Hot Peppers: XI. Developing Colour Standards for Caribbean Hot Peppers (Capsicum chinensis L.)

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Abstract

The Caribbean is a producer of some of the world’s most pungent red hot peppers (Capsicum chinensis L.), but its physico-chemical quality parameters such as color stability and pungency of its peppers are not uniform. A Caribbean hot pepper visual Color Standard and the Natural Pungency of the fresh and processed products has been developed, based on the standards set by ASTA for red color pigmentation and pungency. The Caribbean has two very hot peppers with very high capsaicinoids content viz: Trinidad scorpion (2,180,000 SHU) and Carvalho (780,000 SHU), which also exhibit equally “high heat” based on the Scoville test (1,125,000,000 and 16,000,000 SHU, respectively). The ASTA value for the processed pepper (37,600,000 SHU) and the fresh mature hot (366 ASTA units) were also computed. The study found Carvalho hot peppers can be used for industrial processing as mash, flakes, or powder without loss of color or pungency compared to all the other tested cultivars.

Key words: capsicins, pungency, colour, capsaicinoids, thermal stability.

Introduction

The Caribbean produces one of the world’s most vibrant red and yellow hot peppers (Capsicum chinensis L.) in terms fruit quality, pungency and color (Bridgemohan et al. 2010). They are rich in capsanthin, zeaxanthin, lutein, and cryptocapsin, and are valued for their color and pungency. Red hot peppers are traded as whole chilies, powder or flakes based on color expressed in ASTA color value (Anon 2012). However, there are no available standard for Caribbean fresh hot peppers or systems to monitor the changes or loss of pigments. Kim and Chun (1975) noted that the most pronounced changes occur after 5 days with minimal loss of quality, or extended to 14 days under normal temperature conditions (Bridgemohan et al. 2017; Mohamed et al. 2016). Red hot peppers are traded in whole chilies, powder or flakes based on color expressed in ASTA color value (Anon 2012). Howev..

Paprika Color Index: 2007; 2017) and EU food grade colors were: Carvalho hot (Red); Chili & Scotch bonnet (Green); Scotch bonnet Scotch bonnet scheme and to set the standards for the quantification of colors for all other pepper fruits. The distinct colors and cultivar available standard for Caribbean fresh hot peppers or systems to monitor the changes or loss of pigments. Kim and Chun (1975) and color (Bridgemohan et al. 2016). They are rich in capsanthin, zeaxanthin, lutein, and cryptocapsin, and as mash, flakes, or powder without loss of color or pungency compared to all the other tested cultivars.

Table 1. CIE standard for whole fresh Caribbean hot peppers.

<table>
<thead>
<tr>
<th>Cultivar</th>
<th>Pericarp color</th>
<th>Capsa! acid mg</th>
<th>Hue angle</th>
<th>L*</th>
<th>a*</th>
<th>b*</th>
<th>( %a/b )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trinidad Scorpion</td>
<td>red</td>
<td>2.08</td>
<td>1.07</td>
<td>1.07</td>
<td>324.72</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carvalho</td>
<td>red</td>
<td>1.07</td>
<td>324.81</td>
<td>324.72</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jalapeno</td>
<td>red</td>
<td>0.16</td>
<td>75.57</td>
<td>324.72</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Scotch bonnet</td>
<td>red</td>
<td>0.16</td>
<td>324.72</td>
<td>324.72</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Habanero</td>
<td>red</td>
<td>0.16</td>
<td>324.72</td>
<td>324.72</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bhut Jolokia</td>
<td>red</td>
<td>0.16</td>
<td>324.72</td>
<td>324.72</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Materials and Methods

Variation

Hot peppers which are representative of the distinct and wide color spectrum of Caribbean hot peppers were selected to calibrate the color scheme and to set the standards for the quantification of colors for all other pepper fruits. The distinct colors and cultivars as described by IA (Arnold, 2007, and 2017) and EU hot food color were: Carvalho hot (Red); Chili & Scotch bonnet (Green); Scotch bonnet Scotch bonnet (Yellow); and Congo Brown (Orange).

Color Standards

The capsaicin and dihydrocapsaicin were analyzed using the USDOH-HPLC high performance liquid chromatography (HPLC) and the OGI-2 Beckman 24. Column (250 mm x 4.6 mm) and the external calibration curves were found to be linear (r = 0.998) for dihydrocapsaicin, and values of r were highly significant confirming the goodness of the linearity (Bridgemohan et al. 2010; 2011).

Pungency

The capsaicin and dihydrocapsaicin were analyzed using the USDOH-HPLC high performance liquid chromatography (HPLC) and the OGI-2 Beckman. Column (250 mm x 4.6 mm) and the external calibration curves were found to be linear (r = 0.998) for dihydrocapsaicin, and values of r were highly significant confirming the goodness of the linearity (Bridgemohan et al. 2010; 2011).

Results and Discussion

Caribbean hot pepper visual color standards. The visual color standards were based on the description of the 4 selected peppers with the appropriate Food and Drugs Administration (FDA) and European Union (EU) codes. The qualitative descriptors of the 4 pepper colors spanned a wide spectrum from mature green, chocolate (brown), and yellow (orange), with shades of dark, light and tangerine (Plate 2).

The fresh hot pepper standards using the whole red fruits showed that the "L" value ranged displayed the wide spectrum of reflective diffusion. Thus cv. Congo with "L" value of 20.43 depicted a brown pericarp, whilst cv. Carvalho hot attained a value of 32.7. However, significant (p≤0.05) differences existed for cv. Scotch bonnet with mature green fruits showing "L" values of 57.29 and tangerine fruits with 63.5 (Table 3). That is, the hue form value were closer to the black, and the higher yellow value was closer to the winter spectrum. The highest "a*" value (38.44) demonstrated the most redness (cv. Carvalho hot. Similarly the negative "a*" (18.11) clearly described the green coloration (Chili and green Scotch bonnet), but the positive "b*" (52.54) confirmed the degree of the yellow pericarp coloring for cv. Scotch bonnet (Table 3). The total reflectance color based on the absorbance (467nm) ranged from 68.2 (green) to 1382.6 (brown) ASTM units.

Acknowledgments

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References


Plate 1. Colors of fresh Caribbean hot peppers pericarp used to develop standard color code.

Plate 2. Popular Caribbean Hot Peppers.
Poster

Hot Peppers: XI. Developing Colour Standards for Caribbean hot peppers (Capsicum chinensis L.)

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3Georgia College and State University, GA, USA.

4State University of New York (SUNY), Plattsburg, USA.

Abstract

The Caribbean is the producer of some of the most pungent red hot peppers (Capsicum chinensis L.), but its physio-chemical quality parameters such as colour stability and pungency in particular are unsubstantiated. A Caribbean hot pepper visual colour standard and the relative pungency of the fresh and processed products has been developed and validated, based on the standards set by ASTA for red colour pigmentation and pungency. The Caribbean has two very hot peppers with very high capsaicinoids viz: Trinidad Scorpion (2.08mg) and Carvalho (1.07mg ), which also exhibits equally high heat based on the Scoville test (31,200,00 and 16,000,000 SHU, respectively). The ASTA value for the processed pepper (377 ASTA units) and the fresh mature hot fruit (366 ASTA units) were also computed. The study found Carvalho hot peppers can be used for industrial processing as mash, flakes, or powder without loss of colour or pungency compared to all the other tested cultivars.

Key words: capsanthin, pungency, colorimeter, capsaicinoids, freeze dried.
Introduction

The Caribbean produces some of the world’s most pungent red and yellow hot peppers (Capsicum chinensis L.) in terms fruit quality in terms of pungency and color (Bridgemohan et al. 2016). They are rich in capsanthin, zeaxanthin, lutein, and cryptocapsin, and α and β carotene (Jasim et al. 2002). The mature fresh fruits under ambient conditions can last for 4 - 5 days with minimal loss of quality, or extended to 14-15 days under on-chilling temperature (Bridgemohan et al. 2017; Mohammed et al. 2014).

Red hot peppers are traded as whole chilies, powder or flakes based on color expressed in ASTA color value (Anon 2012). However, there is no available standard for Caribbean fresh hot peppers or systems to monitor the changes or loss of pigments. Kim and Chun (1975) and Hu and Xia (2011) used color reflectance of red pepper from a colorimeter for lightness (L*), redness (a*), and yellowness (b*). The major issues in processing of red and yellow hot peppers are loss of color and pungency, and microbial spoilage. This study was conducted to assess the stability color and the retention of pungency in fresh products of selected Caribbean hot peppers destined for the export trade.

Materials and Method.

Varieties

Hot peppers which are representative of the distinct and wide color spectrum of Caribbean hot peppers were selected to calibrate the color scheme and to set the standards for the quantification
of colors for all other pepper fruits. The distinct colors and cultivars as described by FDA (Anon, 2007; 2017) and EU food grade colors were: Carvalho hot (Red); Chili & Scotch bonnet (Green); Scotch bonnet Scotch bonnet (Yellow); and Congo (brown).

Color Standards.

Fruit colour was obtained using a portable tristimulus Minolta Chromameter (Model CR-200, Minolta Corp, Ramesy, NJ). The meter was calibrated with a white standard (Minolta calibration plate CR-A43) and fruit chromaticity was measured in “L”, ‘a’, ‘b’ coordinates. Colour components “L” represents the value (lightness) of colours and is larger for lighter colours.

Total extractable and oleoresin extractable color.

The capsicum total extractable color and the oleoresin extractable color in the fresh hot peppers were conducted in accordance with ASTA analytical methods 21.3 (ASTA 2004), and colour expressed as ASTA units and Paprika Color Index (Nieto-Sandoval 1999). The Computation formula for capsicum total and Oleoresin extractable color expressed as ASTA units, and the Paprika Color Index are hereunder:

1. **Total extractable**:
   
   \[
   \text{ASTA units} = \frac{\text{Absorbance at 460 nm} \times 16}{\text{Sample weight (g)}}: \text{ Formula 1.}
   \]

2. **Oleoresin extractable**:
   
   \[
   \text{ASTA units} = \frac{\text{Absorbance at 460 nm} \times 164}{\text{Sample weight (g)}}: \text{ Formula 2}
   \]

3. **PACI**:
Paprika Colour Index = (\(1000 \times a^\circ\))/(L+h\(^\circ\)) = [ In (ASTA units)] : **Formula 3**

**Pungency**

The capsaicin and dihydrocapsaicin were analyzed using the U3000-HPLC high performance liquid chromatography (HPLC) and the ODS-2 Beckmann Column [250mm x 4.6mm; 5μm]. The external calibration curves were found at \(r^2 = 0.9982\) for capsaicin and \(r^2 = 0.9996\) for dihydrocapsaicin, and values of \(r^2\) were highly significant confirming the good linearity of the method (*Bridgemohan et al.* 2016; 2017).

**Results and Discussion**

**Caribbean hot pepper visual color standards.**

The visual color standards was based on the description of the 4 selected peppers with the appropriate Food and Drugs Administration (FDA) and European Union (E) codes. The qualitative descriptors of the 4 pepper colors spanned a wide spectrum from mature green, chocolate (brown), and yellow (orange), with shades of dark, light and bright (**Plate 1**).

The fresh hot pepper standards using the whole red fruits showed that the “\(L\)” value ranged displayed the wide spectrum of reflective diffusim. Thus cv. Congo with “\(L\)” value of 29.43 depicted a brown pericarp, whilst re cv. Carvalho hot attained a value of 42.77. however, significant \((p \leq 0.05)\) differences existed for cv. Scotch Bonnet with mature green fruits showing “\(L\)” values of 51.29 and ripe yellow fruits with 62.91 (Table 1). That is, the low brown value were closer to the black, and the higher yellow value was closer to the whiter spectrum. The highest a*
value (38.46) demonstrated the most redness (cv. Carvalho hot. Similarly the negative a* (-18.11) clearly described the green coloration (Chili and green Scotch bonnet), but the positive b* (56.23) confirmed the degree of the yellow pericarp coloration for ripe cv. Scotch bonnet (Table 1). The total extractable color based on the Absorbance (460nm) ranged from 665.8 (green) to 1382.92 (brown) ASTA units.

This study has demonstrated that from the wide selection of Caribbean hot peppers, there are potential varieties which have met the standards set by ASTA for red color and pungency. Carvalho hot which is the second most pungent pepper cultivar (1.07mg capsaicinoids and 16m SHU) has no significant variation in Hue angle (13° - 30°) and is similar to commercially graded paprika.

The pepper fruit can be used for industrial processing as mash, flakes, or powder without loss of color or pungency, thereby pinpointing a new avenue for investment.

Acknowledgments.

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References


Table 1. CIEB standard for whole fresh Caribbean hot peppers

<table>
<thead>
<tr>
<th>Pericarp colour</th>
<th>L*</th>
<th>a*</th>
<th>b*</th>
<th>Colour intensity&lt;sup&gt;1&lt;/sup&gt;</th>
<th>Hue angle&lt;sup&gt;2&lt;/sup&gt;</th>
<th>Oleoresin extractable color</th>
<th>Total extractable color</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Absorbance (460nm) (ASTA units)</td>
<td>Absorbance (460nm) (ASTA units)</td>
</tr>
<tr>
<td>Red</td>
<td>42.77</td>
<td>38.46</td>
<td>26.42</td>
<td>1644.9</td>
<td>34.4</td>
<td>0.07</td>
<td>11.80</td>
</tr>
<tr>
<td>Green</td>
<td>51.29</td>
<td>-18.11</td>
<td>32.54</td>
<td>-928.8</td>
<td>120.2</td>
<td>0.02</td>
<td>4.75</td>
</tr>
<tr>
<td>Yellow</td>
<td>62.91</td>
<td>18.57</td>
<td>56.23</td>
<td>1168.2</td>
<td>71.7</td>
<td>0.50</td>
<td>82.49</td>
</tr>
<tr>
<td>Brown</td>
<td>29.43</td>
<td>9.15</td>
<td>2.25</td>
<td>269.2</td>
<td>13.8</td>
<td>0.60</td>
<td>98.72</td>
</tr>
</tbody>
</table>

<sup>1</sup>Color intensity: L x a*.

<sup>2</sup>Hue angle: (tan<sup>-1</sup>b*/a*)
Table 2. **CIEB standard for whole fresh Caribbean hot peppers**

<table>
<thead>
<tr>
<th>Varieties</th>
<th>Pericarp color</th>
<th>Capsaicinoid mg</th>
<th>SHU $^1$</th>
<th>L</th>
<th>a</th>
<th>b*</th>
<th>Hue angle</th>
<th>PACL</th>
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<tr>
<td>7- Pots</td>
<td>red</td>
<td>1.09</td>
<td>16.3</td>
<td>35.0</td>
<td>12.0</td>
<td>7.6</td>
<td>32.2</td>
<td>377.1</td>
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<td>Cayenne</td>
<td>red</td>
<td>XXXX</td>
<td>37.5</td>
<td>2.0</td>
<td>7.2</td>
<td>73.8</td>
<td>129.5</td>
<td></td>
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<tr>
<td>Bird</td>
<td>red</td>
<td>0.14</td>
<td>2.1</td>
<td>32.3</td>
<td>13.4</td>
<td>3.9</td>
<td>16.3</td>
<td>432.8</td>
</tr>
<tr>
<td>Jalapeno</td>
<td>red</td>
<td>0.16</td>
<td>2.5</td>
<td>40.6</td>
<td>7.9</td>
<td>13.7</td>
<td>60.1</td>
<td>254.8</td>
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<tr>
<td>Habanero</td>
<td>red</td>
<td>0.35</td>
<td>5.3</td>
<td>33.8</td>
<td>14.6</td>
<td>6.3</td>
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<td>red</td>
<td>0.16</td>
<td>2.5</td>
<td>40.1</td>
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<td>9.2</td>
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<td>124.7</td>
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<td>Carvalho Hot</td>
<td>red</td>
<td>1.07</td>
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<td>10.7</td>
<td>10.47</td>
<td>44.1</td>
<td>362.1</td>
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<td>Trinidad Scorpion</td>
<td>red</td>
<td>2.08</td>
<td>31.2</td>
<td>43.2</td>
<td>1.8</td>
<td>14.0</td>
<td>82.5</td>
<td>125.1</td>
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<tr>
<td>Bhut Jolokia</td>
<td>red</td>
<td>0.51</td>
<td>7.7</td>
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<td>11.7</td>
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<td>102.6</td>
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<td>Yelllow and green</td>
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<td>3.5</td>
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<td>0.643</td>
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<td>0.219</td>
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<td>1.68</td>
<td>0.93</td>
<td>7.89</td>
<td>2.96</td>
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Plate 1. Colors of fresh Caribbean hot peppers pericarp used to develop standard color code.
Plate 2.