ลักษณะทางประสาทสัมผัสด้านกลิ่นของข้าวผัด

Aroma Characteristics of Fried Rice

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บทคัดย่อ

การผัดเป็นเทคนิคการประกอบอาหารที่ช่วยทำให้อาหารมีกลิ่นรสดีขึ้น โดยเฉพาะอาหารที่ผ่านการผัดแบบไฟแดงซึ่งจะมีกลิ่นควันหรือกลิ่นไหม้เฉพาะตัว งานวิจัยนี้มีจุดประสงค์เพื่อจำแนกคุณลักษณะกลิ่นในตัวอย่างข้าวผัดสองชนิด ได้แก่ ข้าวผัดไฟแดง และข้าวผัดธรรมดา โดยใช้เทคนิคการวิเคราะห์ทางประสาทสัมผัสเชิงพรรณา (Descriptive Sensory Analysis) ผู้ทดสอบทั้งหมด 8 คนทำการประเมินตัวอย่าง ผลการทดสอบพบ 12 คุณลักษณะกลิ่นที่ในตัวอย่างข้าวผัดทั้งสองชนิดได้แก่ กลิ่นน้ำมันผ่านความร้อน กลิ่นควัน กลิ่นฉุนไหม้ กลิ่นกระทะ กลิ่นไขมันสัตว์ กลิ่นซุป กลิ่น dark brown กลิ่นไหม้ กลิ่นหืน กลิ่นเค็ม กลิ่นหวาน และกลิ่นแห้ง โดยตัวอย่างข้าวผัดไฟแดงมีคุณลักษณะกลิ่นน้ำมันผ่านความร้อน กลิ่นควัน กลิ่นฉุนไหม้ กลิ่นกระทะ กลิ่นไขมันสัตว์ กลิ่น dark brown กลิ่นไหม้ กลิ่นเค็ม และกลิ่นแห้ง แตกต่างจากตัวอย่างข้าวผัดธรรมดาอย่างมีนัยสำคัญ (p<0.05) นอกจากนี้ทำการลดจำนวนตัวแปรในตัวอย่างข้าวผัด โดยใช้เทคนิคการวิเคราะห์องค์ประกอบ (PCA) ผลการวิเคราะห์พบว่าสามารถจำแนกองค์ประกอบหลักได้ 2 องค์ประกอบอธิบายความแปรปรวนได้ทั้งหมด 88.98%

ABSTRACT

Stir frying is a cooking technique that significantly enhanced food flavors during thermal process of cooking. Flash frying technique gives the unique and more pronounced smoke and burnt aroma than the typical stir frying. This study aims to characterize aroma attributes in fried rice samples. Descriptive sensory analysis was carried out by eight trained panelists to evaluate the aroma characteristics of flash fried rice and stir fried rice samples. The result showed that twelve aromas attributes namely heated oil, smoky, acrid, wok, animal fat, brothy, dark brown, burnt, rancid, briny, sweet aromatics and dried were showed in flash fried rice and stir fried rice. The flash fried rice samples has significant difference in heated oil, smoky, acrid, wok, animal fat, dark brown, burnt, briny and dried aroma from stir fried rice sample (p<0.05). Principal component analysis (PCA) applied to the data differentiated between fried rice sample and explained 88.98% of the total variance with two principal components.

Key words: flash frying, stir frying, descriptive analysis, principal component analysis (PCA)

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INTRODUCTION

Stir fried technique is a cooking method that used in Asia. This cooking method can be categorized into stir frying and flash frying. The two techniques differ in the level of heat used and their speed of cooking in the wok (Chao, 1945). Flash frying is a special technique of cooking that significantly enhances food flavor during heating. This technique gives a unique smoke/burnt aroma which generated when the edible oil and the main ingredients attract fire around several seconds.

Wu and Chen (1992) reported that volatile compounds more than 40 compounds were found in stir fried soy bean oil at 200 °C. They were groups of aldehydes, ketones and furans. Furthermore, hexanal, (*E*)-2-heptenal, (*E*)-2-octenal and 2,4-decadienal were principal contributors to the prominent aroma of stir fried soy bean oil which give rancid and heated oil aroma. Flash frying involves heating of foods at a flash point of the cooking oil. Volatile compounds from flash frying can be generated from pyrolysis. Major products from pyrolysis of vegetable oils are *n*-alkanes and 1-alkenes and minor products are groups of alkylcycolalkanes (Alencar *et al*., 1983).

The most prominent volatile compounds of flash fried rice (FFR) were 2,4-heptadienal (stir-fried oil, burnt), nonanal (scented candle), heptanone (metallic, rust) and unknowns which generated fishy, salty and sweet aroma. There were 2 unknowns with FD factors of 9 and 0 that had “wok” or flash fried aroma characteristic. (Piyachaiseth, 2010)

Piyachaiseth (2010) used different from control test and reported that untrained panelist could differentiate the aroma of FFR from stir fried rice (SFR). However, her study did not specify the differences on each attribute. The descriptive sensory analysis was performed to defined attributes in fried rice samples. The principle of descriptive analysis is based on the ability to train panelists to measure specific attributes of a product. The analysis of sensory descriptive data was done by means on the attributes. Panelists work together to identify attributes and score intensity to samples.Many research applied descriptive analysis to evaluate sensory profiles of food products such as coriander (Ravi *et al*., 2007), American dry cured ham (Pham *et al*., 2008) and ultra-pasteurized milk (Chapman *et al*., 2001).

Principal component analysis (PCA) is a widely used multivariate analysis technique that can be applied to sensory data to reduce the number of variables such as sensory attribute to a smaller set of variables based on patterns of correlation among the original variables. PCA has been used for various food products applications in the sensory evaluation such as strawberries (Testoni and Nuzzi, 2006), American dry cured ham (Pham *et al*., 2008) and white wine (Álvarez *et al*., 2011). PCA is also a tool to explain differences in the relations among descriptive sensory attributes of food products (Pavon, 2003).

In this study, the descriptive sensory analysis was performed to defined aroma attributes in FFR and SFR. PCA was applied to reduce the number of aroma attribute to a smaller set and grouped a new set with the fried rice samples. The objectives of this study were to 1). characterize aroma attributes between flash fried rice and stir fried rice. 2). categorize fried rice samples based on the sensory properties of aroma.

MATERIALS AND METHODS

1. Sample preparation

Steamed rice – Six hundred grams of polished white rice was steamed with 650 ml odor-free water using a rice cooker.

SFR and FFR – Two hundred grams of steamed rice were added to 30 ml of heated soybean oil (200 ^{o}C). For SFR samples, stir fried in an iron wok for 60 s were used. For FFR samples, flash fried in an iron wok for 20 s. SFR and FFR were collected in a glass container and held temperature in heating bag before evaluated their aroma properties.

2. Sensory evaluation

A descriptive analysis of the aroma was performed using eight trained panelists from Kasetsart University Sensory and Consumer Research (KUSCR) center. For this study, a total of four 2h sessions were used for 1). aroma attributes development 2). definitions of aroma attributes 3). selection of reference standard and their intensities and 4).individual training on the aroma attributes. After the final session, panelists had agreed on a list of twelve defined terms, the appropriate reference standards and their intensities on the 15-cm intensity line scale (Table 1).

Twenty grams of the FFR and SFR was served to each panelist in ceramic cups with ceramic covers at 70 ^{o}C. During the evaluation, the covers were 1/3 opened, and the samples were sniffed by the panelists. Aroma intensities were scored on a 15 cm intensity line scale with 0 meaning “none” and 15 meaning “extremely”.

3. Data Analysis

Paired *t*-test was performed to determine the differences in aroma attributes between FFR and SFR samples at 5% significance level. Principal component analysis (PCA) of mean rating for each sensory attribute was used to show the relationships among variables and samples. PCA was performed using the XLSTAT® software version 2006.

Table 1 Aroma attributes: definitions and corresponding reference standards used in the trained panel evaluation of FFR and SFR samples.

Aroma attribute	Definition	Reference level	Reference	Reference intensity
Heated oil	Perception of heated oil associated with brown, cooked, nutty, stale and light acrid.	-	Heated rice bran oil by microwave oven for 4 minutes.	7
Smoky	Perception of any type of smoke aroma.	High	Mixed ¼ tea spoon of liquid smoke with 500 ml of water (smoke H).	7
		Low	Mixed 100 ml of smoke H with 100 ml water.	5
Acrid	The aromatic associated with sharp, bitter, stinging, burnt such as burnt rubber or oil.	-	1 drop of liquid smoke on cotton ball.	7
Wok	The aromatic associated with smoke, dried, acrid, mild burnt, briny and heated oil such as flash fried rice or noodle in iron wok.	-	-	-
Animal fat	The aromatic associated with animal fat, soup, brown, meaty, sweet aromatic and briny.	-	1 g of bacon oil.	4
Brothy	The aromatic associated with meaty, metallic, sweet aromatic and briny in boiled meat and soup.	High	10 ml of condensed soup chicken broth.	8
		Low	Mixed 10 ml of condensed soup chicken broth with 100 ml of water.	4
Dark brown	The aromatic associated with mild burnt perceived by smell.	High	1 g of chocolate syrup	7
		Low	Mixed 5 g of chocolate syrup with 200 ml of water.	3
Burnt	Perception of any type of burnt aromatic.	High	1 g of roasted coffee.	8
		Low	Mixed 0.5 g of roasted coffee with 300 ml of water.	5.5
Rancid	The aromatic associated with extremely oxidized fats or oils perceived by smell.	-	Heated 100 ml of Rice bran oil by microwave oven for 3 minutes.	2
Briny	The aromatic associated with salt perceived by smell.	High	Mixed 1 g of Maggi seasoning with 200 ml of water.	6
		Low	Mixed 0.4 g of Maggi seasoning with 200 ml of water.	3.5
Sweet aromatics	The aromatic associated with sugar perceived by smell.	-	Mixed 20g of brown sugar with 200 ml of water.	3
Dried	The aromatic associated with dried product perceived by smell such as soy bean powder.	-	1 g of soy bean powder.	6

RESULTS AND DISCUSSION

1. Sensory profiles of fried rice

The mean values of aroma attributes in FFR and SFR from descriptive analysis are shown in Figure 1. Mean rating and *p*-value for aroma attributes in FFR and SFR are shown in Table 2. The results show that the intensities of aroma attributes namely, heated oil, smoky, acrid, wok, animal fat, dark brown, burnt, briny and dried differed between FFR and SFR samples ($p<0.05$).

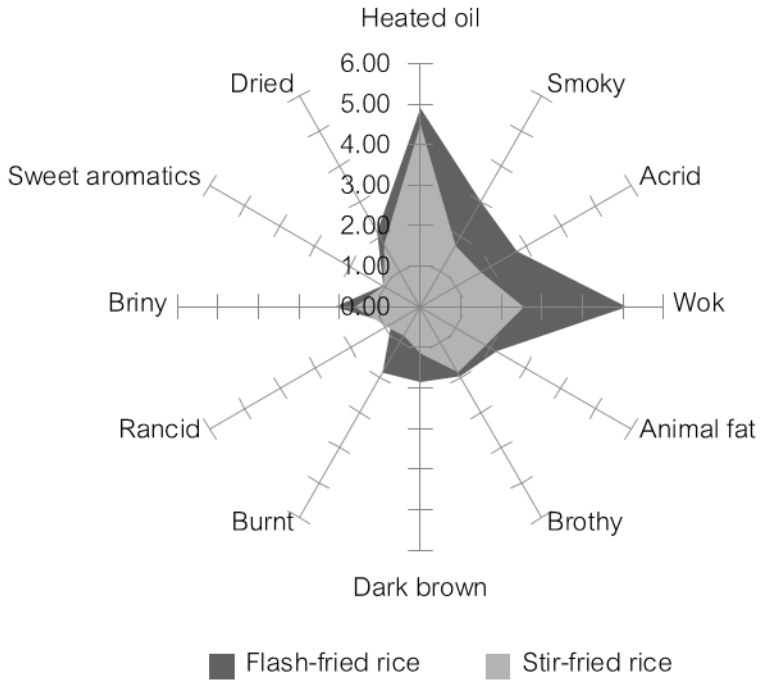

Figure 1 The aroma profiles of flash fried rice and stir fried rice based on the descriptive sensory analysis.

2. Principal component analysis (PCA) in fried rice sample

Principal component analysis (PCA) was applied to the twelve sensory attributes to investigate and interpret data structure. The results showed that the dimensionality of the data was reduced from twelve variables to two uncorrelated components, which explained a total of 88.98% of the variation. The score plot (the map of fried rice sample scores) and loading plot (the map of sensory attribute loadings) on the first two principal components are shown in Figures 2 and 3 respectively. The score plot can be used to detect sample patterns, grouping, similarities or differences, while the loading plots can be used to show how much each variable contributes to the meaningful variation in the data and interpret variable relationships (Rosenfeld and Nes, 2000).

PCA can be used to show the relative locations of the samples with respect to each other and their characterizing attributes (Meilgaard *et al*., 1999). The explained variance on each attributes

Table 2 Mean rating (n=3) ± standard deviation and p-value for aroma attribute in FFR and SFR

Aroma attributes	FFR	SFR	p-value
1. Heated oil	4.90 ± 0.64	4.50 ± 0.51	0.00*
2. Smoky	2.99 ± 0.54	1.74 ± 0.48	0.00*
3. Acrid	2.75 ± 0.49	1.72 ± 0.61	0.00*
4. Wok	5.09 ±0.68	2.55 ± 0.65	0.00*
5. Animal fat	2.18 ± 0.37	1.87 ± 0.43	0.00*
6. Brothy	1.97 ± 0.36	1.86 ± 0.43	0.20
7. Dark brown	1.85 ± 0.38	1.15 ± 0.45	0.00*
8. Burnt	1.87 ± 0.76	0.82 ± 0.57	0.00*
9. Rancid	0.83 ± 0.32	0.97 ± 0.32	0.09
10. Briny	2.12 ± 0.40	1.61 ± 0.46	0.00*
11. Sweet aromatics	1.06 ± 0.18	1.05 ± 0.15	0.77
12. Dried	2.14 ± 0.22	1.79 ± 0.37	0.00*

The p-value followed by * are significant at p<0.05.

in FFR and SFR is shown in Table 3. PC1 accounted for 72.51% of the variation and highly correlated to aroma namely, heated oil, smoky, acrid, wok, animal fat, dark brown, burnt, briny and dried. PC2 explained an additional 16.47% of the variation and highly correlated to aroma namely, rancid, brothy and sweet aromatic. Figure 2 and 3 also shows the same variation on PC1 and PC2 which respectively explained 72.51% and 16.47% of the total variance. Figure 2 shows that SFR samples and FFR samples differ on this plot. There is clear distinction of the scores from the two types of fried rice on PC1. The FFR samples were more shifted towards the higher values of PC1

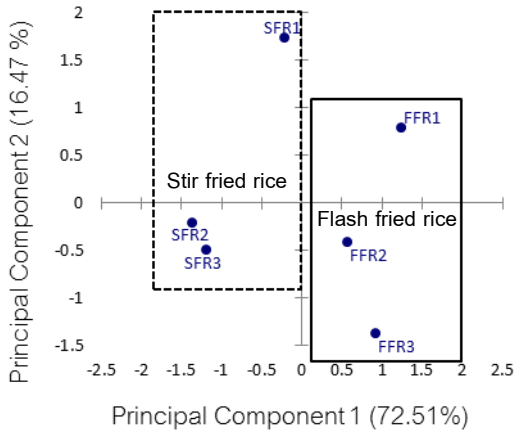

Figure 2 PCA score plot of the 6 fried rice samples performed by sensory data. FFR1-FFR3 are flash fried rice samples and SFR1-SFR3 are stir fried rice samples.

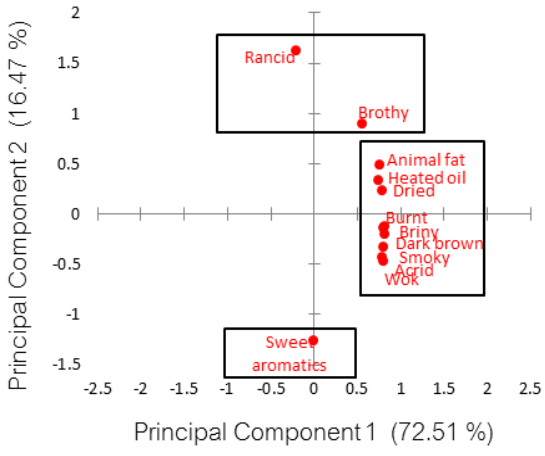

Figure 3 Sensory map of the first two principal components for describing twelve sensory attributes of fried rice.

Table 3 Explained variance for the first two principal components (PCs) from the principal component analysis (PCA).

Attributes	Explained variance (%)	
	Principal component 1	Principal component 2
1.Heated oil	**9.313**	1.802
2.Smoky	**10.670**	1.815
3.Acrid	**10.491**	3.074
4.Wok	**10.564**	3.653
5.Animal fat	**9.589**	3.892
6.Brothy	5.290	**13.306**
7.Dark brown	**10.782**	0.333
8.Burnt	**11.066**	0.260
9.Rancid	0.702	**43.658**
10.Briny	**11.083**	0.687
11.Sweet aromatics	0.002	**26.613**
12.Dried	**10.447**	0.907

Figures in bold represent attributes responsible for the most variation between fried rice samples on two principal components.

than the SFR samples. While Figure 3, the aroma attributes was reduced from twelve variables to two components. The aroma attributes namely, heated oil, smoky, acrid, wok, animal fat, dark brown, burnt, briny and dried were mainly represented by the PC1. The aroma attributes namely, rancid, brothy and sweet aromatic were represented by the PC2. From figure 2 and 3, the results indicated that FFR could be separated from SFR by PC1. FFR was best described by heated oil, smoky, acrid, wok, animal fat, dark brown, burnt, briny and dried notes.

CONCLUSIONS

Descriptive sensory analysis showed significant differences of aroma attributes between flash fried rice and stir fried rice samples. There were aroma attributes namely, heated oil, smoky, acrid, wok, animal fat, dark brown, burnt, briny and dried aroma. Principal component analysis explained a total of 88.98% of the variation. The flash fried rice showed higher degree of aroma attributes namely, heated oil, smoky, acrid, wok, animal fat, dark brown, burnt, briny and dried aroma than the stir fried rice on principal component 1.

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