Enhanced Knowledge in Sciences and Technology Vol. 3 No. 1 (2023) 266-275
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EKST

Homepage: http://publisher.uthm.edu.my/periodicals/index.php/ekst
e-ISSN : 2773-6385

Sensory Evaluation of Fish Flavoured Spicy Tamarind Paste Prepared from Different Type of Chilies

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DOI: https://doi.org/10.30880/ekst.2023.03.01.030
Received 15 January 2023; Accepted 11 April 2023; Available online 3 August 2023

Abstract: Fish-flavoured spicy tamarind dish is one of the traditional foods in Malaysia, especially in Johor and Melaka. The main ingredient in the production of spicy tamarind dish is chilies which has a capsaicin component that gives an effect spiciness to food. The objective of this study to determine the capsaicin content before formulate a fish-flavoured spicy tamarind paste by optimizing the amount of fresh chilli, dried chilli type A and type B in the formulation. The capsaicin content was identified using High Performance Liquid Chromatography (HPLC) and was calculated using standard calibration curve that have been design. Therefore, Simplex Lattice Mixture Design (SLMD) by Design-Expert software was used to optimize the best formulation of fish flavor spicy tamarind in order to investigate the effects of different amount of fresh chilli, dried chilli type A and type B on the consumer acceptance towards sensory properties such as texture, colour, spiciness and overall acceptability by using a 9-point hedonic scale sensory test. The results show that, the capsaicin content for fresh chillies is 289.74±5.15 µg/g, dried chillies type A 311.99±6.08 µg/g and dried chillies type B 494.41±20.46 µg/g. The optimized conditions suggested by SLMD were found to be 0 % of fresh chilies, 12.8 % of dried chilies type A and 15.2 % of dried chillies type B. At the optimize conditions as given above, the highest preference of texture (6.58), colour (6.71), spiciness (6.98) and overall acceptability (7.42) were obtained. The high sensory analysis scores for all sensory properties indicated the success of this study which will benefit the research on fish-flavored spicy tamarind paste products and provide wide opportunities for new chili-based products developments in the future.

Keywords: Chilli, Capsaicin, Optimization

1. Introduction

Chili pepper has long been recognised as a delectable spice with a distinct aroma and flavour all across the globe. It is used to make spicy sauces and is used in Asian cuisines. Based on previous studies by Perucka and Oleszek (2000) [1] reported that the sensory qualities of hot pepper included colour,

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spiciness, and flavour, determine its value. Chilli peppers and their separated compounds, especially capsaicinoids, are valued for medicinal properties.

According to Zewdie (2000) [2], the quantity of capsaicinoids found in a chilli pepper pod is determined by the plant's genetic composition and growth conditions. The amount of capsaicin in a specific cultivar varies based on the amount of ambient light that plant receives, the age of the fruit, and the location of the fruit has been planted. Chilli peppers must be picked at the correct growth stage, according to the variety's and region's specific requirements.

Chili is the foremost essential ingredient in producing spicy tamarind dishes, one of the famous foods in some states in Malaysia. The origin and level of spiciness of dried chilies available on the market typically vary widely. To ascertain the differences between the dried chilis used in food products, it was chosen to use two varieties of dried chilies in this study. This study was conducted for the purpose of considering that some people use fresh chili in the production of spicy tamarind dishes, but it is less popular because most people use dried chilli in the production of a chili-based dish that is also made into chili paste. In Malaysia, "chilli boh," the most basic type of chilli paste, is prepared by cooking fresh or dried chilies with vinegar, salt, and occasionally garlic (Leisner *et al*.,1997) [3].

Sensory evaluation was conducted to find out which chili is suitable as the essential ingredient in the production of fish flavoured spicy tamarind paste. Food products that meet consumers' preferences will provide ideas and opportunities to the food manufacturing industry to produce more innovative food products in the future. Therefore, this research was conducted to optimize the preference formulation of fish flavoured spicy tamarind paste prepared from the mixture of different type of chilies.

2. Materials and Methods

2.1 Materials

The chilies used in this study were fresh chilies (*Capsicum annuum L. var. Kulai*) was taken from a plantation area Perak, Malysia, dried chilies type A was originated from China and dried chilies type B was originated from India.

2.2 Methods

2.2.1 Preparation of standard solution of capsaicin

Firstly, 1 mg of pure capsaicin from Sigma Aldrich (Burlington, MA, United States) was weighed and diluted in 10 ml of methanol (1:10) in the beaker. Secondly, the amount of standard capsaicin solution and 100% methanol that needed to fill up 1.5 ml of vial by make serial dilution using concentration 100, 200, 300, 400 and 500 μg/g was calculated and prepared.

2.2.2 Sample preparation for capsaicin content

All materials were first dried first and then with a few minor adjustments technique of extraction was used on them (Collins *et al*., 2018) [4]. Each dried pepper sample (5 g) was added to ethanol (5 ml) in a 120 ml glass bottle with a Teflon-lined cover to extract the capsaicin. Bottles were sealed, heated to 80 °C in a water bath for four hours, and then manually spun every hour. Samples were taken out of the water bath and chilled to room temperature between 68 and 76°F. Using a 5 ml disposable syringe was used the supernatant layer of each sample (5 mL) and filtered through 0.45 μm filter paper and placed in an HPLC sample vial (Millipore, Bedford, MA, USA). The vial was sealed and kept cold (at 5 °C).

2.2.3 HPLC for capsaicin content

Betasil C18 column (particle size 3 μm, dimension 150 × 4.6 mm) from Thermo Electron (USA) was used for HPLC analysis. The injection volume for sample was 5 μL, the column temperature was 60°C and sample temperature was 20°C. The mobile phase was methanol and distilled water (50:50 v/v). The flow rate was 1.5 mL/min. The UV detection wavelength was 222 nm.

2.2.4 Experimental design on the optimization process for the preparation of fish flavoured spicy tamarind paste.

Table 1 shows the variable ingredient in the production of fish flavoured spicy tamarind dish. The optimization process used Simplex Lattice Mixture Design (SLMD) by Design-Expert software was obtained four center points to investigate the effect of independent variables on the responses. After that, there are three variable ingredient (fresh chili, dried chili type A and dried chili type B) and four dependent variables (texture, colour, spiciness and overall acceptance). Each formulation has 28 % variable ingredient and 72 % was fixed ingredient. The results were compared to the predicted values by determining the error percentages. Results with less than 5% error were regarded as being in line with the predicted values. The percentage error numbers indicated that the models were adequate since there were no appreciable discrepancies between the experimental and predicted values.

$$\text{Percentage of error} = \frac{predicted\ value - experimental\ value}{experimental\ value} \times 100 \qquad \textit{Eq.1}$$

Table 1: Variable ingredient in the production of fish flavoured spicy tamarind paste

Run order	Variable ingredient					
	Fresh chili		Dried chili type A		Dried chili type B	
	%	g	%	g	%	g
1	0.0	0.0	28.0	50.0	0.0	0.0
2	0.0	0.0	14.0	25.0	14.0	25.0
3	0.0	0.0	28.0	50.0	0.0	0.0
4	9.3	16.6	9.3	16.6	9.3	16.6
5	14.0	25.0	14.0	25.0	0.0	0.0
6	28.0	50.0	0.0	0.0	0.0	0.0
7	14.0	25.0	14.0	25.0	0.0	0.0
8	18.7	33.4	4.7	8.4	4.7	8.4
9	4.7	8.4	4.7	8.4	18.7	33.4
10	28.0	50.0	0.0	0.0	0.0	0.0
11	14.0	25.0	0.0	0.0	14.0	25.0
12	0.0	0.0	0.0	0.0	28.0	50.0
13	4.7	8.4	18.7	33.4	4.7	8.4
14	0.0	0.0	0.0	0.0	28.0	50.0

2.2.5 Sample preparation for sensory evaluation

All paste formulations are prepared into a gravy with rice which is the custom served to consumers. Each type of gravy has been served as much as 30 g in a small plastic bowl (Meilgaard, Civille & Carr, 2007) [5]. 14 fish flavoured spicy tamarind dish and 14 plate of rice has been placed on a tray with a cup of water. Panellists are also provided with score sheets and pens to fill in their opinions on each fish flavoured spicy tamarind pastes formulation that has been served.

2.2.6 Selection of panelist

Panellists are frequently chosen randomly from consuomers who frequent a specific place, such as a grocery store or a shopping mall. On the other hand, the test completed with people around Johor Bahru and Batu Pahat. According to ASTM (1968), Hootman (1992) [6], Meilgaard, Civille & Carr.,

(2007) [5] and Stone and Sidel (2004) [7], at least 30 panellists must acquire a thorough knowledge of consumer opinions, with more preferred. Therefore, this test has been used 100 untrained panellists.

2.2.7 Statistical analysis

One- way ANOVA were done by using Microsoft Excel 15.0 for Excel 2010, United States with *p*-values ≤ 0.05, considered significant different. The t-test was applied to the data with significant level of 0.05 using the Microsoft Excel. The percentage of fresh chili, dried chilli type A and dried chilli type B were the independent variables while the sensory properties such as texture, colour, spiciness, and overall acceptance were the responses measured in this study.

3. Results and Discussion

3.1 Determination of capsaicin content

The capsaicin content was extracted from fresh chilli, dried chilli type A and dried chilli type B as shown in Table 2. The amount of capsain content in fresh chili, dried chili type A and dried chili type B was calculated.

Table 2: Capsaicin concentration in fresh and dried chilli peppers

Type of chili	Capsaicin (μg/g)
Fresh chili	289.74±5.15[a]
Dried chili type A	311.99±6.08[a]
Dried chili type B	494.41±20.46[b]

Means values followed by the different letter within a column are significant different *(p<0.05)*

The level of capsaicin in two dried chilli samples is higher than fresh chilies due to temperature and peroxidase enzyme activity. The hydrolysis of glycosides in the fruit caused by blanching and drying heat is another explanation for an increase in capsaicin levels in dried chillies. According to Topuz and Ozdemir, (2004) [8] found that Turkish paprika chilli that had been sun-dried for 5-7 days had lost 24.6 % of its capsaicin level after being dehydrated for 90 minutes at 70 °C. Dried chilli type A (311.99±6.08 μg/g) had the low capsaicin content compare dried chilli type B had the highest capsaicin concentration (494.41±20.46 μg/g) while fresh chilli had (289.74±5.15 μg/g) capsaicin content. The difference in the capsaicin plays a role in the spiciness of food products produced, such as fish flavour spicy tamarind paste.

3.2 Sensory evaluation

Previously, fresh chili, dried chilies type A and dried chilies type B was chosen as the variable ingredient in fish flavoured spicy tamarind dish with 14 formulation using 100 panellists. This part of study discusses the results of sensory evaluation using affective test.

Table 3: Means score of sample attribute from panellist of preference test

Run order	Coded samples	Fresh (g)	Dried chilli type A (g)	Dried chilli type B (g)	Sensory Parameter			
					Texture	Colour	Spiciness	Overall acceptance
1	849	0.00	50.00	0.00	5.82±0.46[a]	5.75±0.74[a]	5.83±0.49[a]	5.74±0.60[a]
2	803	0.00	25.00	25.00	5.78±0.65[a]	5.75±0.66[a]	5.85±0.66[a]	5.59±0.51[a]
3	924	0.00	50.00	0.00	6.49±0.54[a]	6.54 ±0.58[a]	6.49 ±0.54[a]	6.50 ±0.50[a]

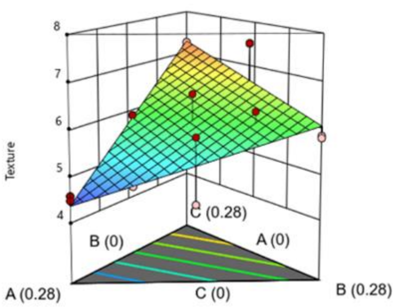
4	859	16.60	16.60	16.60	5.93±0.36[a]	5.03±0.22[a]	5.10±0.96[a]	5.41±0.49[a]
5	721	25.00	25.00	0.00	5.83±0.60[a]	5.79±0.74[a]	5.85±0.59[a]	5.68±0.58[a]
6	983	50.00	0.00	0.00	4.58±0.78[a]	4.66±0.88[a]	4.63±0.77[a]	4.48±0.70[a]
7	641	25.00	25.00	0.00	4.59±0.95[a]	4.98±0.20[a]	4.60±0.51[a]	4.45±0.50[a]
8	468	33.4	8.40	8.40	4.36±0.58[a]	4.40±0.62[a]	4.38±0.58[a]	4.52±0.50[a]
9	871	8.40	8.40	33.40	5.89±0.49[a]	5.90±0.61[a]	5.90±0.52[a]	5.78±0.63[a]
10	`619	50.00	0.00	0.00	4.48±0.72[a]	4.49±0.77[a]	4.55±0.70[a]	4.55±0.61[a]
11	418	25.00	0.00	25.00	7.26±0.65[b]	7.10±0.58[b]	5.25±0.98[a]	4.89±0.40[a]
12	783	0.00	0.00	50.00	7.17±0,65[b]	7.15±0.72[b]	5.18±0.67[a]	4.91±0.51[a]
13	964	8.40	33.40	8.40	6.22±0.48[a]	6.08±0.56[a]	6.25±0.56[a]	6.03±0.50[a]
14	542	0.00	0.00	50.00	7.51±0.54[b]	7.49±0.58[b]	7.57±0.50[b]	7.61±0.51[b]

Means values followed by the different letter within a column are significant different ($p<0.05$)

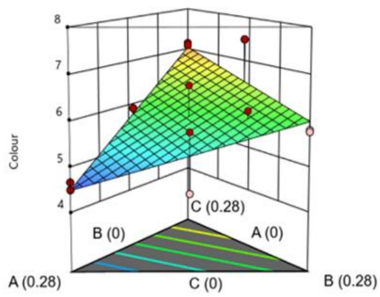
Based on Table 3, the mean of the formulation that only used fresh chili in the texture parameter had a lower value than the formulation that used dried chili types A, B, or a combination of the three chilies. After that, for the colour parameter, the mean for the formulation that uses only dried chili type B has the highest value (7.49) compared to the other formulations. There is a significant difference between the formulation that uses dried chili type B and the formulation that has a mixture of the three types of chili that has the lowest mean value, which is 4.40. As for the spiciness parameter, it shows the same results, where the highest mean value is the formulation that uses dried chili type B which is 7.57 and the lowest mean is 4.38 (mixture of all three types of chili). Then, for the fourth parameter, which is overall acceptance, the mean value of using dried chili type B was the highest at 7.61, while the mixture of fresh chili and dried chili type A has the lowest mean value at 4.45.

3.2.1 Sensory analysis attribute

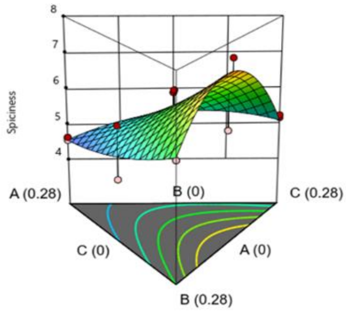
This study was conducted to formulate fish-flavoured spicy tamarind paste and to optimize the ingredients variables (percentage of fresh chilli, dried chilli type A and type B using Design of Experiment (DoE) in simplex lattice design. The mean response values for sensory analysis are presented in Table 3.2. Figure 3.1 (a)-(d) show the representation of the predicted values of the response surface models as 3D graph for four parameters which were texture, colour, spiciness and overall acceptance.



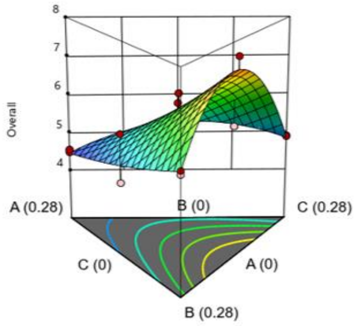
b) Texture



a) Colour



c) Spiciness



d) Overall acceptance

Figure 1 : Response surface plot showing parameter of a) texture, b) colour, c) spiciness and d) overall acceptance on fish flavoured spicy tamarind pastes

The ANOVA findings showed that the linear and quadratic models were comparable for practically all sensory qualities. Linear model fit to texture and colour, while the quadratic model was for spiciness and overall acceptability. The R^2 is a statistical measure in a regression model that determines the proportion of variance in the dependent variable that can be explained by the independent variable. It was discovered that low R^2 values were frequently observed on consumer assessments of food appearance. The value of R^2 at least 60 % was required since the behaviour of molecules or other particles may be predicted with high precision in the field of pure science. However, an R^2 lower than that is typically acceptable for studies involving people since predicting human behaviour is challenging (Peterson, 2016) [11]. Additionally, it was discovered that low R^2 values were frequently observed on consumer assessments of food appearance in a number of earlier studies (Zwimpfer, 2013) [12]. Then, according to Pattabhiraman (2020) [13], value of R^2 below than 0.3 is weak, value between 0.3 and 0.5 is moderate and value more than 0.7 means strong effect on the dependent variable. The dependent variable was strongly impacted by the colour parameter, as seen by its lowest R^2 value (0.65), which was close to 0.7.

Figure 1 (a) presents the results from the preference test for the fish-flavoured spicy tamarind paste on the texture characteristic ($p<0.05$; $R^2 = 0.78$). The panellists favoured textures made with dried chilies type A and type B over those made with fresh chilies based on 3D graph shown above. Texture can affect taste in a variety of ways, and food texture causes a psychological reaction that determines whether or not the food is palatable (Mathoniere, Mioche, Dransfield, and Culioli, 2000) [14]. Discriminative touch, jaw position or movement, pain, and feelings of cold and warmth are the four main senses that are involved in texture perception. Szczesniak (2002) [15] states that texture is one of the important parameters of sensory evaluation, but cannot be treated as the absence of a defect.

The Figure 1 (b) displays the typical preference test response rate for parameter of attribute colour. A linear model was used to match the colour of fish flavour spicy tamarind paste ($p<0.05$; $R^2 = 0.65$). The panellists prefer colours made with dried chilies type B over those made with fresh chilies and dried chili type A. This is might be due to the drying process, which makes the dried chili darker. Employing eyesight to evaluate the food's colour, size, shape, and other potential flaws is the optimal drying procedure (Park & Kim, 2007; deHamer, 2012) [16] [17]. In sensory evaluation, colour one of the important parameters while indicate the preference test to the consumers. According to Brown (2010), the sensory evaluation process begins with vision, enabling people to form perceptions about any food product without actually tasting it.

The Figure 1 (c) displays the data that have been analysed based on preference test response rate for the spiciness characteristic of a spicy tamarind paste. ($p<0.05$; $R^2 = 0.70$). The panellists prefer spicy foods that use dried chilies rather than fresh ones, which shows the panellist can distinguish different levels of spiciness from each formulation. This shows that most of the panelists involved in this test are more interested in spicy food than non-spicy. Testing to determine the level of taste in a food product is important to ensure consumers can accept it. Hot air drying (HD) is now widely used to dried chillies due to its rapid drying time, uniform heating, and better sanitary qualities. Drying time is shortened to less than 20 hours when the temperature is between 45 ℃ and 70 ℃ (or around 10 % moisture content). According to studies by Menguez-Mosquera *et al*. (1994) [18], Daz-Maroto *et al*. (2003) [19], Ibrahim *et al*. (1997) [20], and Berke and Shieh (2001) [21], this temperature range minimising volatile oil loss.

The Figure 1 (d) shows the data that have been recorded and analyzed based on the overall acceptance parameter for the spicy tamarind paste ($p < 0.05$; $R^2 = 0.78$). Overall acceptance is an important parameter to determine the formulation that is more accepted by the panellists in each formulation. According to Mela (2001) [22], the overall acceptability of a food is determined by the product's sensory quality as well as the consumer's perception of the food. The optimal choice of main ingredients is important to achieve the right texture and organoleptic properties, and the quantity of ingredients used also plays an important role in obtaining a product that is accepted by consumers and is in accordance with consumer demand. This parameter helps to determine which formulation is preferred by the consumer and can optimize the appropriate formulation using the attribute parameters that have been measured. In this parameter, the panelists preferred formulations that had a combination of variable ingredients of dried chili type A and dried chili type B. This shows that most of the panelists did not choose fresh chilies in the last aspect of fish-flavoured spicy tamarind paste product which is the overall acceptance. These results indicate that fresh chili is not a suitable variable ingredient in the production of fish-flavored spicy tamarind paste.

Then, the percentage coefficient of variance (CV %) for the all parameter in range of 9.14% to 11.22 %. The CV % for texture (9.14 %), colour (11.18 %), spiciness (11.22 %) and overall acceptance (10.00 %). The uses of the classification and states that CV lower than 10% can guarantee high accuracy of the experiment (Cargnelutti Filho *et al*., 2018) [23]. In contrast, according to Jelliffe *et al.*, (2015) [24] the upper acceptable limit of CV % is often arbitrarily taken to be 15% or 20%. The results show the CV % for all parameter which were texture, colour, spiciness and overall acceptance in between 9 % and 12 % of CV.

3.3 Response optimization

According to Arunkumar (2009) [25], reported that the desirability near 1.00 is the most acceptable for the optimization of the mixture. A constrained mixture design was used and predicted the best formulation of the variable ingredient in fish flavoured spicy tamarind paste which were fresh chilies, dried chilies type A and dried chilies type B with appropriate responses of each food parameters were presented in Table 3.3.

Table 4: Optimization formulation for fish flavoured spicy tamarind paste

Fresh chili	Dried chili type A	Dried chili type B	Texture	Colour	Spiciness	Overall acceptance	Desirability
0.00	12.8	15.2	6.72	6.56	7.18	7.24	0.84

Based on Table 4, the optimized formulation was mentioning the condition exhibited texture (6.72), colour (6.56), spiciness (7.18) and overall acceptance (7.18). The desirability of the formulation is 0.84 and the values of desirability functions lie between 0 and 1. According to Derringer and Suich, (1980) [26] and Jeong and Kim (2009) [27], the value 0 is attributed when the factors give an undesirable response, while the value 1 corresponds to the optimal performance for the studied factors.

3.4 Validation of model

The linear model and quadratic model developed by SLMD was previously recommended through optimization analysis as 14 mixes. The optimized formulation (0.00 % of fresh chilies, 12.80 % of dried chilies type A and 15.20 % of dried chilies type B) with the highest appeal was chosen for the validation procedure. Table 5 shows the illustrates of predicted and experimental results for the optimized formulations.

Table 5: Illustrates the predicted and experimental results for the optimized formulations

Parameter	Experimental value	Predicted value	Percentage error (%)
Texture	6.58	6.72	2.08
Colour	6.71	6.56	2.29
Spiciness	6.98	7.18	2.76
Overall acceptance	7.42	7.24	2.54

The experimental values were 6.58 (texture), 6.71 (colour), 6.98 (spiciness), and 7.42 (overall acceptability), while the predicted response values were 6.72 (texture), 6.56 (colour), 7.18 (spiciness), and 7.24. (overall acceptance). The percentage of errors obtained were 2.08 %, 2.29 %, 2.76 %, and 2.54 %. (Table 4.7). To be considered acceptable, the percentage error value must be lower than 10% (Varma & Simon, 2006) [28]. In this investigation, the various results were 2.08 %, 2.29%, 2.76 %, and 2.54 %, which were acceptable and validated the model. The desirability of formulation in combination between dried chilies type A and type B was acceptable.

4. Conclusion

The capsaicin content in variable ingredient which are fresh chilies, dried chilies type A and dried chilies type B have been identified. The formulation of fish flavour spicy tamarind paste had been successfully developed and optimized with the used of variable ingredient which are fresh chilies, dried chilies type A and type B by using RSM. The optimized conditions obtained was 0.00 % of fresh chilies, 12.80 % of dried chilies type A and 15.20 % of dried chilies type B. At this optimized condition, the score of texture (6.58), colour (6.71), spiciness (6.98) and overall acceptability (7.42) had below than 3.00 % of percentage error. From the result, it can be concluded that the formulations of fish flavour spicy tamarind paste were successful due to the improvement in all sensory scores which indicated increased consumers' acceptance towards the products. Further studies should be conducted to determine the nutritional compositions and possible addition of ingredients such as protein replacement to fish flavoured spicy tamarind paste.

Acknowledgement

The authors gratefully acknowledge the Department of Food Sciences and Technology, Faculty of Applied Sciences and Technology, University Tun Hussein Onn Malaysia, Pagoh for providing necessary facilities for the successful completion of this research work.

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