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Effect of spices on sensory characteristics of catfish emulsion products

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Abstract

Objectives of this research were to screening 7 spices including of black pepper, white pepper, coriander seeds, garlic, cumin, cinnamon and nutmeg powder that influence on spices odor and fishy odor of catfish emulsion products as 12 runs Plackett-Burman design by using trained panels. A result indicated that there was significant effect of black pepper and white pepper on fishy odor. In addition, significant effect of coriander seeds on rancid odor was found. Therefore, these 3 spices were used to determine their effect on sensory characteristics and consumers' liking in the next part. Response surface methodology was used to study the effects of selected spices (black pepper, white pepper and coriander seeds) on sensory characteristics and consumers' liking of the catfish emulsion product. The results revealed that black pepper and coriander seeds had the affected on spices odor. Black pepper, white pepper, and coriander seeds had the affected on rancid odor, consumers' spices odor liking and overall liking of catfish emulsion products. The highest spice odor and the lowest rancid odor of sample obtained with the highest level of these spices used. The highest consumers' spices odor liking and overall liking values of catfish emulsion products were found at the highest amount of black pepper, white pepper, and coriander seeds for 0.2, 0.2 and 3%, respectively.

Introduction

Catfish has been very popular freshwater fishes. In Thailand, catfish aquaculture production continuously increases with the yield of over 136,000 tons (the value of 4,710.27 million Bath) in 2008 (Noorit, 2012). Usually in Thailand, the consumers have been consumed in fresh more than product forms. Since, catfish comprise high level of 8.99-10.6% oil (Ibrahim and Yusof, 2012). This oil could be oxidized between processing such as during grinding, mixing and heating. Lipid oxidation can cause rancid flavor and fishy odor, changes of texture and color and essential fatty acids loss (Pornchareanwong and Rattanapanon, 2010). In addition Lindsay (1988) was reported fishy odor can be cause by auto-oxidation that activates by light and iron in the center of heme molecule. -2, 4, 7-decatrienal is final product of auto oxidation that cause rancidity odor and fishy odor.

In meat and fish emulsion products, the spices such as black pepper, white pepper, coriander seeds, garlic, cumin, cinnamon and nutmeg powder are used to decrease unaccepted natural flavors of raw materials and increasing the consumers' liking of final products. As a reason of high fishy odor in catfish emulsion product, the spices could be used to dissolve this problem. However, no information of the spices effecting on sensory characteristics of catfish emulsion product is reported. Therefore, the objectives of this study was to investigate the effect of black pepper, white pepper, coriander seeds, garlic, cumin, cinnamon and nutmeg powder on fishy odor and spices odor of catfish emulsion product using Plackett -Burman design. In addition, the effects of selected spices on sensory characteristics, consumers' spices odor liking and overall liking using central composite design were studied.

Materials and Methods

Materials

The spices used in this study were black pepper powder, white pepper powder (ArtjitInternational Pepper and Spice Co., Ltd.), coriander seeds, garlic powder (Inter Herd Co., Ltd.), cumin powder (Herbs and Spices Land Co., Ltd.), cinnamon powder, and nutmeg powder (Herbs and Spices Land Co., Ltd.). Hybrid catfish (*Clarias macrocephalus X Clarias gariepinus*) were purchase from local market in Khon kaen province Thailand.

Catfish fillets preparations

Hybrid catfish was carved and freeze at -37°C until its inner temperature fell to -20°C and then frozen the fillets at -18°C until used.

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Influence of spices on odors of catfish emulsion product

The catfish emulsion products samples were prepared follow by firstly; fish fillet was chopped (Jrd 120 model single-screw grinder, Inspire March Co., Ltd China) and blend using a silent cutter (TQ-5 model, Better Pack Company Limiter) with 2% sodium chloride, 0.2% sodium tripolyphosphate, 3% soy protein isolate and different concentration of spices (0.1 - 0.2% of black pepper, white pepper, garlic, cumin, cinnamon and nutmeg powder and 1.5 – 3% of coriander seeds) 12 runs Plackett-Burman design was adopted for the study as showed in Table 1. Secondly, the sol was stuffed into a 2.5 cm diameter and 25 cm long aluminum casing using a stuffer (Dick; D73728, Esslingen, Germany). Finally, the sample was incubated at 95^0C for 20 min in a water bath (Thermo Haake, Karlsruhe, Germany). After heating, the gel was immediately cooled in ice water for 20 min, packed in polyethylene bags and kept at 4^0C for evaluate within 48 hours.

To evaluate the effect of spices on spices odor and fishy odor of catfish emulsion product, the catfish emulsion products were cooked using microwave at 400 watt for 1.3 minutes before serving. Eleven trained panels were evaluated 12 catfish emulsion samples in the individual a booth with questionnaire. Panels are evaluated the catfish emulsion samples for a spices odor and fishy odor attributes using structural line scale (scale for spices odor, 0 = no spices odor, 100 = spices odor extremely and scale for fishy odor, 0 = no fishy odor, 100 = fishy odor extremely). Each sample was coded with randomly selected three-digit numbers. The panelists were instructed to cleanse their palates between the samples using water.

The spices showed significant effect on spices odor and fishy odor (has different effect at low concentration) were selected to use in next experiment. In addition, the spices showed non-significant effect on spices odor and fishy odor (has not different effect at high concentration) were still used at low concentration in next experiment.

Influence of selected spices on sensory characteristics and consumers' liking of catfish emulsion product

Response surface methodology (RSM) was used to study the effects of selected spices (black pepper, white pepper and coriander seeds) on sensory characteristics and consumers' liking of the catfish emulsion product. Rang of black pepper, white pepper and coriander seeds explored in this study were 0.1-0.2, 0.1-0.2 and 1.5-3% respectively. Three factors of central composite design (CCD) with three central points and two levels of axial point were calculated as HU (1999). The data were analyzed by using respond surface methodology regression to fit the following first-odor and second-odor polynomial to all dependent Y valuables. The assessment of error was derived from three replications of the central point treatment condition. The significant level was defined at $P<0.05$.

The catfish emulsion product samples were prepared follow by firstly; fish fillet was chopped (Jrd 120 model single-screw grinder, Inspire March Co., Ltd China) and blend using a silent cutter (TQ-5 model, Better Pack Company Limiter) with 2% sodium chloride, 0.2% sodium tripolyphosphate, 3% soy protein isolate, 0.1 % of garlic, cumin, cinnamon and nutmeg powder and seventeen combinations of selected spices (black pepper, white pepper and coriander seeds) were organized according to central composite design (Hu, 1999). Secondly, the sol was stuffed into a 2.5 cm diameter and 25 cm long aluminum casing using a stuffer (Dick; D73728, Esslingen, Germany). Finally, the sample was incubated at 95^0C for 20 min in a water bath (Thermo Haake, Karlsruhe, Germany). After heating, the gel was immediately cooled in ice water for 20 min, packed in polyethylene bags and kept at 4^OC for evaluate within 48 hours. The catfish emulsion products were cooked using microwave at 400 watt for 1.3 minutes before serving.

Sensory evaluation

The samples were tested by eleven trained panels in individual booth. The 17 samples were served in a random order and eleven panels were evaluated the spices odor, rancid odor, fishy odor, springiness, firmness, cohesiveness, and smoothness in a structure line scale (scale for spices odor, 0=no spices odor and 100= spices odor extremely; scale for rancid odor, 0=no rancid odor and 100= rancid odor extremely; scale for fishy odor 0=no fishy odor, and 100=fishy odor extremely; scale for springiness 0= no springiness, and 100=springiness extremely; scale for firmness, 0=no firmness and 100= firmness extremely; scale for cohesiveness, 0=no cohesiveness and 100= cohesiveness extremely and scale for smoothness, 0=no smoothness and 100 = smoothness extremely). (Wiriyajaree, 2002).

Consumers liking test

The samples were evaluated by 48 consumers who had eaten meatballs equal to or more than three times a week. The 17 samples were served in a random order and the consumers evaluated the spices odor liking and overall liking by using 9-point hedonic scale. (1=dislike extremely, 9=like extremely). The panelists were instructed to cleanse their palates between the samples using water.

Table 1. Plackett-Burman design in 12 runs for catfish emulsion samples preparation

Runs	Pattern	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11
1	++++++++++	+1	+1	+1	+1	+1	+1	+1	+1	+1	+1	+1
2	-+-+++---+-	-1	+1	-1	+1	+1	+1	-1	-1	-1	+1	-1
3	--+-+++---+	-1	-1	+1	-1	+1	+1	+1	-1	-1	-1	+1
4	+--+-+++---	+1	-1	-1	+1	-1	+1	+1	+1	-1	-1	-1
5	-+--+-+++--	-1	+1	-1	-1	+1	-1	+1	+1	+1	-1	-1
6	--+--+-+++-	-1	-1	+1	-1	-1	+1	-1	+1	+1	+1	-1
7	---+--+-+++	-1	-1	-1	+1	-1	-1	+1	-1	+1	+1	+1
8	+---+--+-++	+1	-1	-1	-1	+1	-1	-1	+1	-1	+1	+1
9	++---+--+-+	+1	+1	-1	-1	-1	+1	-1	-1	+1	-1	+1
10	+++---+--+-	+1	+1	+1	-1	-1	-1	+1	-1	-1	+1	-1
11	-+++---+--+	-1	+1	+1	+1	-1	-1	-1	+1	-1	-1	+1
12	+-+++---+--	+1	-1	+1	+1	+1	-1	-1	-1	+1	-1	-1

When X1: Black pepper, X2: White pepper, X3: Coriander seeds, X4: Garlic, X5: Cumin, X6:Cinnamon, X7:Nutmeg and X8-X11: Dummy variables

Results and Discussion

The effect of spices on spices odor and fishy odor of catfish emulsion product

Plackett-Burman designs were used to screen the effect of 7 spices including of black pepper, white pepper, coriander seeds, garlic, cumin, cinnamon, and nutmeg on spice odor and fishy odor of catfish emulsion product. From the result revealed that black pepper, white pepper and coriander seeds affecting on spices odor and fishy odor of catfish emulsion product (T=80%), its means that the high concentrations of black pepper, white pepper and coriander seeds have higher influence (significant value of more than +1.533) on spices odor and fishy odor than at low concentrations as showed in Table 2. Whereas, a T value of garlic, cumin, cinnamon and nutmeg powder showed non-significantly different (there were no different in spices odor and fishy odor at high concentration of these spices). This was probably due to the black pepper and white pepper comprised of volatile oil such as phenolic ethers: r-cymene methyl ether, myristicin, safrole and ketone: di-hydrocarvone, piperitone aldehydes, piperinal, caryophyllene oxide that caused spice odor and spice taste in pepper (Thai Health Foundation, 2004). Coriander seeds has anti-oxidation properties corresponding as Anilakumar *et al.* (2001) was reported coriander seeds can reduce hexachlorocyclohexane (HCH) formation in rat liver, which HCH is product from oxidation reaction.

Table 2. Effect of the variables and statistical analysis of Plackett-Burman design

Effect	Spices odor	Fishy odor	Sig. T=80 df=4
White pepper	2.57*	-1.55*	1.533
Black pepper	1.86*	-1.16	
Coriander seeds	0.75	-1.74*	
Garlic	1.09	-0.49	
Cumin	1.08	-0.86	
Cinnamon	0.87	-0.15	
Nutmeg	0.27	-0.46	

*Significantly difference at t-test = 80% degree of freedom =4

However, spices that non-significantly effect on spices comprised difference type of volatile oil such as garlic essential oil comprises trisulfide di-2-propenyl (32.76%), diallyl disulfide (28.41%) and trisulfide methyl 2-propenyl (14.26%) (Anassori *et al*., 2001). In addition garlic essential oil is effective on free radical and has anti-oxidation (Lawrence and Lawrence, 2011). Cumin contains oil which comprise ketone carvone hasn't less than 50% by volume and 40-50% of terpene, d-limonene; moreover, cumin oil has carveol and dihydrocarvone slightly (Mernwongyard, 2014). Nutmeg oil is a volatile essential oil from nutmeg (Myristica fragrans) containing numerous components such as α-thujene, α-pinene, camphene, P-menth 1-en-4ol and β-ocimene etc (Helen *et al.*, 2012). In addition Muchtaridi *et al.* (2010) has been reported that the volatile compounds of nutmeg seeds essential oil identified in the blood plasma correlate with the locomotor-inhibiting properties of the oil when administered by inhalation. Cinnamon oil comprised essential that inhibition *Streptococcus mutans* (major causative bacteria of dental plaque) (Gupta *et al*., 2011). In addition, cinnamon oil can be inhibiting the initiation and propagation step of oxidation that leading to the termination of the reaction and delay the oxidation process (Jakhetia *et al*., 2010).

Therefore, black pepper, white pepper and coriander seeds were selected to study their effect on sensory characteristics and consumers' liking of catfish emulsion product. However, garlic, cumin, cinnamon and nutmeg powder were still used at low concentration in the product formulas.

The effects of selected spices on sensory characteristics of catfish emulsion products

The effects of selected spices on sensory characteristics were investigated by response surface

Table 3 Significant of regression models of the effect of black pepper, white pepper and coriander seeds concentrations on sensory characteristics and consumers' liking of catfish emulsion product

Sensory Characteristics	Model			Coefficient									Lack of fit	Agj_R^2
	Linear	Quadratic	Constant	X_1	X_2	X_3	X_{12}	X_{13}	X_{23}	X_{11}	X_{22}	X_{33}		
Fishy odor	0.17	0.42											0.72	0.21
Spices odor	0.00**	0.76	2.97	5.43		0.99							0.91	0.72
Rancid odor	0.00**	0.00**	11.45	25.12	18.30	-3.11		6.87	6.13	-188.59			0.024*	0.94
Smoothness	0.57	0.16											0.07	-0.06
Springiness	0.25	0.64											0.086	0.09
Cohesiveness	0.77	0.84											0.27	-0.13
Consumers' liking														
Spices odor' liking	0.00**	0.69	2.73	8.67	9.39	0.49							0.05	0.53
Overall liking	0.00**	0.31	3.55	8.04	8,24	0.48							0.02	0.54

Significance: *0.05, **0.01; non significance: ns

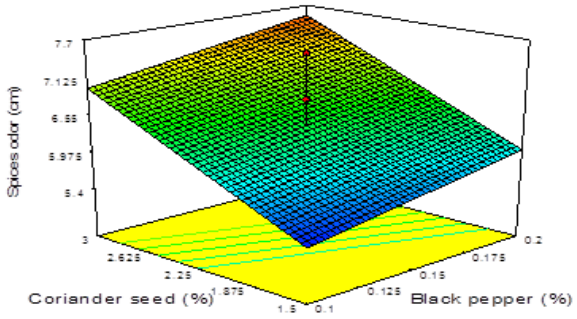
methodology over a range of 0.1-0.2% black pepper and white pepper and 1.5-3% coriander seeds. The correlation between three spices concentration on spice odor and rancid odor of catfish emulsion product were found as linear and quadatic terms, respectively. However, there was non significantly effect of three spices concentration on fishy odor, smoothness, springiness, firmness, and cohesiveness were obtained (P>0.05) as showed in Table 3.

Table 3 revealed that changes in black pepper and coriander seeds concentration took into account of changes in spices odor. In addition, rancid odor of catfish emulsion product was changed according to three spices concentration changed. Spices odor models showed a non significant lack of fish (P>0.05) and rancid odor models showed a significant lack of fish (P<0.05) indicating that the spices odor was showed adequate for prediction. However rancid odor model was showed not adequate for prediction as Table 3.

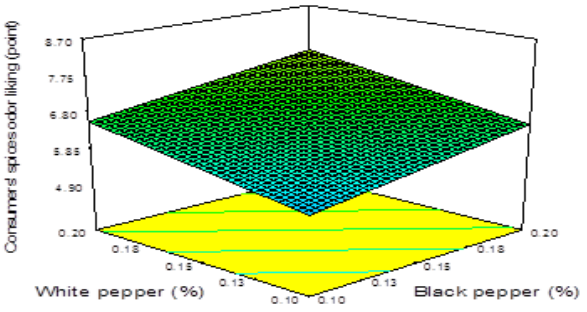
Estimated response surfaces were plotted for spice odor and rancid odor of catfish emulsion products. The results showed that an increase in black pepper and coriander seeds resulted in an increase spices odor of catfish emulsion products. An increasing in black pepper, white pepper and coriander seeds resulted in a decrease catfish emulsion product's rancid odor as showed in Table 3, Figure. 1A, and 1B (Figure of the effect of coriander seeds on emulsion type catfish product's rancid odor hadn't shown). The highest spices odor was found at the highest concentration of black pepper and coriander seeds with the value of 0.2 and 3%, respectively. Whereas, the lowest rancid odor was observed at the highest concentrations of black pepper, white pepper and coriander seeds with the value of 0.2, 0.2 and 3%, respectively, because black pepper and white pepper comprise essentials oil such as phenolic, ethers and ketone. Fishy odor and rancid odor can cause by lipid oxidation in fish meat between processing (Lindsay, 1988). In addition Ramadan and Wahdan (2012) have been reported blend 12-22% of cumin seeds oil and 26-36% of coriander seeds oil with corn oil that leading to reduce oxidation reaction in the product. In this study microwave treatment was applied to cooked catfish emulsion samples before served. This was corresponded with a study of Plessi *et al*. (2002) who suggested microwave treatment seems to preserve the principal aroma compounds of white and black pepper had significant the influence on rancid odor.

The effects of selected spices on consumers' spices odor liking and overall liking of catfish emulsion product

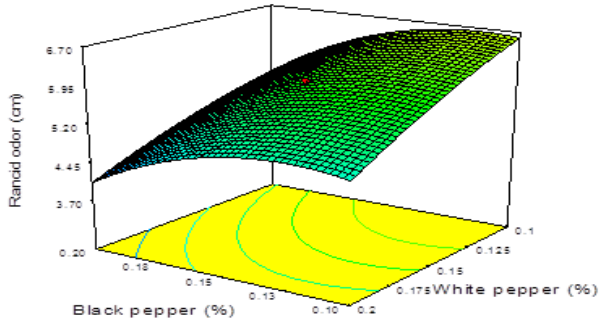
In the case of consumers' liking, the correlation of three spices concentration on consumers' spices odor liking and overall liking of catfish emulsion product were found as linear terms (P<0.05) as showed in Table 3. Mathematical models expressing the correlation were shown in Table 3 that showed changes in black pepper, white pepper and coriander seeds concentrations took into account of changes in consumers' spices odor liking. In addition, consumers' overall liking of catfish emulsion product was changed according to three spices concentration changed. Consumers' spices odor liking and overall



1A

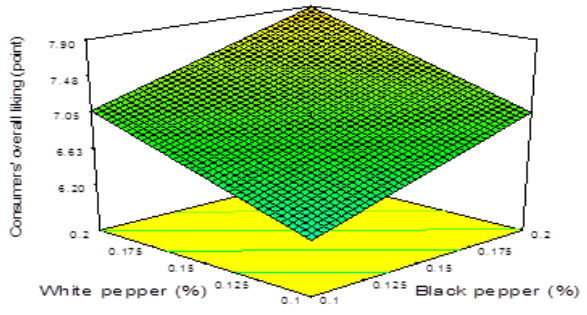


2A



1B

Figure 1. (A) Response surface plots of catfish emulsion product's spices odor with respect to black pepper and coriander seeds additions. (B). Response surface plots of catfish emulsion product's rancid odor with respect to black pepper and white pepper additions



2B

Figure 2. (A) Response surface plots of consumers' spices odor liking of catfish emulsion product with respect to black pepper and white pepper additions. (B). Response surface plots of consumers' overall liking of catfish emulsion product with respect to black pepper and white pepper additions

liking model showed a significant lack of fit ($P<0.05$), indicating that the models were not adequate for prediction (Table 3).

Estimated response surfaces were plotted for consumers' spices odor liking and overall liking of catfish emulsion products. The results showed that the highest consumers' spices odor liking and overall liking were found at the highest concentration of black pepper, white pepper and coriander seeds with the value of 0.2, 0.2 and 3%, respectively as showed in Figure. 2A, 2B (Figures of the effect of coriander seeds on consumers' spices odor liking and overall liking of emulsion type catfish product hadn't shown). Black and white peppers comprised of volatile compound, anti-oxidation and anti-microbial reagents. This was corresponded with a study of Dorman and Deans (2000) that reported that the volatile oils of black pepper were assessed for antibacterial activity against 25 different genera of bacteria. These included animal and plant pathogens, food poisoning and spoilage bacteria. The volatile oils exhibited considerable inhibitory effects against all the organisms under the test while their major components demonstrated various degrees of growth inhibition.

Conclusion

As the conclusion The black pepper, white pepper, and coriander seeds had the affected on spices odor, rancid odor, consumers' spices odor liking and consumers' overall liking of catfish emulsion products, rancid odor of catfish emulsion products significantly decreased with increases in amounts of black pepper, white pepper and coriander seeds addition. The spices odor of catfish emulsion products were significantly increases with increases in amounts of black pepper and coriander seeds addition. Consumers' spices odor liking and overall liking of catfish emulsion products significantly increase with increases in amounts of black pepper, white pepper and coriander seeds addition, because those spices comprise volatile oil and anti-oxidation as previous description.

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