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

[1]Puran Bridgemohan, [2]Majeed Mohammed, [3]Ronell S. H. Bridgemohan and [4]Zareef Mohammed.

[1]Biosciences Agriculture and Food Technology, The University of Trinidad and Tobago, Waterloo Research Campus, Carapichaima.

[2]Department of Food Production, Faculty of Food and Agriculture, University of the West Indies, Trinidad.

[3]Georgia College and State University, GA, USA.

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

Abstract.

The Caribbean is a producer of some of the world's most pungent red hot peppers (*Capsicum chinensis L.),* but its physio-chemical quality parameters such as color stability and pungency in particular are unsubstantiated. A Caribbean hot pepper Visual Color 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 color pigmentation and pungency. The Caribbean has two very hot peppers with very high capsaicinoids content viz: Trinidad Scorpion (2.08mg) and Carvalho (1.07mg), which also exhibits equally "high heat" based on the Scoville test (31,200,000 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 color or pungency compared to all the other tested cultivars.

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

Introduction.

The Caribbean produces of some of the world's most pungent red and yellow hot peppers (Capsicum chinensis L) in terms fruit quality, 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.

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

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 color 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 colors and is larger for lighter colors.

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:

Total extractable:

ASTA units = Absorbance at 460 nm x 16 / Sample weight (g): **Formula 1**

Oleoresin extractable:

ASTA units = Absorbance at 460 nm x 164/ Sample weight (g): **Formula 2**

PACl:

Paprika Colour Index = ((1000 × a°))/ (L+h°)) = [ln (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).

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

pericarp color	L*	a*	b*	Colour intensity [1]	Hue angle [2]	Oleoresin extractable color		Total extractable color		
						Absorbance (460nm)	(ASTA units)	Absorbance (460nm)	(ASTA units)	PACI 1
Red	42.77	38.46	26.42	1644.9	34.4	0.07	11.80	1.008	1653.12	933.71
Green	51.29	-18.11	32.54	-928.8	120.2	0.02	4.75	0.406	665.84	-413.9
Yellow	62.91	18.57	56.23	1168.2	71.7	0.50	82.49	7.042	11548.88	366.90
Brown	29.43	9.15	2.25	269.2	13.8	0.60	98.72	8.428	13821.92	324.72

[1]Color intensity: L x a*

[2]Hue angle: ($\tan^{-1}$b*/a*)

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 diffusion. 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 (130 - 300) 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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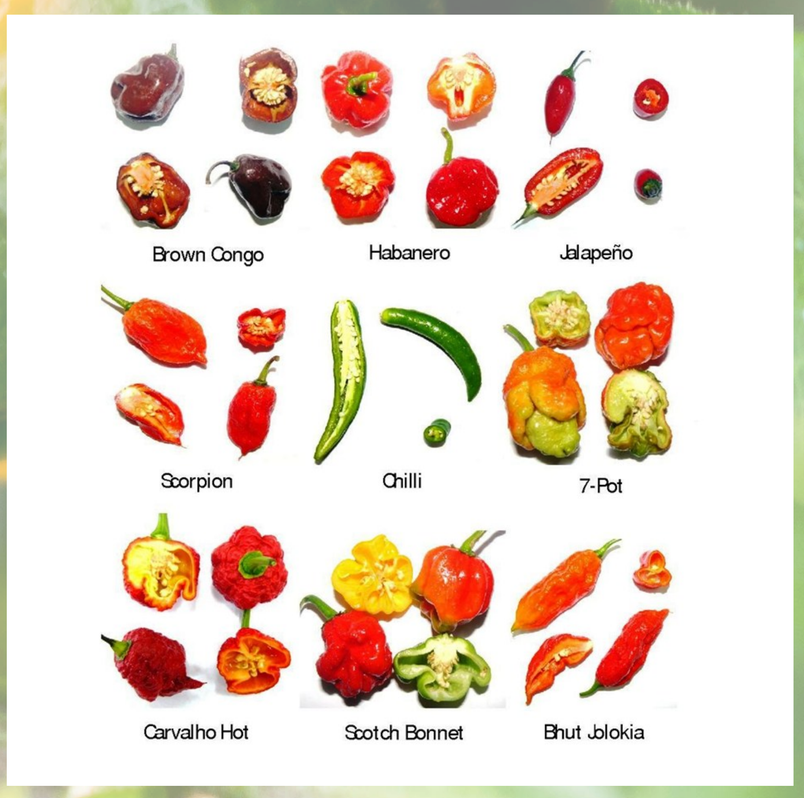

Plate 2. Popular Caribbean Hot Peppers.

Table 2. CIEB standard for whole fresh Caribbean hot peppers.

Varieties	Pericarp color	Capsaicinoid mg	SHU [1]	L	a	b*	Hue angle	PACL
7- Pots	red	1.09	16.3	35.0	12.0	7.6	32.2	377.1
Cayenne	red	—	—	37.5	2.0	7.2	73.8	129.5
Bird	red	0.14	2.1	32.3	13.4	3.9	16.3	432.8
Jalapeno	red	0.16	2.5	40.6	7.9	13.7	60.1	254.8
Habanero	red	0.35	5.3	33.8	14.6	6.3	23.4	455.0
Chilli	red	0.16	2.5	40.1	1.8	9.2	78.6	124.7
Carvalho Hot	red	1.07	16.0	33.8	10.7	10.47	44.1	362.1
Trinidad Scorpion	red	2.08	31.2	43.2	1.8	14.0	82.5	125.1
Bhut Jolokia	red	0.51	7.7	46.9	0.7	11.7	86.2	102.6
Scotch Bonnet	yellow & green	0.23	3.5	48.0	0.8	8.4	84.5	101.2
Congo	brown			38.0	2.1	8.2	75.5	131.0
X		0.643	0.643	39.0	0.62	9.1	59.75	377.12
SE		0.219	0.219	1.60	1.68	0.93	7.89	2.96

Poster presented at the 24th International Pepper Conference 2018, November 4–6, 2018, Fort Myers, Florida, USA .

Poster

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   ASTA units = Absorbance at 460 nm x 16 / Sample weight (g): **Formula 1.**

2. **Oleoresin extractable :**

   ASTA units = Absorbance at 460 nm x 164/ Sample weight (g**): Formula 2**

3. **PACI :**

Paprika Colour Index = ((1000 × a°))/(L+h°)) = [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; 5µmThe 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).

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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.

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Table 1. CIEB standard for whole fresh Caribbean hot peppers

pericarp colour	L*	a*	b*	Colour intensity [1]	Hue angle [2]	Oleoresin extractable color		Total extractable color		
						Absorbance (460nm)	(ASTA units)	Absorbance (460nm)	(ASTA units)	PACI 1
Red	**42.77**	**38.46**	**26.42**	**1644.9**	**34.4**	0.07	11.80	1.008	1653.12	933.71
Green	**51.29**	**-18.11**	**32.54**	**-928.8**	**120.2**	0.02	4.75	0.406	665.84	-413.9
Yellow	**62.91**	**18.57**	**56.23**	**1168.2**	**71.7**	0.50	82.49	7.042	11548.88	366.90
Brown	**29.43**	**9.15**	**2.25**	**269.2**	**13.8**	0.60	98.72	8.428	13821.92	324.72

[1]Color intensity: L x a*.

[2]Hue angle: ($\tan^{-1}$b*/a*)

Table 2. **CIEB standard for whole fresh Caribbean hot peppers**

Varieties	**Pericarp color**	***Capsaicinoid mg***	***SHU*** [1]	***L***	***a***	***b****	***Hue angle***	***PACL***
7- Pots	red	*1.09*	*16.3*	*35.0*	*12.0*	*7.6*	***32.2***	*377.1*
Cayenne	red	*XXXXX*		*37.5*	*2.0*	*7.2*	*73.8*	*129.5*
Bird	red	*0.14*	*2.1*	*32.3*	*13.4*	*3.9*	*16.3*	*432.8*
Jalapeno	red	*0.16*	*2.5*	*40.6*	*7.9*	*13.7*	*60.1*	*254.8*
Habanero	red	*0.35*	*5.3*	*33.8*	*14.6*	*6.3*	*23.4*	*455.0*
Chilli	red	*0.16*	*2.5*	*40.1*	*1.8*	*9.2*	*78.6*	*124.7*
Carvalho Hot	red	*1.07*	*16.0*	*33.8*	*10.7*	*10.47*	***44.1***	*362.1*
Trinidad Scorpion	red	*2.08*	*31.2*	*43.2*	*1.8*	*14.0*	*82.5*	*125.1*
Bhut Jolokia	red	*0.51*	*7.7*	*46.9*	*0.7*	*11.7*	*86.2*	*102.6*
Scotch Bonnet	Yelllow and green	*0.23*	*3.5*	*48.0*	*0.8*	*8.4*	*84.5*	*101.2*
Congo	brown			*38.0*	*2.1*	*8.2*	*75.5*	*131.0*
X		*0.643*	*0.643*	*39.0*	*0.62*	*9.1*	*59.75*	*377.12*
SE		*0.219*	*0.219*	*1.60*	*1.68*	*0.93*	*7.89*	*2.96*

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


Brown Congo
Habanero
Jalapeño
Scorpion
Chilli
7-Pot
Carvalho Hot
Scotch Bonnet
Bhut Jolokia

Plate 2.