more chlorophyll than pan-fired green tea. This was the reason why green tea...
powder2 enzyme-deactivated by steaming had a higher value of chlorophyll contents than green tea powder1 enzyme-deactivated by pan-fired.

3.3 Color Cards and Portable Identification Device

Paired sample t test showed $\Delta L^*$, $\Delta a^*$, $\Delta b^*$ and $\Delta E^*$ values of matcha and green tea powder in different forms had significant difference ($\alpha=0.05$), thus, color cards of matcha and green tea powder were designed as gradients, as shown in Figure 4. On the basis of color cards, blueprints of matcha colorimetric cards and portable matcha identification device were designed as shown in Figure 5 and Figure 6. For the convenience of productions (printing and then folding), some characters are inverted. Paper with a certain thickness and hardness was selected to make samples.

Figure 4 – Color cards versus photos of matcha and green tea powder

![Color cards versus photos of matcha and green tea powder](image)

Figure 5 – Blueprints of matcha colorimetric cards (a) outward appearance (b) inner face

![Blueprints of matcha colorimetric cards](image)

Figure 6 – Blueprints of portable matcha identification device (a) outward appearance (b) inner face

![Blueprints of portable matcha identification device](image)
In Figure 6, dotted lines mean turning to inner face when folding. After printing and then folding, a portable matcha identification device with the appearance of a box was produced. Follow the introduction, it was rapid and accurate to identify matcha and green tea powder by this device.

Quality parameters such as smell and contents of tea polyphenols, amino acids and caffeine along with specific elements could also be applied to identify matcha and green tea powder. Corresponding portable devices deserve further research.

4. CONCLUSIONS

Color was one of the quality parameters that could be applied to identify matcha and green tea powder. Owing to its covering step before picking and using steam for enzyme-deactivation, matcha had a higher level of chlorophyll contents in addition to a lower ratio of chlorophyll a and chlorophyll b, which made matcha have a higher values of ΔL* and Δa* in negative and thus, looked dark green.

Color cards of matcha and green tea powder, blueprints of matcha colorimetric cards and portable matcha identification device were designed. Follow the introduction, identifying matcha and green tea powder would be portable, rapid and accurate by employing these devices.

5. REFERENCES