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Change of Sensory Characteristic of Fermented Rice Flour and Fermented Rice Noodle (Kanom-jeen) During Fermentation by *Lactobacillus plantarum* A1

[1]Orawan Oupathumpanont and [2]Thongchai Suwonsichon

[1]Rajamangala University of Technology Thanyaburi., Department of Food and Nutrition, Faculty of Homme Economics Technology, Pathumthani, Thailand.
[2]Kasetsart University, Department of Product Development, Faculty of Agro-industry, Bangkok, Thailand.

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ABSTRACT

The study aimed to investigate effects of *L. plantarum* A1 on sensory properties of fermented rice flours and Kanom-jeen during fermentation 0-24 h. Results of identify the aroma characteristics of fermented rice flour at different fermentation time by Electronic nose (e-nose) indicated that ethanol, aldehyde and ketonehad been change during fermentation and can separate fermented rice flour sample in 3 big group is 1) powder group that doesn't change fermenting (Control), 2) flour for fermentation group that 6 and 12 hours and 3) flour for fermentation groups that 18 and 24 hours and sedimented flour from Kanom-jeen manufacture. Identify the descriptive sensory characteristics of Kanom-jeen from fermented rice flour at different fermentation time indicated that the train panels found 33 attribute. The average of sensory scores can separate fermented rice noodles samples out to 3 groups;(1) noodles sample A and B which be fermented rice noodles in the market, sample G and H,which be fermented rice noodle that made from fermented flour 18 and 24 hour respectively,(2) sample F which be fermented rice noodle that made from fermented flour 12 hour, (3) sample D, which be non fermented rice noodle in the market, sample C and D which be fermented rice noodle that made from fermented flour 0 and 6 hour respectively.

Key words: fermented rice flour, Lactobacillus plantarum, Sensory characteristic, Electronic nose

INTRODUCTION

Fermented Thai rice noodle called as " Kanom-jeen" is a kind of tradition lactic acid fermentation that has little fermented odor, smoothness and flexibility. The quality of fermented Thai rice noodle depend on fermentation but natural fermentation is technology used to produce fermented Thai rice noodle. However, natural fermentation in traditional Kanom-jeen process could not be controlled due to different types and amount of natural flora in each Kanom-jeen production which caused many problems in Kanom-jeen product such as various qualities, lacking of quality standard and food safety. To conquer these drawbacks, developing starter culture and improving the process technology under necessary hygienic condition could be an alternation way to control the quality of end product. *L. plantarum* A1, a strain originally isolated from a slurry in Kanom-jeen production, has been shown to produce high lactic acid, large hydrolyze starch and Kanom-jeen with *L. plantarum* P1 and commercial were not significant difference ($p > 0.05$). But the mechanism of fermentation and its effects on sensory characteristic of rice flour and Kanom-jeen are not completely clear. Electronic nose is one analytical tool, proposed in recent year to address the need for routine quality tasting in the food industry. This device consists of an array of weakly specific or broad spectrum chemical sensors that intend to mimic the humam olfactory system and convert sensor signals to dato can be analysed with appropriate statistical software Such characteristics greatly facilitate the application of the electronic nose to rapid monitoring of the volatile compound of food, providing real-time information about various characteristic of food under study (Schaller *et al*., 1999). Beside of a quantitative descriptive analysis (QDA) is a sensory evaluation of various food products. The QDA technique is depend on the principle of the panelist in a reliable food manner. The technique has composed of screening and training, developing the descriptive terms and intensity scales. Therefore, study of changing aroma and sensory properties is important to uses for the quality control between fermentation in Kanom-jeen process by pure culture that collate with the quality of end product.

Corresponding Author: Orawan Oupathumpanont, Rajamangala University of Technology Thanyaburi., Department of Food and Nutrition, Faculty of Homme Economics Technology, Pathumthani, Thailand.
E-mail: parun_o@yahoo.com Tel. +661-697-3836

The objective of this study to:
1. To identify the aroma characteristics of fermented rice flour at different fermentation time by Electronic nose (e-nose).
2. To identify the descriptive sensory characteristics of Kanom-jeen from fermented rice flour at different fermentation time.
3. To compare the aroma characteristic of fermented rice flour at different fermentation time by Electronic nose with descriptive sensory characteristics of Kanom-jeen during fermentation

Material and Methods

Material:

1. Starter culture of Lactobacillus plantarum A1:

Lactobacillus plantarum A1 was isolated from fermented starch of traditional Khanom-leen manufacture. The culture of A1 was maintained in MRS slant and grown at 35°C for 48 hrs.. One loop of isolates were inoculated into MRS broth and grown at 35°C for 24 hrs. Cells were separated by centrifuge 8000 rpm. 15 min. The cells were washed twice time in a water. 1 g. of cells were transferred into buffer solution 100 ml. at final concentration of cell 10^{10} CFU/ml.

2. Broken rice:

The broken rice of Chinant1 cultivars provide by manufacture of traditional Kanom-jeen in Chachoengsao province, with an apparent amylase content of 29 – 33 %(dry basis).

Methods:

1. Prepare fermented rice flour and Kanom-jeen using L.plantarum A1:

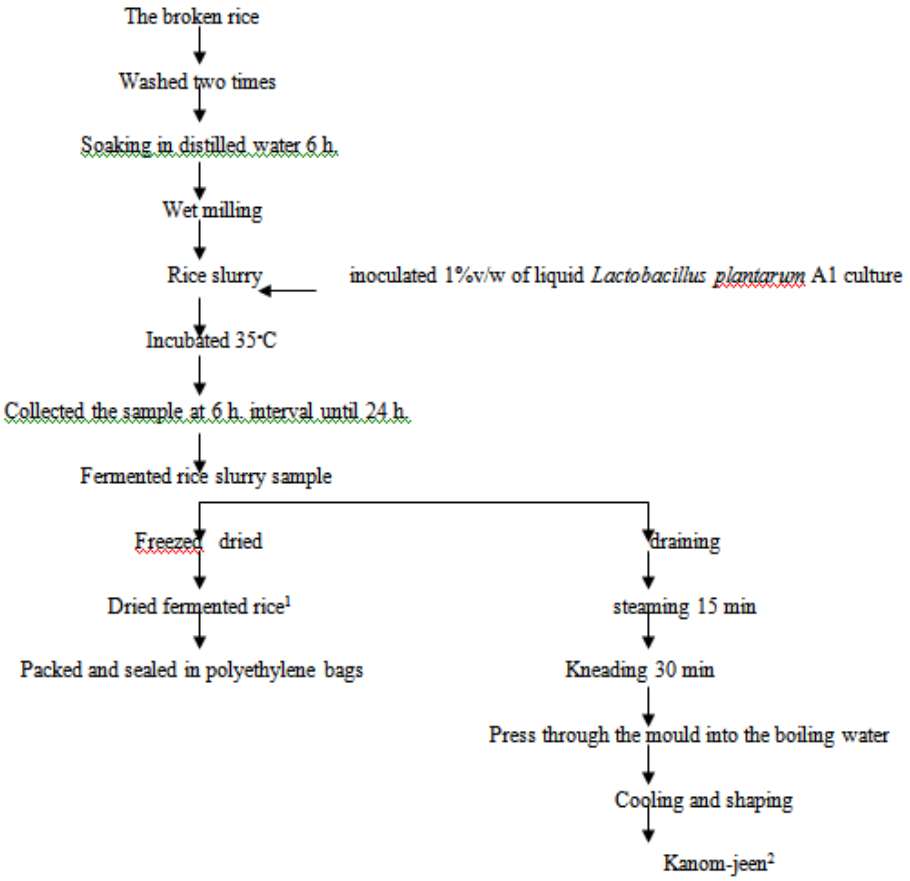

Fig. 1: Process to produce fermented rice flour and Kanom-jeen.
[1]: Sample for Electronic nose measurement
[2]: Sample for descriptive analysis

2. Electronic nose measurement:

The e-nose (Model Fox 3000, Alpha M.O.S., Toulouse FR) with MOS chambers equipped with 12 sensors (LY/LG, LY/G, LY/AA, LY/Gh, LY/gCTI, LY/gCT, T30/1, P10/1, P10/2, T70/2 and PA2) was connected to auto sampler (HS100). A change in mass of chemical compound caused a change in electrical resistance as indicated by each sensor.

Mashed sample 1 g was placed into glass vial. Using a crimping tool, each sample vial was sealed with fitted cap and septum. Each vial was sealed tighty to prevent leaks and uncharacteristic decrease in sensor signal. Then, the sample vials were placed in the instrumental tray for further analysis. In this study, The sample was incubated at 80°C, 1800 sec, then inject the sample 2000 µl with speed at 2000 µl/sec. The data collected from e-nose were analyzed using PCA to differentiate the aroma at different fermentation time

The data obtained from the sensor array for the 8 Kanpm-jeen samples were analysed by Principal Component Analysis (PCA) performed with STATISTICA (v. 5.1 Statsoft Inc., Tulsa, Oklahoma, USA) and Artificial Neural Network (ANN) using Neuro Solutions software (V. 4.2 Neuro Dimension Inc., Gainesville, Florida, USA)

3. Descriptive analysis of Kanom-jeen from fermented rice flour at different fermentation time:

The eight samples (table 1) of Kanom-jeen products were keep in plastic box before studied. Sensory testing was conducted with the KUSCR (Kasetsart University Sensory and Consumer Research unit) department of product development, faculty of Agro-Industry, Kasetsart University Bangkok Thailand. Four samples were presented in random during each session. In each testing period, samples were presented to panel (10 g. in plastic cup at 35 degree centigrade) Eight panelists (age 38-55 years) were selected and trained on the generic quantitative descriptive analysis method and evaluated Kanom-jeen according to focus sensory of Kanom-jeen in appearance, aroma, flavor, basic taste, mouth fell and after test (table 2). Throughout training session, panelists evaluated and discussed Kanom-jeen to clarify about the concept and scale intensity on attributes of Kanom-jeen. A similarity scale consisting of a 9-point scale with the words "high end" = 9 and "low end" = 1 was presented t each panelist. Panelists rinsed their mouths with distilled water. Therefore, all samples were categoried base on sensory properties using principle component analysis (PCA) to combination.

Table 1: Definition of sample code.

Code	Definition
A	Traditional fermented rice noodle
B	Traditional fermented rice noodle
C	Traditional non-fermented rice noodle
D	Fermented rice noodle from fermented rice flour at 0 h.
E	Fermented rice noodle from fermented rice flour at 6 h.
F	Fermented rice noodle from fermented rice flour at 12 h.
G	Fermented rice noodle from fermented rice flour at 18 h.
H	Fermented rice noodle from fermented rice flour at 24 h.

The database was analyzed with uncreamble version version 8.0 and SPSS for Windows Version 11, and the descriptive statistic measure was first calculated for all attribution. Analysis of variance was performed to determine a significant difference between Kanom-jeen samples. Cluster analysis was applied to attribute score which significantly discrimination between samples. Consequently, principle component analysis was applied to the means of the attributetion and used to illustrate the relationships among variables and sample.

Table 2: Sensory language used in descriptive analysis of Kanom-jeen.

Attribute	Definition
Appearance	
Whiteness	The intensity of white color
Noodle size	The size of of sample diameter
Attachment	Sticking level of sample (Use a fork pulls an example has gone up then see sticking to sample character
Shininess	The extent to which the light reflects on surface
Transparency	The extent to which light glows
Aroma	
Blended	The unity of Kanom-jeen aroma
Fermentation	The intensity of sour odor from fermented rice flour
Boiled rice flour	The intensity odor of boiled rice flour
Rice wash water	The intensity of water from washing rice
Chlorine	The intensity of chlorine odor from tap water
Dried chili	The intensity of Dried chili
Dusty Musty	The intensity of odor that is born from long kept in unventilated air
Cardboard	The intensity of aroma associated with cardboard
Flavor	
Blended	The unity of Kanom-jeen flavor
Fermentation	The intensity of sour flavor from fermented rice flour
Boiled rice flour	The intensity flavor of boiled rice flour

Chlorine	The intensity of chlorine flavor from tap water
Taste	
Sweet	Fundamental taste sensation elicited by sucrose
Sour	Fundamental taste sensation elicited by citric acid
Salt	Fundamental taste sensation elicited by sodium chloride
Texture	
Manual Testing	
Stickiness	The measure of quantity sticking to finger when pick up the noodles Testing by pick noodles with a thumb and the forefinger already assess sticking to quantity takes something long with someone 3 time already seek the average (wash one's hands cleanly everytime before)
Springiness	The returning level gets back to the figure originally the sample. Testing by observe the power that use in pressure sample.
Lips Feel	
Adhesive to lips	The amount of produce adhering on lips after mastication of a half of teaspoon
Chew down	the amount time in chewing sample until fully for swallow. Testing by the amount time in chewing with the rate is stable (1 time / second) with the molar one-sided until can swallow
Moistness of mass	
Starchy	the feeling is sample powder when chew be circumspect [powdery]. Testing by chew quantity sample 1/2 teaspoon with molar until the sample is powdery.
Cohesive of mass	Combination sample level between chewing (Chewing sample, teaspoon half with 10 molars time)
Chew count	The amount time in chewing with the stable rate with the molar one sided until fully for swallow
Swallow	
Particle	The amount of particle in mouth after swallow
Astringent	Fundamental taste sensation elicited by alum
Coating	The sensation associated with flour not remove after swallow

Result and Discussion

1. Electronic nose measurement:

Electronic nose were used to determine the aroma of rice flour during fermentation. The result showed in Fig. 2 and 3. Those sensors, LY2/LG, LY2/G, LY2/AA, LY2/Gh and LY2/gCTi, could detect the compound that change during fermentation. Those sensors sensitive with ethanol, aldehyde and ketone, so the result indicated that ethanol, aldehyde and ketonehad been change during fermentation. The result agree with Nawarat study the volatile compound that found in fermented rice noodle were ethanol group

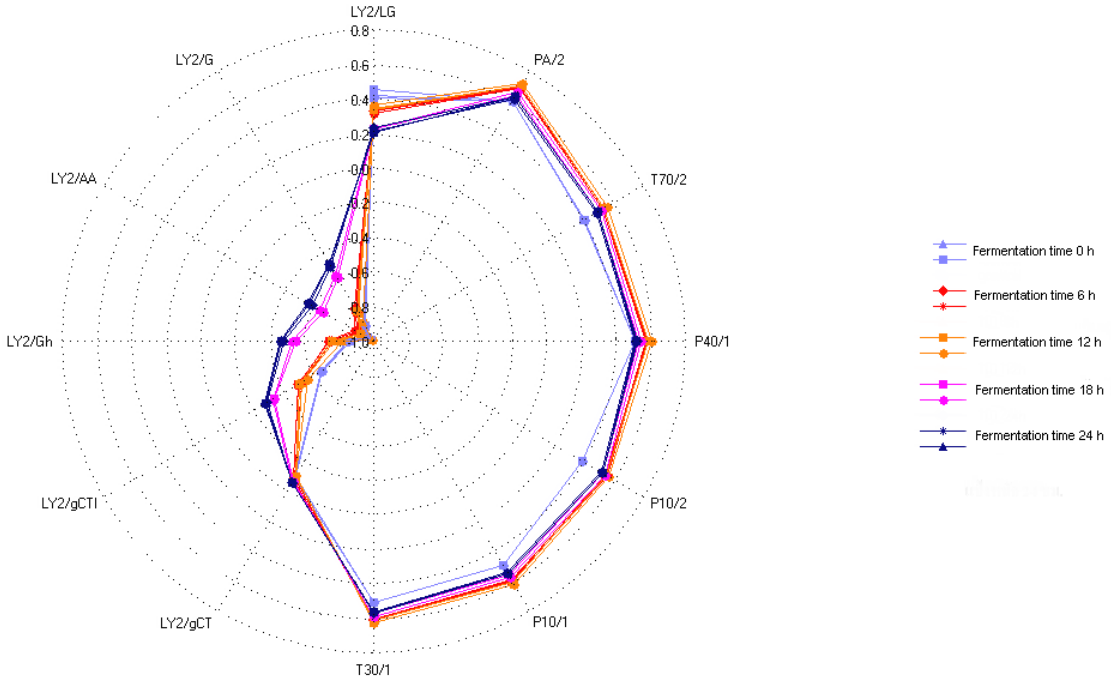

Fig. 2: Sensitivity report of sensor responses for values fingerprint rice flour during fermentation.

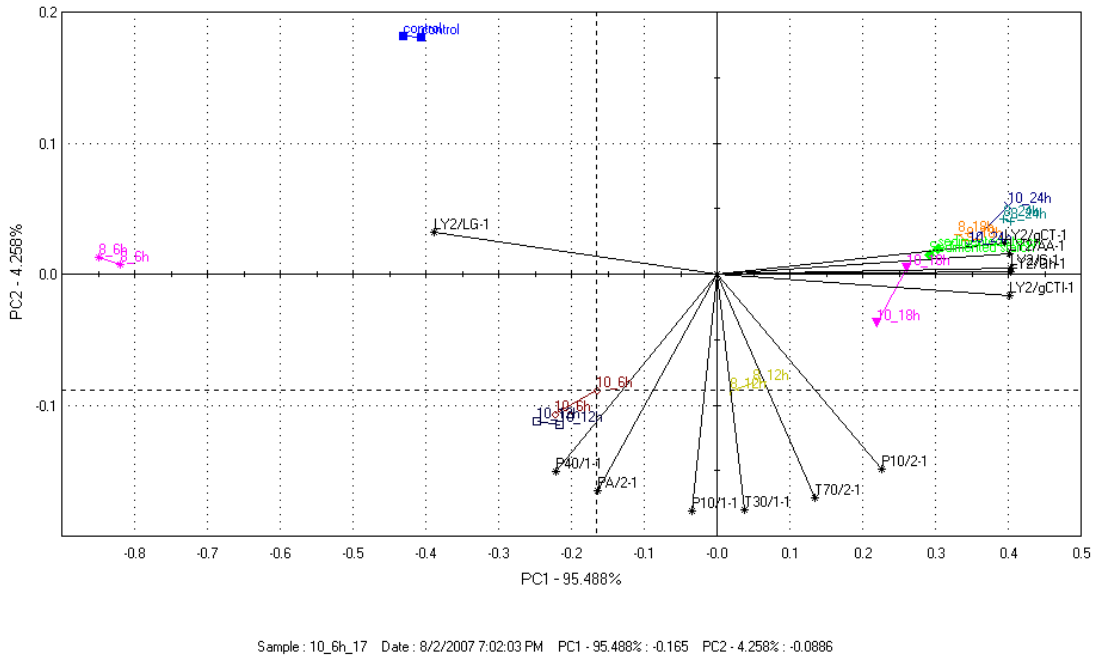

Fig. 3: Bi-plot of the scores responses for the fermented rice flour samples.

Principle Component Analysis plot of the scores by 6 sensors responses along the first two principal showed in Fig. 4.

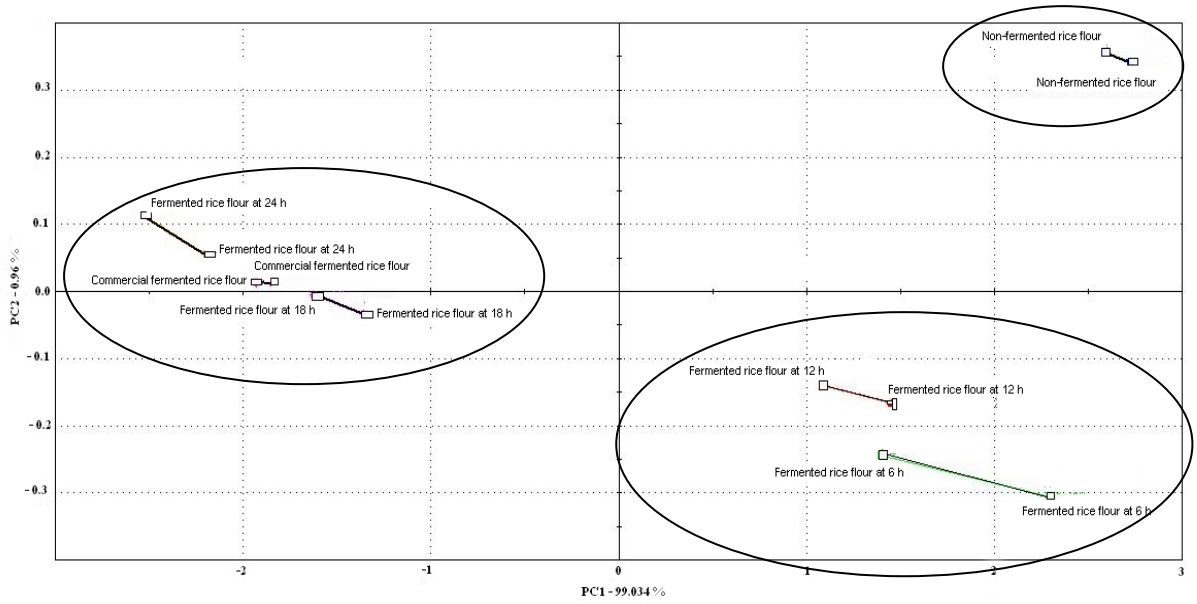

Fig. 4: Principle Component Analysis plot of the scores produced by the 6 sensor responses along the first two principal components.

From Figure 4 PC1, this can separate sample flour for fermentation both of 6 examples difference has been 3 big group is 1) flour group that doesn't change fermenting (Control), 2) flour for fermentation group that 6 and 12 hours and 3) flour for fermentation groups that 18 and 24 hours and sedimented flour from Kanom-jeen manufacture. Volatile compounds are born from the work of the enzyme that was established from the microorganism in the procedure ferments, and reacting between lactic acid acid with chemical compound such as carbohydrate, protein and lipid make to have biochemistry change of all nutrient in fermented rice noodles. Ketone is a main group volatile compound that give characteristic solvent odor (Flavorbase, 1998). It might affect smell character generally of

rice ferments. Ketone such as propanone, diacetyl and acetone etc. is volatile compound in alcohol group and the majority is ethanol. Gesuda (2547) studied the aroma compound in fermented rice noodle by GC-MS, the result indicated volatile compound in alcohol group is important aroma compound and it is substance gives other odor of fermented rice noodles. Beside of amino acid and peptide that produce from hydrolyze the protein during fermenting were pass transamination reaction, decarboxylation reaction and deamination reaction, cause a volatied compound in ester group, alcohol, amino acid. There is a role in sour odors in fermented rice noodles.

2. Descriptive analysis of Kanom-jeen from fermented rice flour at different fermentation time:

When analysis the intensity of sensory characteristic in 8 noodles samples ; traditional non-fermented Thai rice noodle, traditional fermented Thai rice noodle 2 samples, fermented Thai rice noodle by *L. plantarum* A1 from fermented flour 0, 6, 12, 18, and 24 hour, a sample vacates 2 repeated. Panels will receive a sample each a sample and analysis assessment respectively by begin from character assessment appears with the sight, test the aroma, taste flavor, meat test touches manually, area lips feeling, the erosion for the first time, chewing, swallowing, show in tables 3.

Table 3: Score of descriptive sensory analysis of Kanom-jeen samples.

Attributes	Samples							
	A	B	C	D	E	F	G	H
Appearance								
Whiteness	7.5	8.5	6.0	6.5	7.5	5.5	6.5	6.5
Noodle size	7.0	7.5	7.0	6.5	6.5	8.0	7.5	7.0
Attachment	8.0	7.0	11.5	12	11	5	8	8.5
Shininess	6.0	5.0	5.5	5.5	7.0	4.0	8.0	7.0
Transparency	5.5	5.5	7.0	7.0	7.0	4.5	6.0	6.0
Aroma								
Blended	9.0	8.5	7.0	7.5	5.5	5.5	8.0	8.5
Fermentation	5.5	5.0	3.0	2.5	3.0	3.0	4.0	4.0
Boiled rice flour	4.0	4.5	6.5	6.0	6.0	5.5	5.0	5.0
กลิ่นน้ำซาวข้าว	1.5	1.0	0	0.5	1.0	1.0	1.0	1.0
Chlorine	0	1.0	0	0	1.0	0.5	0.5	0.5
Dried chili	0.5	0.5	1.5	2.5	2.0	0	0.5	0.5
Dusty Musty	1.0	0.5	2.0	1.5	3.5	2.5	2.0	2.0
Flavor								
Blended	5.5	5.0	6.5	6.0	3.5	2.5	5.0	4.5
Fermentation	4.0	4.5	2.5	2.5	3.0	3.0	3.5	3.5
Boiled rice flour	3.5	3.5	5.5	5.5	5.0	4.5	4.0	3.5
Chlorine	0.5	1.0	1.0	0.5	1.5	1.5	1.0	1.0
Taste								
Sweet	0.5	0.5	0.5	1.0	1.0	1.0	1.0	0.5
Sour	1.0	1.5	0.5	0.5	0.5	0.5	1.0	1.5
Salt	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Texture								
Manual Testing								
Stickiness	4.5	3.5	6.5	7.0	7.0	6.5	5.0	4.5
Springiness	4.5	5.0	4.0	3.5	4.0	4.0	4.5	5.0
Lips Feel								
Adhesive to lips	6.5	6.5	12	12	11.5	9.0	8.0	7.0

Table 3: Score of descriptive sensory analysis of Kanom-jeen samples.

Attributes	Samples							
	A	B	C	D	E	F	G	H
First Bite								
Firmness	7.0	6.5	5.0	5.0	5.5	6.0	6.5	6.5
Hardness	6.0	6.5	4.0	4.0	4.0	5.0	5.5	5.5
Moistness of mass	6.0	5.5	7	7.5	6.5	6.0	6.0	5.5
Starchy	4.5	5.0	6.5	6.5	5.5	5.5	5.0	5.0
Cohesive of mass	4.0	3.5	5.5	6.0	6.0	5.0	4.5	4.5
Chew count	8.0	8.5	6.5	6.5	6.5	7.0	7.5	8.0
Swallow								
Particle	4.5	5.0	3.5	3.5	4.0	4.0	4.5	4.5
Astringent	2.5	1.5	2.0	2.0	2.0	2.5	3.0	3.0
Coating	4.0	3.0	5.5	5.5	5.0	5.0	4.5	4.0

A, B = fermented rice noodle (Kanom-jeen) commercial, C = non-fermented rice noodle (fresh Kanom-jeen) commercial, D,E,F,G and H = Kanom-jeen from fermented rice flour at 0, 6, 12, 18 and 24 h, respectively.

Table 4: Factor Loading of Fermented rice noodle attribute.

Attributes	Factor Loading	
	PC1	PC2
Chew count	0.963	0.223
Hardness	0.960	0.272
Particle	0.915	0.329
Boiled rice flour aroma	0.903	-0.322
Starchy	0.898	-0.375
Water from washing rice aroma	0.895	-0.059
Boiled rice flour flavor	0.860	-0.241
Noodle size	0.851	0.226
Dusty Musty aroma	0.839	-0.465
Coating	0.676	0.466
Astringent	0.637	-0.260
Chlorine aroma	0.331	-0.194
Shininess	-0.416	-0.136
Fermentation flavor	-0.698	0.675
Moistness of mass	-0.719	0.309
Fermentation aroma	-0.748	-0.097
Blended flavor	-0.769	0.535
Dried chili aroma	-0.816	-0.407
Adhesive to lips	-0.896	-0.421
Stickiness	-0.922	-0.296
Cohesive of mass	-0.927	-0.363
Transparency	-0.949	-0.297
Attachment	-0.950	-0.273
Blended aroma	-0.211	0.890
Sour	-0.011	0.771
Salt	0.155	0.595
Whiteness	-0.160	0.456
Firmness	-0.125	0.321
Springiness	0.083	-0.088
Chlorine flavor	0.485	-0.644
Sweet	0.135	-0.752
	50.000	21.000
	71.000	

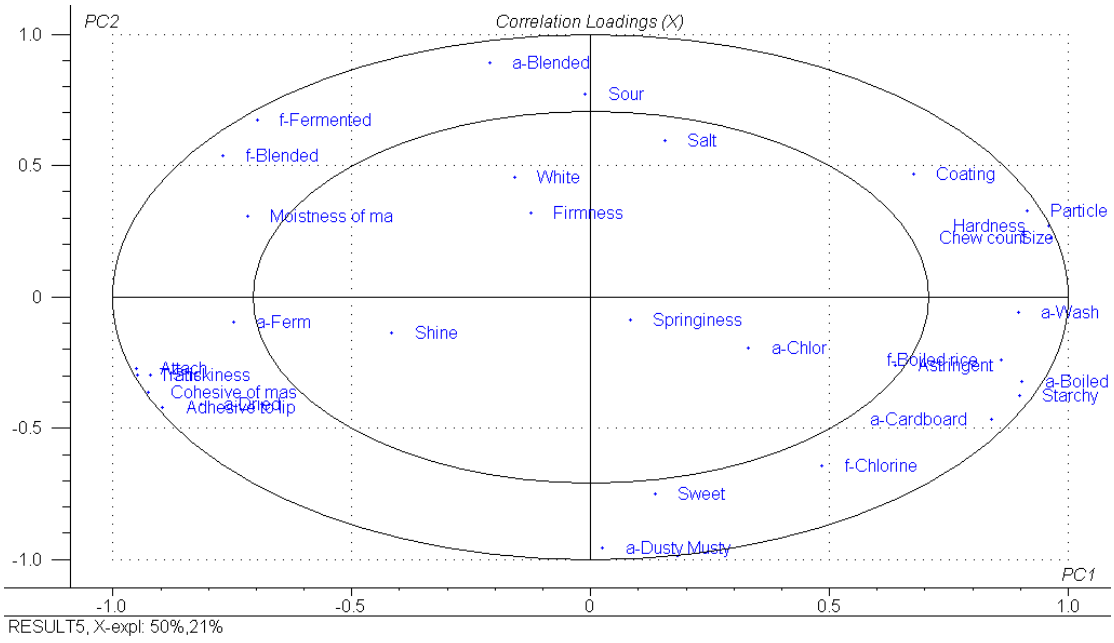

Fig. 5: Bi-plot.

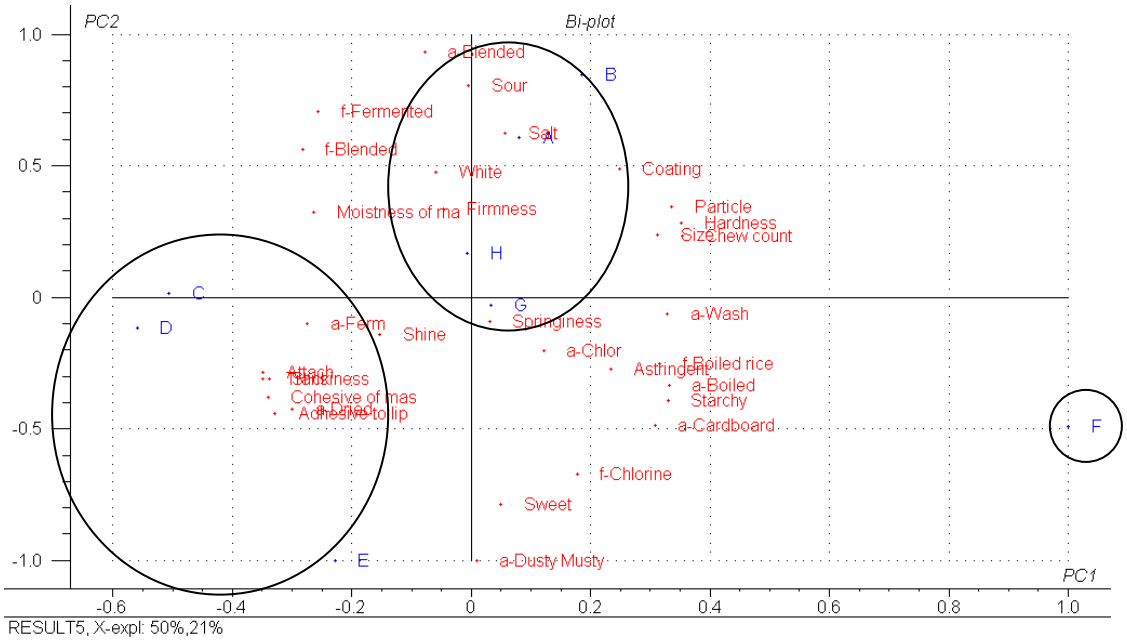

Fig. 6: Principle Component Analysis (PCA) biplot of descriptive sensory analysis of eight Kanom-jeen.

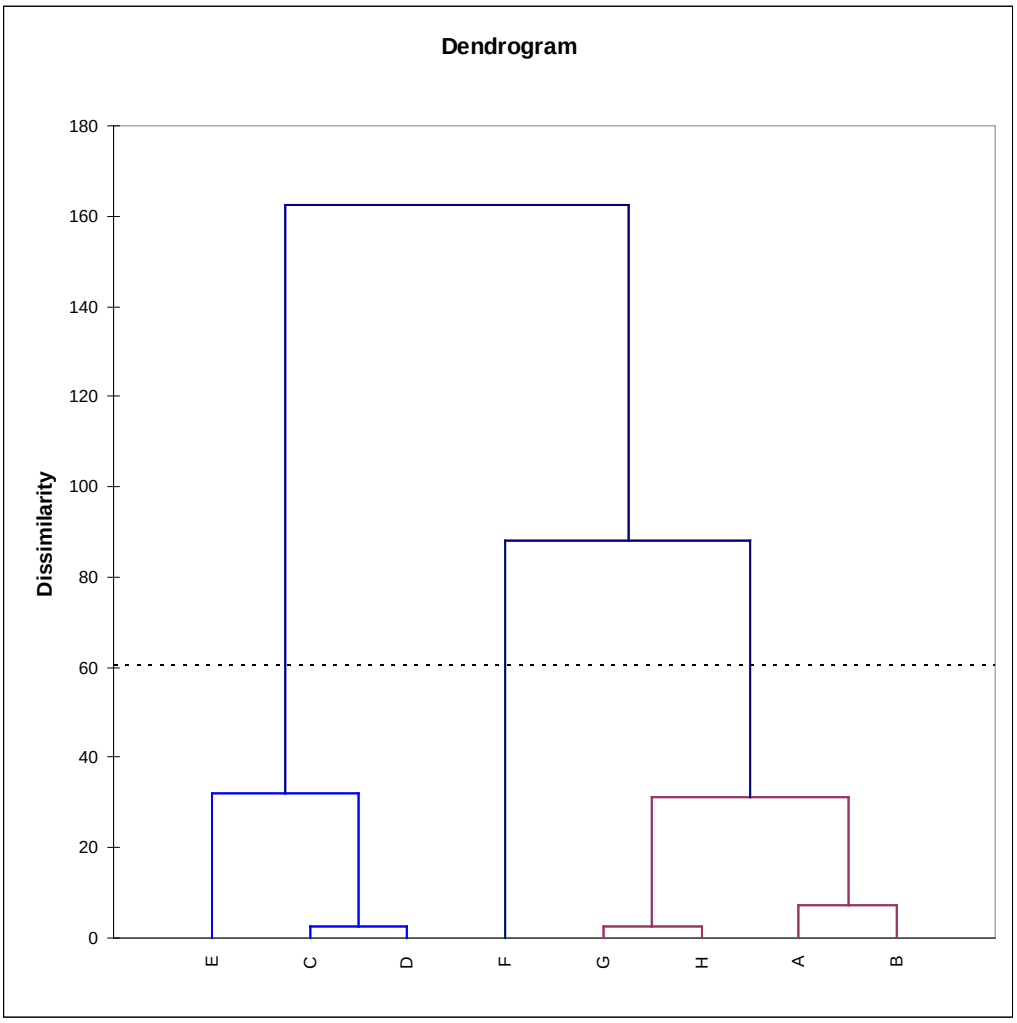

Fig. 7: The cluster tree of 8 fermented rice noodles samples base on the sensory properties and PCA score plot.

The average of sensory scores were analyze the relation between fermented rice noodles samples using Principal Component Analysis (PCA) (Figure 5). The result indicated the commutative variance explained by the first two principal component was 71 % with the first component providing 50 % of total (Table 4). The first two principle components clearly separated the fermented rice noodle from three groups (Figure 6). When consider the relation generally of 2 both of component of sensory scores of amount 8 samples fermented rice noodles by Cluster analysis (Figure 7). The result can separate fermented rice noodles samples out to 3 the groups ;(1) noodles sample A and B which be fermented rice noodles in the market, sample G and H,which be fermented rice noodle that made from fermented flour 18 and 24 hour respectively,(2) sample F which be fermented rice noodle that made from fermented flour 12 hour, (3) sample D, which be non fermented rice noodle in the market, sample C and D which be fermented rice noodle that made from fermented flour 0 and 6 hour respectively.

4. Compare the aroma characteristic of fermented rice flour by Electronic nose with descriptive sensory characteristics of Kanom-jeen at different fermentation time:

When consider the relation generally of 2 both of an aroma properties of fermented rice flour by electronic nose and sensory of fermented rice noodles by descriptive analysis during fermentation amount 8 samples. Both of 2 the experiment gives a result to conform that can separate sample in 3 groups ; (1) noodles sample A and B which be fermented rice noodles in the market, sample G and H,which be fermented rice noodle that made from fermented flour 18 and 24 hour respectively,(2) sample F which be fermented rice noodle that made from fermented flour 12 hour, (3) sample D, which be non fermented rice noodle in the market, sample C and D which be fermented rice noodle that made from fermented flour 0 and 6 hour respectively. The result indicated fermentation helps to improve the quality adaptation of rice flour are appropriate to produce fermented rice noodles. Fermenting is chemistry change of the molecule of substance, carbohydrate compound or other compound that have the character resembles, to modifies texture, appearance and flavour that change the procedure ferments often already is accepted (Hirayama, 1982). Volatile organic compound from fermentation process present in headspace aroma contribute significantly to the fermented rice flour and to its variation in relation with fermentation time. The result suggest that the electronic nose could use in industrial quality control applications. The device consists of an array of weakly specific or broad spectrum chemical sensors that intend to mimic the human olfactory system and convert sensor signals to data that can be analyzed with appropriate statistical software [2].

Conclusion:

1. The aroma characteristics of fermented rice flour at different fermentation time by Electronic nose (e-nose) indicated that ethanol, aldehyde and ketonehad.
2. The descriptive sensory characteristics of Kanom-jeen from fermented rice flour at different fermentation time can separate fermented rice noodles samples

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