Scoville Heat Units of Jungle Curry Paste and Sensory Evaluation of Jungle Curry Made of Different Dried Capsicum Varieties Grown along Thai-Myanmar Border

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Abstract

The objective of this research was to utilize and compare different varieties of dried Capsicum (peppers) fruits in Jungle Curry paste (Thai traditional curry paste from forested areas of Thailand). Four different varieties of dried Capsicum were chosen for the study. One of the Capsicum, Yodson (CH 1), belonging to Capsicum annum, obtained from the local fresh market in Ratchaburi. The other three types belonging to Capsicum frutescens, as locally called Karen chili, were obtained from different locations as follows; CH 2 was cultivated and harvested in Huay Muang Village, Ratchaburi Province, CH 3 was cultivated and harvested in Kanchanaburi Province, and CH 4 was cultivated and harvested in the northern region of Thailand. Eight treatments of jungle curry pastes with four different dried Capsicum fruits (CH1, CH2, CH3, and CH4), and two time points during storage (0 and 30 days) were made in triplicate. Scoville heat units (SHU) of jungle curry paste and sensory evaluation of jungle curry were determined. SHUs were measured by electro-chemical method, and capsicinoid were calculated. 9-Point Hedonic scale was used for sensory evaluation. Results indicated that at both 0 and 30 days of curry paste storage, capsaicin and SHU content in jungle curry paste made with Karen chili from Huay Muang, Ratchaburi was significantly highest, followed by jungle curry made with Karen Chili from Kanchanaburi, while jungle curry pastes made of Yonson chili and Karen chili from Northern region had the lowest capsaicin and SHU. Sensory evaluation results of jungle curry indicated no significant differences in odor, pungency, and overall

liking, while jungle curry made of Yondson chili had the highest scores in both color and overall taste attributes.

Keywords: Scoville heat units/ capsaicin/ jungle curry/ Karen chili

Introduction

Chilies are a significant ingredient of Thai food and culture since Thai food is world widely known for its hot and spiciness. The most important characteristic and the main quality parameter of Capsicum is its burning taste, which is due to compounds from phenylalkylamide alkaloid (capsaicinoids) group. Capsaicin, dihydrocapsaicin, nordihydrocapsaicin, homocapsaicin, and homodihydrocapsaicin are the main compounds responsible for the burning taste, with capsaicin being the most abundant (Supalkova et al., 2007; Orellana-Escobedo et al., 2013). The first method developed for the measurement of chili pungency was the Scoville Organoleptic

Test where a number is assigned to each hot pepper according to the dilution test and expressed it as a scale called the Scoville Heat Units or SHU. The heat levels vary widely from 0–500,000 Scoville heat units (SHU). They are classified as:

- (0–700 SHU) non-pungent
- (700–3,000 SHU) mildly pungent
- (25, 000–70,000 SHU) highly pungent
- (3,000–25,000 SHU) moderately pungent
- (>80,000 SHU) very highly pungent

In order to convert between SHU and capsaicinoid, 15 Scoville units is equal to 1 ppm capsaicinoids (Mathur et al., 2000; Usman et al., 2014).

According to Thai Community Product Standard, curry paste or namphrik gaeng can be defined as food product made with varieties of fresh, dried, fried or roasted spices and herbs such as fresh chili, dried chili, shallot, garlic, galangal, lemongrass, and kaffir lime peel. Salt and fermented shrimp paste may also be added. Then all the ingredients are crushed and ground until well-mixed and fine

paste is formed. Some types of curry paste might be sautéed with oil until well-cooked (TSI, 2556). Jungle curry or 'Gaeng Pa' is a type of curry commonly consumed in Thailand. Jungle curry paste mainly consists of approximately 55% dried red chili, 16% garlic, 7% shallot, 3% lemongrass, 3% galangal, and 2% kaffir lime peel (Saengsuwan, 2009). The types and amount of ingredients can be varied according to different local plants available in each region. Karen chili and fermented shrimp paste are often added to the jungle curry in the western region, while the curry in the central region often uses both fresh and dried red chili (Kongpan, 2557). Unlike other curries, jungle curry is made without coconut milk, resulting in curry with thinner and clearer liquid than curries made with coconut milk.

Karen chili or phrik krarieng belongs to Capsicum frutescens. The word 'Karen' is used to describe this type of chili because this chili is mostly cultivated and harvested by the Thai-Karen people that reside along Thailand and Myanmar border. Karen chili is renowned for its intense pungency or its burning taste, which provides an intense spiciness in Thai food. Initially, Karen chili was only wildly grown in the mountain area along Thai-Myanmar border, resulting in very limited supply of the chili and remarkably high price in the market. Nowadays, Karen chili has been commercially cultivated and harvested in some area of the western and northern part of Thailand. In order for the Karen chili to be available all-year-round, they are harvested and sun-dried in bulk prior to selling in the market. To better understand the utilization of Karen chili in jungle curry paste, the objective of this study was to determine scoville heat units of jungle curry paste and sensory evaluation of jungle curry made from different dried Capsicum varieties grown along Thai-Myanmar border.

Research Objective

The objective of this research was to utilize and compare different varieties of dried Capsicum fruits in jungle curry paste.

Scope of Research

The scope of research was to utilize and compare different varieties of dried Capsicum fruits in jungle curry paste.

Variables

Independent Variables - four different varieties of dried Capsicum.

CH 1. Yodson Chili (Capsicum annum)

CH 2. Karen Chili (Capsicum frutescens) from Ratchaburi

CH 3. Karen Chili (Capsicum frutescens) from Kanchanaburi

CH 4. Karen Chili (Capsicum frutescens) from Northern Region

Dependent Variables - capsaicin, SHU and sensory scores.

Materials and method

Experimental Design

A 4X2 factorial experiment was utilized to make jungle curry pastes. This experiment utilized four different varieties of dried Capsicum fruits, and two time points during storage (0 and 30 days) for a total of eight treatments as shown in Table 1. The treatments were; TRT1 - CH1-0, TRT2 - CH2-0, TRT3 - CH3-0, TRT4 - CH4-0, TRT5 - CH1-30, TRT6 - CH2-30, TRT7 - CH3-30, and TRT8 - CH4-30. Each treatment was manufactured jungle curry paste in triplicate.

Table 1 Experimental design treatments

Experimental Factors		**Different *Capsicum* Varieties**			
		CH1	**CH2**	**CH3**	**CH4**
Time (Day)	**0**	TRT1	TRT2	TRT3	TRT4
	30	TRT5	TRT6	TRT7	TRT8

Dried Capsicum Cultivars

Four different varieties of dried Capsicum were chosen for the study. One of the Capsicum cultivars, Yodson (CH1), belonging to Capsicum annum, obtained from the local fresh market in Ratchaburi Province. The other three cultivars belonging to Capsicum frutescens, as locally called Karen chili, were obtained from different locations as follows; CH2 was cultivated and harvested from Huay Muang Village in Ratchaburi Province, CH3 was cultivated and harvested in Kanchanaburi Province, and CH4 was cultivated and harvested from the northern region of Thailand. The specific growing location of Capsicum from CH3 and

4 were not known as they were obtained from the local fresh market in Ratchaburi Province. Ratchaburi and Kanchanaburi provinces are geographically located along Thai-Myanmar border.

Jungle Curry Paste Preparation

Jungle curry paste recipe was obtained based on the area based study. The recipe consisted of 300 g of dried red chili, 400 g of chopped lemongrass, 320 g of chopped garlic, 60 g of chopped kaffir lime peel, 160 g of chopped galangal, and 400 g of fermented shrimp paste (Phadungath and Chalermsaenyakorn, 2016). Dried red chili was first soaked in 40 degree Celsius water for 30 minutes until all the chilies were soft and then water was drained. All the ingredients were crushed and ground with a medium speed commercial food processor for 5 minutes until well-mixed and paste was formed. Jungle curry paste was stored in the polystyrene plastic container and kept in a commercial refrigerator at 4 degree Celsius. Scoville heat units (SHU) of jungle curry paste and sensory evaluation of jungle curry were determined at 0 and 30 days of the curry paste storage.

SHU Determination

Jungle curry paste was analyzed for SHU by electro-chemical method (Capsella, Mobilis Automata Co., Ltd., Bangkok, Thailand) and capsicinoid were calculated. According to Mathur et al. (2000) 15 SHU is equal to 1 ppm capsaicinoid; thus, capsicinoid is equal to SHU divide by 15.

Sensory Evaluation

Jungle curry was prepared according to Kongpan (2557). 9-Point hedonic scale was used to monitor sensory evaluation. Sensory attributes were color, odor, pungency, taste, and overall liking. A ballot for 9-point hedonic scale was adapted from Lawless and Heymann (1999).

Panelist: Fifty judges from students and staff of Muban Chombueng Rajabhat University were randomly selected.

Testing: Eight treatments with three replicates of jungle curry were tested. Each sample was randomly assigned with the 3-digit number. The panelists were provided with one small cup of jungle curry liquid. The panelists were asked taste

one treatment at a time and indicate their hedonic response (liking response) to the sample on the 9-point scale. Small cups of water at room temperature were served the panelists in order to cleanse the palate between tasting each sample.

Statistical Analysis

A 4X2 factorial experiment with three replications was used for statistical analysis, and mean separation ($P < 0.05$) by Tukey HSD Test, were used for the data analyses (Statistix 9).

Results

Appearance of Jungle Curry Paste

Figure 1 and 2 showed jungle curry paste from different treatments at 0 and 30 days of storage, respectively. It can be seen that at both 0 and 30 days of storage, jungle curry paste made from yodson chili had the most bright red, while the other curry pastes made from Karen chilies had orange-brown color. All the curry pastes appeared to be mixed quite well and in the paste form.

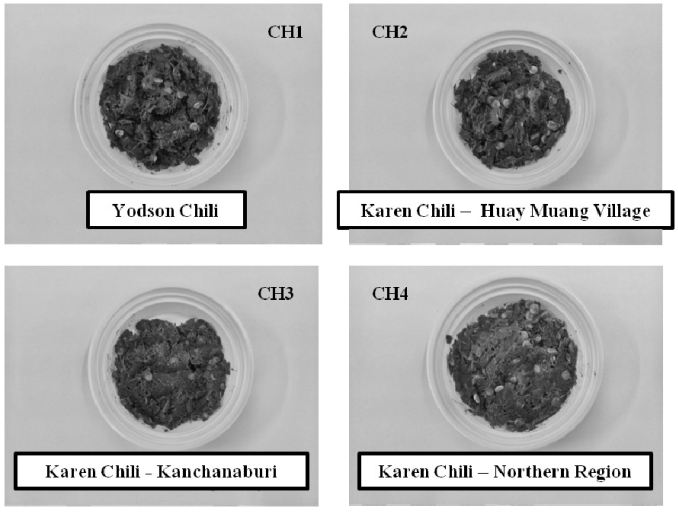

Figure 1 Jungle curry paste at 0 day of storage;
CH1 - jungle curry paste made from Yodson Chili
CH2 - jungle curry paste made from Karen Chili - Huay Muang Village
CH3 - jungle curry paste made from Karen Chili - Kanchanaburi
CH4 - jungle curry paste made from Karen Chili - Northern Region

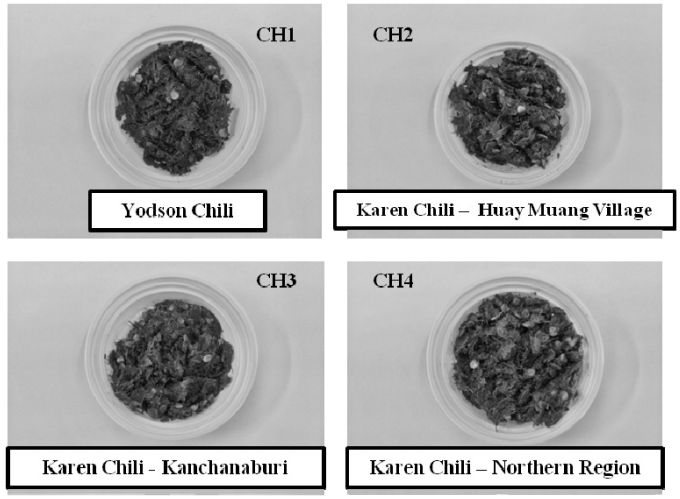

Figure 2 Jungle curry paste at 30 days of storage.
CH1 - jungle curry paste made from Yodson Chili
CH2 - jungle curry paste made from Karen Chili - Huay Muang Village
CH3 - jungle curry paste made from Karen Chili - Kanchanaburi
CH4 - jungle curry paste made from Karen Chili - Northern Region

Capsaicin and SHU

Capsaicin and SHU were significantly affected ($P<0.05$) by different Capsicum varieties and time. Scoville Heat Units or SHU, which is a unit used to express the pungency or burning taste of chillie peppers, were measured by electro-chemical method and capsaicin were calculated. From Table 2, at both 0 and 30 days of storage, capsaicin and SHU content in jungle curry paste made with Karen chili from Huay Muang, Ratchaburi was significantly ($P<0.05$) highest, followed by jungle curry made with Karen Chili from Kanchanaburi, while jungle curry pastes made with yodson chili and Karen chili from Northern region had the lowest capsaicin and SHU.

Table 2 Mean values of capsaicin and SHU of jungle curry paste made from different varieties of dried Capsicum fruits during 0 and 30 days of storage

Treatments		Capsaicin (μg/g)	SHU
0 Day	CH1	641 ± 21^{c}	9611 ± 340^{c}
	CH2	1272 ± 17^{a}	19083 ± 227^{a}
	CH3	1000 ± 57^{b}	15001 ± 748^{b}
	CH4	632 ± 53^{c}	9480 ± 855^{c}
30 Days	CH1	408 ± 6^{f}	6127 ± 90^{f}
	CH2	565 ± 15de	8479 ± 243de
	CH3	516 ± 17^{e}	7745 ± 280^{e}
	CH4	370 ± 14^{f}	554 ± 229^{f}

* ^{a,b,c} Means within the column not sharing common superscripts are different (Tukey's HSD at $P < 0.05$).

Appearance of Jungle Curry

Figure 3 and 4 showed jungle curry from different treatments at 0 and 30 days of storage, respectively. Similarly to the curry paste, at both 0 and 30 days of storage, jungle curry made from yodson chili had the most bright red, while the others made from Karen chilies had lighter red to orange color.

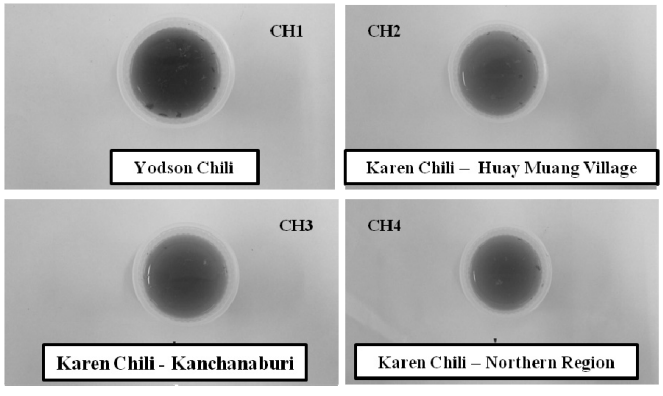

Figure 3 Jungle curry at 0 day of storage
CH1 - jungle curry paste made from Yodson Chili
CH2 - jungle curry paste made from Karen Chili - Huay Muang Village
CH3 - jungle curry paste made from Karen Chili - Kanchanaburi
CH4 - jungle curry paste made from Karen Chili - Northern Region

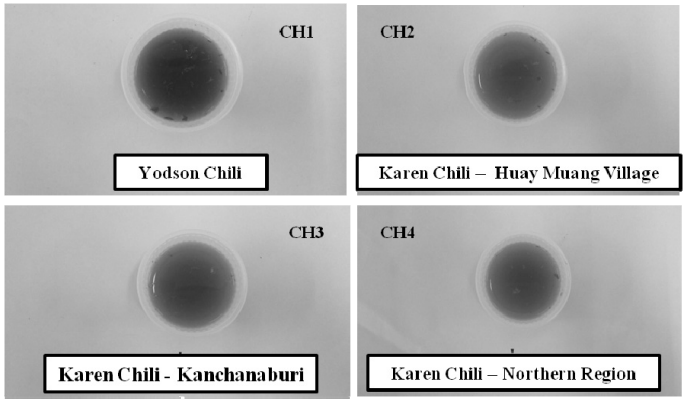

Figure 4 Jungle curry at 30 days of storage.
CH1 - jungle curry paste made from Yodson Chili
CH2 - jungle curry paste made from Karen Chili - Huay Muang Village
CH3 - jungle curry paste made from Karen Chili - Kanchanaburi
CH4 - jungle curry paste made from Karen Chili - Northern Region

Sensory Evaluation of Jungle Curry

Odor, pungency, and overall liking scores were not affected by Capsicum varieties, time and interaction between Capsicum varieties and time. Color scores were significantly affected ($P<0.05$) by different Capsicum varieties and time, while overall taste scores were significantly affected ($P<0.05$) by different time. From table 4, the mean value of all curry paste sensory attributes during 0 and 30 days of storage were in the range of 6 to 7, which could be interpreted as 'ligke slightly' to 'like moderately'.

Table 3 Mean values of sensory attributes from 9-point hedonic scale of jungle curry during 0 and 30 days of storage

Treatments		Color	Odor^{ns}	Pungency^{ns}	Overall Taste	Overall Liking^{ns}
0 Day	CH1	7.0±0.22^{a}	6.9±0.22	6.5±0.22	6.8±0.21^{a}	6.9±0.22
	CH2	6.1±0.23^{ab}	6.2±0.24	6.1±0.23	6.5±0.22^{ab}	6.4±0.21
	CH3	6.2±0.21^{ab}	6.2±0.25	6.6±0.21	6.7±0.22^{ab}	6.7±0.20
	CH4	6.4±0.22^{ab}	6.3±0.23	6.3±0.24	6.1±0.23^{ab}	6.4±0.22
30 Days	CH1	6.4±0.22^{ab}	6.5±0.21	6.7±0.21	6.2±0.21^{ab}	6.5±0.22
	CH2	5.7±0.21^{b}	6.1±0.20	6.0±0.22	6.0±0.20^{ab}	6.3±0.21
	CH3	5.8±0.23^{b}	6.0±0.22	6.2±0.20	5.9±0.22^{b}	6.3±0.20
	CH4	6.1±0.23^{ab}	6.1±0.23	6.1±0,22	6.2±0.21^{ab}	6.4±0.21

* ^{a,b,c} Means within the column not sharing common superscripts are different (Tukey's HSD at *P* 0.05).

*^{ns} Means within the column stating ns are not significant different.

Discussion

Phadungath and Chalernsaenyakorn (2015) recently studied the profile of β-carotene, capsaicinoid, and aflatoxin content on dried capsicum varieties grown along Thai-Myanmar border, and they rerported that capsaicin content in dried Capsicum frutescens fruits, which were Karen chilies grown and harvested from different locations, were significantly higher than those in dried Capsicum annum fruits, which were chinda and yodson chiles. In addition, the levels of capsaicinoids are largely influenced by both genotypes and environmental conditions (Wahyuni et al., 2011). As reported by Meckelmann et al. (2015), capsaicinoid content in 23 native Peruvian chili peppers grown in different locations were significantly different. Therefore, it is not surprising to see the differences in capsaicin contents of jungle curry pastes since they were made from dried chilies that have been cultivated and harvested from different locations. Additionally, over 30 days of storage, both capsaicin and SHU were degraded by 40-50%, which is in agreement with Schweiggert et al. (2006) where they also reported siginificant degradation of capsaicin content in Capsicum fretescens during six months of storage. It has

been reported that capsaicin degradation caused by enzymatic reaction from peroxidase and lipoxygenase, and also by oxidation reaction from light and oxygen (Supalkova et al., 2007). During the curry paste processing, all the dried chili samples had undergone the mixing process, where the chilies were chopped, crushed, and ground. This, then, caused more exposure of the chiles to oxygen and enzyme. In addition, curry past was not vacuum packed; thus, and exposure of the curry paste to the oxygen could also cause more degradation of capsaicin.

One of many important attributes that consumers require in jungle curry is pungency. The pungent flavor in the curry is the main quality parameter of Capsicum, which is due to compounds from phenylalkylamide alkaloid (capsaicinoids) group. Capsaicin, dihydrocapsaicin, nordihydrocapsaicin, homocapsaicin, and homodihydrocapsaicin are the main compounds responsible for the burning taste, with capsaicin being the most abundant (Supalkova et al., 2007; Orellana-Escobedo et al., 2013). As aforementioned, capsaicin and SHU content in jungle curry paste made with Karen chili from Huay Muang, Ratchaburi was significantly highest. However, from Table 3, pungency scores among jungle curry samples were not significant. Kostyra et al. (2010) and Schneider et al. (2014) studied relationship between pungency and food matrices. They similarly reported that fat and starch could reduce the perception of pungency in food, while water could not. Thus, tasting the water-based food like jungle curry in this study could result in a lingering burning effect from the chili, and could cause the sensory panelists to not be able to differentiate the pungency effect amongst curry samples. In addition, hedonic scale was evaluated based on how the testers like the products and not product intensity; thus, using the pungency scores to identify the hotness level of the curry might not be entirely correct. Color of jungle curry is also an important attribute for consumer justification. As can be seen from figure 1 - 4, both jungle curry paste and jungle curry made from dried yodson chili had the brightest red color, which resulted in the highest color scores.

Conclusions

Results from this study suggested that making curry paste by using dried chilies from different genotypes and different cultivating environments had impacts on capsaicin content contents in the final curry pastes. Capsaicin content and SHU of curry paste made with dried Karen chili from Huay Muang, Ratchaburi was highest than other curry pastes. During storage, capsaicin content and SHU dramatically degraded. Sensory evaluation scores indicated no differences in odor, pungency and overall liking amongst jungle curry samples, whereas color was highest in curry sample made with yodson chili.

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