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Evaluation of pungency of chillie using the Scoville Index and the comparison of the sensory evaluation method and the spectrophotometric method in determining the pungency level

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Abstract

Chillie is well known as a spice for its colour and pungency, especially in Asian and African countries. Capsaicin is identified as the major compound responsible for the pungency in chillie. Different chillie varieties have different Capsaicin levels and, thus, determination of the Capsaicin content of chillie facilitates the grading of different varieties according to the level of pungency. The objectives of the present study were to grade different varieties of chlille according to the pungency using the Scoville Index and to develop a novel spectrophotometric method for determination of Capsaicin content. The Scoville test was based on the Sensory evaluation method and in order to obtain a high accuracy, a panel of assessors was selected and trained. Five chillie varieties namely Sannam best, Sannam medium best, Cashmere, MI1 and Sannam long were selected for the study. Ethanol was used as the solvent for the extraction of Capsaicin. Sannam Best, Sannam Medium Best, MI1, Sannam long and Cashmere varieties showed 60000, 20000, 24000, 25000 and 18000 Scoville Heat Unit (SHU) values, respectively. These varieties can be categorized as hot, moderate and mild considering the pungency and SHU. The samples used for the Sensory evaluation were further tested using the UV-VIS spectrophotometer to confirm the Capsaicin content. The results obtained from the spectrophotometric analysis were highly correlated (r = 0.86) with the results of the sensory evaluation method. It can be concluded that both sensory and UV-VIS spectrophotometric methods can be used to determine the Scoville Index and to grade chillie varieties according to the pungency.

Keywords: chillie, pungency, Scoville Index, capsaisin, sensory evaluation

Introduction

Chillie is one of the most important cash crops grown in Sri Lanka and has become an essential ingredient in Sri Lankan cuisine as a spice. Per capita consumption of dry chillie is estimated to be 2.32 kg per annum and the national annual requirement of dry chillie is around 42,634 mt (Department of Agriculture, 2010).

Capsinomides including capsaicin has been identified as the major compound responsible for hazardous effects of chillie whereas capsaicin is the compound responsible for pungency of chille that can be extracted from the pod (Chillie Pepper Hell, 2010). Determination of the level of pungency of chillie would facilitate consumer to choose the exact chillie product with the required level of pungency that suits the organoleptic preference as well as the health conditton. Moreover, determination of Scoville Index is important for grading of suitable chillie varieties for the export market. Considering the the previous reported research findings, Scoville Index has been identified as a practical approach for this purpose. Scoville Index can be defined as the highest dilution factor at which characteristic pungent sensation from chillie is perceived (Purthi, 1998).

A sensory panel consisting of trained or semi trained tasters would be required for the accurate determination of the Scoville Index in the laboratory. Panelists are screened and selected for their sensory acuity and potential for describing and communicating their sensory perception.

The accurate grading of the product can also be done by comparing the level of capsaicin in different varieties using the UV-VIS spectroscopic method. The values obtained by the sensory evaluation and the spectroscopic method can be compared by statistical methods and the producer can select the most economically and practically feasible method for the future experiments. Therefore, the objectives of the present study were to determine the Scoville Index of different varieties of chillie, to establish a sensory evaluation panel and to develop a new spectrophotometric method to grade different types of chillie powder according to their pungency.

Materials and Methods

Determination of Scoville Index of chillie varieties by sensory evaluation

Extraction of capsaicin from chillie was carried out according to the method described in ISO (1995). One of the test portions of the laboratory samples of chillie powder listed in Table 1 according to the anticipated pungency was transferred quantitatively to a clean flask.

Table 1: Mass of the test portion of the lab samples of chillie powder used to determination of Scoville Index and corresponding schedule

Test Portion (g)	10.00	5.00	2.00	1.00	0.50	0.25	0.10	0.05	0.05	0.05
Schedule	A'	B'	C'	D'	A	B	C	D	E	F

Test samples were weighed accurately and were quantitatively transferred to 50 ml volumetric flasks.

A sufficient volume of ethanol was added to the flask containing the test portion and diluted up to the mark. The flask was closed and shaken vigorously for 1 min and left to stand for 30 min. This operation was repeated for further 2 times and left to stand for 30 min. This was repeated again and left for 15 h.

In the preparation of serial dilutions, considering the quantities of test solution for the schedule, corresponding test portion was selected. The weakest dilution for which eight out of ten panelists gave a positive response was chosen to determine the Scoville Index. The dilution factor at which the pungent sensation is perceived was considered as the Scoville Index of the tested variety.

The volumes used in preparation of samples for the sensory evaluation and the Scoville Index are shown in Table 2.

The highest value of the dilution factors recorded by at least three assessors was expressed as the Scoville Index for the laboratory sample.

Selection and training of the sensory evaluation panel was carried out according to the standard procedure mentioned in ISO 8586-1 (1993). The type of a trained panel needed has to be decided before making a decision on a sensory panel (Meilgaard *et al.*, 1999). The required panel was identified to be a descriptive panel considering the research and development plans of the company. Screening tests were carried out to select most potential individuals with best sensory perceptions to be trained. Thirty questionnaires were distributed among the staff members in order to select appropriate individuals who would like to participate in a trained sensory evaluation panel. Sucrose solution (8 g/l), Sodium chloride solution (1.6 g/l), citric acid solution (1 g/l) and

caffeine solution (1.5 g/l) were used as the basic taste. The sweet, salt, sour and bitter tastes were tested respectively. The number of selected panelists was nineteen. Ginger oil (2 ml), clove oil (2 ml), vinegar (2 ml) and cinnamon powder (2 g) were used for the basic odor test. Seventeen individuals who obtained 65% correct answers in specifying the odor were selected for the following test. Necto (a red colored artificial carbonated beverage) was diluted and 10, 15, 20, and 25% diluted samples were prepared for the test for color intensity. Sixteen panelists who obtained 65% correct answers in raking the samples were selected for the next screening test. Diluted sugar solutions (5%, 7%, 10% and 12.5%) were prepared using distilled water for the test of taste intensity. Panelists who obtained 65% correct answers in ranking the samples were selected. The number of panelists selected was fifteen. Different products having different textures were presented to the panelists in random order. Twelve individuals who obtained 65% correct answers in describing the texture were selected. Training in similar type of work was provided for the panel.

Table 2: Volume of extracted solution of capsaicin used for preparation of serial dilutions (II) for sensory evaluation

Dilution factor (10^3)	Portion of test solution (ml) Schedules						Dilution factor (10^3)	Portion of test solution (ml) Schedules					
	A	B	C	D	E	F		A	B	C	D	E	F
1500						0.67	75			0.33	0.67		
1400						0.72	70			0.35	0.72		
1300						0.77	65			0.38	0.77		
1200						0.83	60			0.42	0.83		
1100						0.91	55			0.45	0.91		
1000					0.5	1	50			0.5	1		
950					0.53	1.06	45			0.55			
900					0.56	1.11	40			0.63			
850					0.59	1.18	37			0.68			
800					0.63	1.25	34			0.74			
750					0.67	1.33	31			0.8			
700					0.72	1.43	28			0.89			
650					0.77		26		0.38	0.96			
600					0.83		25		0.4	1			
550					0.91		24		0.42				
500					1		22		0.46				
450					1.11		20		0.5				
400					1.25		18		0.56				
350					1.43		16		0.63				
300					1.67		14		0.72				
250					2		12		0.83				
200				0.25	2.5		10	0.5	1				
175				0.29			9.5	0.53	1.11				
150				0.33			9	0.56	1.25				
125				0.4			8.5	0.59					
100				0.5			8	0.63					
95			0.26	0.53			7.5	0.67					
90			0.28	0.56			7	0.72					
85			0.29	0.59			6.5	0.77					
80			0.31	0.63			6	0.83					
							5.5	0.91					

The sensory panelists were trained to describe their sensory experiences using words they used in previous training sessions. The training was mainly based on educating the panel members on expressing their sensory perception on diluted chillie extractions. In addition of providing the basic knowledge of sensory evaluation, trial tests were carried out to ensure the reliability of the results. The basic knowledge included the instructions that should be followed in participating in a sensory evaluation.

Development of UV-VIS Spectrophotometric method to determine the Scoville Index of chillie varieties

Spectrophotometric method was carried out in order to grade different varieties of chillie quantitatively. Capsaicin standard solutions containing 10, 20, 30, 40 and 50 µg/ml were prepared in ethanol. A standard curve plotting absorbance against capsaicin concentration (µg/ml) was prepared. The absorbance values for each sample were measured at 281nm using the UV-VIS spectrophotometer (Model: 1601 Shimadzu, Japan). Triplicates were carried out in order to obtain high accuracy. The average absorbance of each variety was recorded. The Capsaicin concentrations of different varieties were calculated according to the calibration curve (Gonzales and Tamirano, 1973). The relationship between the Capsaicin concentration and the Scoville units was obtained using the following equation first suggested by Purthi (1998).

$$\text{Capsaicin (ppm)} \times 15 = \text{Scoville Unit}$$

The correlation coefficient was obtained by fitting data of relevant variable into Pearson Correlation Test using 'STATISTIX" software (Ver 2.0) for Windows.

Results and Discussion

The five tested varieties showed five different values for Scoville Index according to the sensory evaluation method. Scoville Indexes obtained from sensory evaluation method are shown in Table 3.

Table 3: Scoville Index of chillie varieties determined using the sensory evaluation method

Variety	Test schedule	Volume of extract	Scoville Index
MI1	B (0.25)	0.25	24000
Sannam best	C (0.1)	0.42	60000
Sannam Medium Best	B (0.25)	0.50	20000
Sannam Long	B (0.25)	0.40	25000
Cashmere	B (0.25)	0.56	18000

According to the sensory evaluation method, Sannam Best showed the highest pungency level out of the tested varieties while Cashmere showed the lowest pungency. The variation of the level of pungency of chillie depends on various reasons. Pith (the placenta that attaches the seeds to the fruit) contains a considerably high Capsaicin content compared to the other parts of the fruit. The

pith of the variety Cashmere is comparatively shorter than the other selected varieties resulting a low pungency level. Due to this, Cashmere chillie powder is mostly used for preparation of baby food items. The climate, soil condition, water schedule, weather too have an impact on the level of pungency in chillie. Capsicum plants that are stressed produce fewer fruits and those fruits will tend to be much hotter than the fruits on a similar type of bush that bears many fruits (The Chillie Pepper Institute, 2010). Thus, the similar varieties in different environmental conditions would result different levels of pungency. The results may also vary due to the personal bias and the taste fatigue. Even though there are several drawbacks in the sensory evaluation method, it can be accepted as a cost effective method that can be used in the absence of an equipped laboratory with specrophotometric and chromatographic instruments.

The pungency in Scoville Heat Units can be graded into three major categories as "Mild", < 5,000 SHU; "Moderate" , 5,000-20,000 SHU; and "Hot" , <20,000 SHU. Accordingly, MI 1, Sannam Best and Sannam Long could be categorized as "Hot" while Sannam Medium Best and Cashmere is categirized as "Moderate". The pungency grades of tested chillie varieties are shown in Table 4.

Table 4: Grading of chillie varieties according to Scoville Heat Units

Variety	SHU	Grade
MI1	24000	Hot
Sannam Best	60000	Hot
Sannam Medium Best	20000	Moderate
Sannam Long	25000	Hot
Cashmere	18000	Moderate

Scoville Indexes obtained by the spectrophotometric method are shown in Table 5.

Table 5: Scoville Index derived from the capsaicin content obtained by the spectrophotometric method

Variety	Concentration (µg/ml)	µg/50 ml	µg/g of chillie (ppm)	Scoville Heat Units
Sannam Best	13.348	667.399	2669.597	40043.956
Sannam Long	11.062	553.114	2212.454	33186.813
Sannam Medium Best	7.048	352.381	1409.524	21142.857
MI1	7.201	360.073	1440.293	21604.396
Cashmere	6.762	338.095	1352.381	20285.714

The comparison of the pungency level of different chillie varieties obtained by sensory evaluation method and the UV – VIS spectrophotometric data are given in Figure 1.

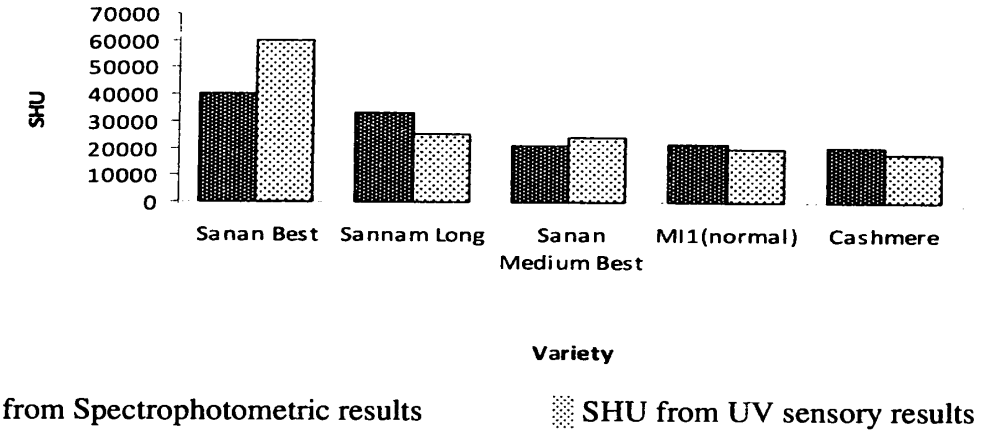

Figure 1: Comparison of pungency level of Scoville Index obtained from sensory evaluation method and spectrophotometric method

The results obtained for the Scoville Index in sensory evaluation method and the UV – VIS spectroscopic method has a significant relationship (r = 0.86). According to this value, there was a positive significant relationship between the two methods.

Conclusion

Chillie varieties can be categorized as hot, moderate and mild, according to the Scoville Index. These graded products can target the export market where the quality, grading and the healthiness of the food are highly concerned. The results obtained for the determination of Scoville Index in sensory evaluation method and the UV-VIS spectrophotometric method has a significant positive relationship (r = 0.86). Even though the sensory evaluation method is considered less precise in certain aspects, it has provided acceptable level of accuracy compared to the spectrophotometric method. The techniques developed in the present study to determine the pungency level of chillie can be used by the chillie exporters in order to attract novel markets in Europe, North America *etc* where the quality is a critical factor.

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