Development Process of Frying Distillation in Capturing Flavor that Formed During Deep Frying

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Frying distillation was a new process that developed to capture the flavor that formed during deep frying. It was studied using simple water distillation apparatus. The design experiment were carried out to map the best combination between time, temperature, and ratio (between material and heating medium) that used in the frying distillation process. From the best design experiment of frying distillation will be obtained the flavor and the components will be analysed using GC-MS.

The material that used in the frying distillation process were dried shallot, dreid onion, and dried garlic. They have specific flavor when deep frying. The flavor that formed during deep frying will be captured by frying distillation and will be analysed by GC-MS. Shallot, onion, and garlic were pelled, cut, and then dried using a cabinet dryer (45-50 ^{o}C) for 22-24 hours. After that, tempering during 20-24 hours and then weighing. Dried shallot, dried onion, and dried garlic were inserted into the distillation flask and mixed with oil, until each of them was completely submerged.

There were differences in the frying distillation time, temperature, and ratio between material and heating medium for dried shallot, dried onion, and dried garlic. Each components that captured from deep frying shallot, onion, and garlic were not contain burnt attributes.

Keywords: ***shallot, onion, garlic, flavor, deep frying, frying distillation, distillate, flavor component***

1. Introduction

Deep frying is an important method of food preparation, which immerse foods in hot oil. Deep frying is a common practice in food processing. Shallot, onion, and garlic are important seasoning spices that can be applicated in deep frying. It has specific flavor when it was crushed and cut into pieces, and then put in the deep frying oil at high temperature. Another frying method that produce typical shallot flavor is pan frying. Both of pan and deep frying method, will be produced specific flavor that can stimulate and create hunger. In Chinese cuisine such as instant noodles, fried noodles, fried rice and rice with ground pork, applicated with shallot after being deep frying then were taken out of the frying oil (Chyau and Mau, 2001).

Recently, the usage of deep fried shallot, onion, and garlic flavouring in the foods is becoming increasingly popular. Thus, the recent research did to investigate the volatile compounds of deep fried shallot flavouring. Chan, Liou, and Wu (1991) used the methods of short path distillation to separate the volatiles of deep fried shallot flavourings. Volatiles from the acidic, alkaline and neutral fractions included sulphides, pyrroles and compounds from the degradation of lipid. The lipid-degraded compounds were identified as (E)-2-hexenal, (E)-2-heptenal, (E)-2-decenal, (E,E)-2,4-heptadienal, (E,E)-2,4-decadienal, pentanoic, and hexanoic acids.

In the other hand, there is no information about the flavor that formed during frying shallot, onion, and garlic. And also there is no technology that is used to capture flavor formed during the frying shallot, onion, and garlic. To capture the delicious flavor formed during frying shallot, onion, and garlic, made a frying distillation process innovation.

Frying distillation is a new method of distillation process. Frying distillation process has the same principle with general distillation process. The difference lies in the usage of heating medium or distiller medium. Heating medium that used instead of water, steam, or organic solvent, but frying oil. The purpose of this research was to design the process of capturing flavor formed during the frying shallot, onion, and garlic and to analyze the volatile components that make up savory flavor for frying shallot, onion, and garlic.

2. Material and Methods

2.1. Materials

Shallot, onion, and garlic were purchased from local market (Yogyakarta, Indonesia). They were peeled, sliced (± 1 mm) and dried at 45-50^{o}C, 20-25 hour. During the experiment, all the samples were saved in isolated condition, using silica gel at ambient temperature. In each batch, 30 g of dried shallot mixed with frying oil, 30 g of dried onion mixed with frying oil, and 25 g of dried garlic mixed with frying oil (depend on the condition of material under the frying oil).

2.2. Experimental Design

The dried shallot, dried onion, and dried garlic samples were weighed and quantitatively transferred into a 250-ml flask, then distillated with different volume for a given time and distillation temperatures. The flavor compound of distillate was determined by GC-MS analysis.

Table 1. Experimental Design of Frying Distillation Process for Dried Shallot, Dried Onion, and Dried Garlic

Material	Given Time (minutes)	Given Temperature (^{o}C)	Ratio Between Material - Frying Oil
Dried Shallot	20, 30, 40, 50, 60, 70	140, 150, 160, 170, 180	1:5, 1:6, 1:7
Dried Onion	20, 30, 40, 50, 60, 70		
Dried Garlic	20, 30, 40, 50, 60, 70	130, 140, 150, 160, 170	1:2, 1:3, 1:4, 1:5

Determination of optimum frying distillation time carried out by looking at the large amount of distillate (distillate weight) every 10 minutes started from 20th minute and ending at 70th minute. Weighing distillate obtained performed at 20th, 30th, 40th, 50th, 60th, and 70th minute. Determination of optimum temperature was done by varied the temperature of frying distillation. The optimum frying distillation temperature was obtained from the greatest weight among the five variations of temperature. Another parameter of determination for frying distillation temperature was based on the quality of flavor that was captured. It was intended to get the flavor that escaped and avoided from burnt flavor. Determination of ratio between materials and frying oil performed after obtained the optimum time and temperature of the frying distillation.

Optimization process of frying distillation consist of time factor, temperature factor, and ratio between material and frying oil factor. Each of these factors was all factor that had undergone optimization meant that the optimum conditions to produce the best quality and quantity of the distillate. The relationship between best quality and quantity can be demonstrated by the high amount of distillate but didn't contain burnt flavor.

2.3. Frying Distillation

Each of the samples were weighed and quantitatively transfered into a 250 ml flask, then fried with different ratio between frying oil and dried shallot for a given time when the frying temperatures were respectively set.

After frying process, the distillate was collected. The best combination between time process, frying temperature, and ratio between frying oil and dried shallot will be the frying distillation condition.

2.4. Gas chromatography-mass spectrometry (GC-MS) analysis

The distillate was analyzed using AGILENT GC 6890N equipped with a 5975B MSD and HP-5ms capillary column (30m x 250 μm, film thickness 0.25 μm). Injector temperature were set at 300^{o}C, GC-MS *interface* temperature at 325^{o}C. Column temperature was initially kept at 50^{o}C for 2 min, then gradually increased to 200^{o}C with a rate of 10^{o}C/min. Helium was carrier gas, at a flow rate of 0.5 mL/min. Samples of 1 μL were injected manually and in the splitless mode. Tentative identification of the compounds was based on the comparison of their mass spectra with those of library data.

3. Result and Discussion

3.1. Determination of Frying Distillation Time

Determination of optimum conditions for the time factor was based on the weight of distillate that obtained and the quality of the flavor, which was the largest amount of distillate and flavor during frying shallot, onion, and garlic instead of burnt flavor. Longer the frying distillation taken place, heavier distillate that obtained had increased.

3.2. Determination of Frying Distillation Temperature

Frying distillation temperature was directly proportional to the amount of distillate that produced. The higher the frying distillation temperature, the bigger amount of distillate that produced previously. The heat penetration process was greater so that the process of releasing vapor components over the maximum. However, increasing frying distillation temperature was inversely proportional to the quality of the condensed flavor. The higher the frying distillation temperature, the worst quality of condensed flavor. It was associated with the accelerated process of burnt due to the higher temperature. So that the condensed flavor was the burnt flavor that was undesirable flavor in foods.

Burnt flavor was distillate quality parameter that resulted from the isolation of flavor formed during the frying shallots. According to Ojeda, et al (2001), burnt flavor formed by overcooked, and had burnt attributes, namely odor produced when food was burned. Compounds that describe burnt attribute were pyrocatechol; 3-methoxypyrocatechol; dimethoxybencebe 1.2-, 2.6-dimethoxy 4-methylphenol, 2.6-dimethoxy-4-(1-propenyl)-phenol; burnt bread. The usage of different frying temperatures caused the difference in time of appearance burnt flavor. The higher temperature, burnt flavor that was formed more quickly.

3.3. Determination of Ratio Between Dried Shallot and Frying Oil

Obtained inverse relationship between distillate weight and ratio dry shallot-cooking oil, the greater the ratio the smaller the distillate obtained. It was associated with greater volume of dried shallot-frying oil mixture that be heated so that the longer the heat transfer process. The longer time the heat taken to reach the middle part of the mixture, the smaller components that were successful to exit. So for the same time frame, the higher volume of the mixture, it will produce smaller amount of distillate.

3.4. Optimization Process of Frying Distillation and Distillate Yield

Each of the temperature, time, and ratio between material and frying oil factors were all factors that had undergone optimization, meant that the optimum conditions to produce the best quality and quantity of the distillate. The relationship between best quality and quantity can be demonstrated by the high amount of distillate but didn't contain burnt flavor (Table 2).

Table 2. Weight of Distillate that Obtained in Several Frying Time and Temperature of Frying Distillation for Dried Shallot, Dried Onion, and Dried Garlic

Dried Shallot		Time (minutes)						
		0	20	30	40	50	60	70
Temp (^oC)	140	0	0.0851	0.1551	0.1945*	0.1945	0.1945	0.1945
	150	0	0	0.2911	0.3154*	0.3154	0.3424	0.3548
	160	0	0	0.9082	0.9792*	1.0076	1.0270	1.0270
	170	0	0	1.0390	1.1231*	1.1922	1.4637	1.7791
	180	0	0.1211	1.6586*	2.0999	2.4569	2.6364	2.6364

Dried Onion		Time (minutes)						
		0	20	30	40	50	60	70
Temp (^oC)	140	2.3511	2.8080	2.8084	2.8384*	2.8694	2.8844	2.3511
	150	2.3134	3.0320	3.0702*	3.0717	3.1014	3.1014	2.3134
	160	2.0753	4.0975*	4.1808	4.2131	4.2170	4.2221	2.0753
	170	2.5318	6.1879*	6.6392	6.6648	6.6825	7.1058	2.5318
	180	1.8143*	4.7157	5.0870	5.1549	5.7332	5.7332	1.8143*

Dried Garlic		Time (minutes)						
		0	20	30	40	50	60	70
Temp (^oC)	130	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	140	0.000	0.000	0.000	0.000	0.000	0.065	0.065
	150	0.000	0.095	0.190*	0.225	0.305	0.365	0.378
	160	0.000	0.835*	0.985*	1.065	1.175	1.220	1.230
	170	0.000	0.985*	1.210	1.305	1.370	1.415	1.460

Ratio between Dried Garlic and Frying Oil	Weight of Distillate (g) **	Weight of Distillate (g) ***	Flavor Quality (Burnt Factor)
1:2	0.80	0.47	++
Ratio between Dried Garlic and Frying Oil	Weight of Distillate (g) **	Weight of Distillate (g) ***	Flavor Quality (Burnt Factor)
1:3	0.87	0.53	+
1:4	1.00	0.55	-
1:5	0.00	00.0	-

* Sign apostrophe here indicated the frying process had entered the the burnt process
** 1^{st} condition = 160^{o}C, 25 minutes
*** 2^{nd} condition = 150^{o}C, 35 minutes

Based on the weight of distillate and quality of the flavor, the optimum conditions for capturing flavor process that formed during the frying shallot was at temperature of 170 ^{o}C for 30 minutes with the ratio between dry shallots and cooking oil was 1:5. The optimum conditions for capturing flavor process that formed during the frying onion was at temperature of 170 ^{o}C for 30 minutes with the ratio between dry shallots and cooking oil was 1:6. And the optimum conditions for capturing flavor process that formed during the frying garlic was at temperature of 160 ^{o}C for 25 minutes with the ratio between dry shallots and cooking oil was 1:4.

3.5. Volatile Components in the Distillate

Volatile components of frying distillation from dried shallot, dried onion, and dried garlic can be grouped into several major components. From the results of GC-MS analysis, contained pyrazine group, ketone group, aldehyde group, alcohol group, oxygen-containing heterocyclic compound group, carboxilate acid group and other components.

Pyrazine compound was the main compound in chocolate odour. According to Chambers, et al (1998), pyrazines had characteristics minty, but not the characteristic musty or sweet roasting results. Another characteristic that was like baked beans, acetone, and hydrolyzed. According Nuwiah (2008), the composition of hydrophobic acid and fructose as in Ghana cocoa roasting results in cocoa fat lindak, produced derivative compounds such as trimethyl pyrazine and dimethyl pyrazine.

The second and the third group were ketone and aldehyde group. Aldehydes and ketones were the degradation result of unsaturated fatty acid during the heating process and it was important in the Maillard reaction and flavor forming (Erikson, 1981 in Santi, 2002). The resulted ketones were also used in the Maillard reaction in addition to the usege of amino acids and reducing sugar from the shallot itself. According to Pokorny, et al (1998), acetaldehyde was the decomposition result (such as oxidation and other reactions such as retroaldolisation) of oxidized linalool storage.

Other components found in the distillate was derived from the alcohol group, oxygen-containing heterocyclic compound group, carboxilate acid group and other component. Alcoholic compound was found in the form of 2-propene-1-ol, 2-furancarboxaldehyde included in the oxygen-containing heterocyclic compounds, acetic acid included in carboxilate acid group and other components was carbon dioxide. According to Spanier, et al (1998), acetic acid had an odour description like vine strong, quick and contain some sulfur. According Pudil, et al (1998), acetic acid was one component of bergamot oil that slightly oxidized on the heating condition of 40^{o}C for 20 hours.

Table 3. The Components in the Distillate from Flavor Condensation during Frying Distillation of Dried Shallot, Dried Onion, and Dried Garlic by GC-MS Analysis

Component	**% Concentration**		
	A	B	C
Carbon dioxide	7.659	7.659	31.48
Acetaldehyde	32.442	18.266	-
Propanal	27.282	9.173	-
2-propen-1-ol	1.630	-	6.90
2-methyl propanal	8.793	-	-
2,3-butanedione	0.412	1.618	-
3-methyl butanal	8.212	8.752	-
2-methyl butanal	4.210	2.659	-
2-methyl-2-butenal	1.397	-	-
Methyl pyrazine	0.379	-	-
Component	**% Concentration**		
	A	B	C
2-furancarboxaldehyde	0.661	1.493	-
Acetic acid	1.626	21.751	-
1-hydroxy-2-propanone	2.181	2.462	-
2,5-dimethyl pyrazine	1.774	-	-
Dimethyl pyrazine	1.343	-	-
Propanal,2-methyl-iso butyraldehyde	-	7.485	-

2,3-pentanedione	-	0.355	-
2,3-dimethyl-oxirane	-	0.521	-
2,4,5-trimethyl-1,3-dioxolane	-	0.226	-
(methylthio)acetaldehyde	-	0.532	-
Furfural	-	3.139	-
Oxirane (CAS)	-	-	6.50
Oxiranemethanol	-	-	1.14
Allyl alcohol	-	-	53.98

A, Distillate from flavor condensation during frying shallot; B, Distillate from flavor condensation during frying onion; A, Distillate from flavor condensation during frying garlic

Based on those components in the distillate, there were not components that describe burnt attributes such as pyrocatechol; 3-methoxypyrocatechol; 1.2-,dimethoxybenzene 2.6-dimethoxy 4-methylphenol, 2.6-dimethoxy-4-(1-propenyl) -phenol; burnt bread. Burnt flavor was a distillate quality parameter resulted from the flavor isolation from frying shallot. According to Ojeda, et al (2001), burnt flavor formed due to overcooked process, which had burnt attributes, odor that produced when food was burned. That was to say this distillate was the result of condensation from frying process before reaching the burnt condition. This was indicated there wasn't detection of compounds that described the burnt attributes.

4. References

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