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VOLATILE COMPONENT OF POWDER FLAVOR FROM NARROW-BARRED SPANISH MACKEREL'S MEAT WITH CONVENTIONAL DRYING METHOD

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ABSTRACT

Volatile flavor compound is the sensation perceived when aroma is sensed. These group of compounds influence the flavor of the overall product and consumer acceptance due to their impact on the aroma characteristics. Volatile flavor components are affected by various processing parameters. The purpose of this study was to determine the volatile compounds and their composition in the flavor powder derived from mackerel fish meat using conventional drying methods using a Teflon frying pan. The research method used is an experimental method with the following stages: boiling to extract the volatile compounds of the sample using a temperature of 65^0, for ± 90 minutes, then drying it on a frying pan, followed by the sample extraction stage using solid phase microextraction (SPME) (80^0C) for 30 minutes. The compounds in the sample were then identified using a Gas Chromatography-Mass Spectrometry (GC / MS) device. The data analysis was discussed in a comparative descriptive. The results showed that 148 volatile compounds were detected in the flavor powder of mackerel fish meat, where pentanal had the highest proportion (21.16%). Most of the components detected came from these group of compounds: aldehyde, alcohol, hydrocarbon, organic acid, ketone, ester and others.

1. INTRODUCTION

Narrow-barred Spanish mackerel (*Scomberomorus commerson*) is one of the pelagic fish that is favored by the public because of its fishy meat and umami taste [1]. Fish meat contains compounds that are very beneficial for humans, namely protein, fat, carbohydrates, vitamins and mineral salts. Fish is a very potential source of animal protein because of its high protein content [2]. Many people in Indonesia process mackerel into various traditional products such as pempek, otak-otak, meatballs and dumplings. This fish is called "tenggiri" in the local language and it is one of Indonesia's most popular capture fisheries products because of its high yield and wide use in various traditional dishes. In 2016, the catch production of this commodity in Indonesia was 225.936 tons, which increased to 438.658 tons the following year [3].

According to [4], the fishery product processing industry will inevitably produce wastes such as skins, bones, backbones, heads and tails, as well as liquid waste. Many traditional fishery processing units in Indonesia have not yet fully utilized this generated waste, and usually they directly discharged it into drains, rivers and even the soil. Generally, it has been recognized that fish processing waste still contains many useful ingredients, which can be further used as secondary products. It is known that certain ingredients contained within can affect the flavor of the product and impart its characteristics. Fish bones are waste produced by many types of fish processing industries. Fish bones mainly contain three elements, namely calcium, phosphor and carbonate. Calcium is the highest content element in fish bones compared to other parts of fish [5].

Flavor can produce a sensation from food ingredients when placed in the mouth which is caused by taste and aroma [6]. The sensation that appears in flavor is caused by volatile chemicals (affecting the aroma of the product) or non-volatile (affecting the taste) [7]. Volatile flavors that are volatile are the sensations obtained when smelling food that is felt by the sense of smell. Aldehydes, alcohols, ketones, acids and hydrocarbons are usually a group of components of volatile compounds detected in fishery products [8], while non-volatile flavors are components that play a role in the formation of flavors. Flavor in powder form is made through the drying method, namely by heating the flavor in the form of liquid broth.

The conventional drying method, which is commonly used at the household scale, is easy to do with widely available tools, but it takes longer than modern drying methods [9]. Pans made of Teflon coating are commonly used in cooking and drying ingredients (reducing water content) so they can also be used in making flavor powders. The resulting powder is in the form of dry spices that function as a flavoring ingredient, which can add to the taste of food. Flavor powders are included as a food additives to add and enhance flavor of a product. The production of this powder product is expected to be able to compete with other flavorings that are widely accepted by the community [10]. The application of flavoring powder in dry form is easier and more practical because it can be used as a flavor enhancer in various processed products. Information about the composition of volatile compounds in flavor powders made from fishery products has not been widely studied.

Research on volatile flavor compounds in fishery products has been widely conducted abroad, some of which are research by [8] who used the SPME and GC / MS methods to study the effect of re-cooking on volatile and non-volatile compounds in silver fish. [11] studied changes in volatile compounds in fresh fish using the seripa method, while [12] studied volatile compounds in smoked salmon products identified by gas chromatography. This research can provide information about the aroma characteristics of flavor powder made from mackerel's meat and provide basic data for further research applications. Based on the background described, it is necessary to study and identify the volatile compound composition of the mackerel fish meat flavor powder using conventional drying methods.

2. MATERIALS AND METHODS

2.1 Samples Preparation

The first stage of this research is taking mackerel fish samples at the Karangsong Fish Auction Place, Indramayu on the Northern part of West Java. The fresh mackerel fish were transported using a cool box to the Fisheries Product Technology Laboratory at the Fisheries Product Processing Laboratory, Faculty of Fisheries and Marine Sciences, Universitas Padjadjaran for preparation. The samples were rinsed with clean water, eviscerated, cutted into fillets, and the bones were separated from the meat. The filleted meat was then boiled for 90 minutes at a maximum temperature of 65° C with a ratio of 1:2, that is, 1 kg of meat and 2 liters of water. The resulting broth was then cooled first, filtered with a clean filter cloth and then put into a closed glass jar [13]. The next step is adding maltodextrin as much as 10% of the volue of the broth produced which act as a fillers. The application of maltodextrin in liquid broth is added gradually so that it does not clot and has to be stirred until homogeneous [14]. The liquid samples were then measured before entering the drying process.

Drying stage was carried out on the liquid meat broth samples which was priorly spread finely into the Teflon surface until they evenly distributed. Afterwards, the broth were heated over low heat for approximately 2 minutes until they dried and transferred to a container. Samples that have dried produce a thin layer which then were crushed using a mortar up until they are smooth and become powder [10]. Packaging is carried out on the resulting powder sample using aluminum foil wrapped in cling wrap and then labeled and placed into a glass jar. The packaged samples (30 g at minimum) were then taken to Flavour Laboratory, Indonesian Centre for Rice Research, Sukamandi, Subang, West Java for analysis of volatile flavor compounds [15].

2.2 Volatile Compound Analysis

The identification of volatile flavor compounds is carried out based on the modification and adjustment of the [16] research procedure. The identification process was carried out using gas chromatography and mass spectrometry (GC / MS) apparatus. The solid phase micro extraction method (SPME) is used for extraction by evaporating the volatile compounds contained in the sample. DVB/Carboxen/Polydimethylsiloxane fibers is used to absorb volatile flavor compounds from the sample. A total of 6 grams of powder samples were put into a special 22 ml SPME vial. The extraction temperature of the mackerel fish meat flavor powder sample used was 80 ° C which was carried out for 30 minutes in a waterbath. The fiber that has finished absorbing volatile compounds is inserted into the GC / MS injector part, then this device is set up first before running the analysis. The GC column used is HP-5MS (325 °C: 30 m x 250 µm x 0.25 µm), with helium carrier gas. The initial temperature used was 45°C (maintained for 2 minutes), then heated at 6°C / minute, and the final device temperature reached 250°C (maintained for 5 minutes). The total time spent is 36 minutes with the resulting data in a form of chromatograms.

2.3 Data Analysis

The mass spectra of the detected compounds were then compared with the mass spectra patterns contained in a data center or library NIST 14 (National Institute Standard and Technology) on a computer. The data on the components of the volatile flavor compounds were further analyzed using the Automatic Mass Spectral Deconvolution and Identification System (AMDIS) software [17] to correct the compound mass spectra data. The identification data of the volatile flavor compound from the flavor powder made of meat of mackerel with conventional drying methods will be discussed in a comparative descriptive manner.

3. RESULTS AND DISCUSSION

3.1 Volatile Component

Analysis of volatile flavor compounds in mackerel meat flavor powder sample successfully detected 148 compounds which derived from the aldehyde, ketone, alcohol, hydrocarbon, organic acid, esters and others groups. The aldehyde group was identified to have 21 compounds, 16 compounds from ketone groups, 23 alcohol compounds, 42 hydrocarbons, 4 organic acid compounds, 3 ester compounds and 39 which categorized as other compounds group. The hydrocarbon group with 42 compounds is the group with the highest number of compounds compared to other compound groups. Pentanal compound which came from the aldehyde group was detected to have a proportion value of 21.16% which is the highest proportion value compared to other types of compounds. The volatile flavor compounds contained in the mackerel meat flavor powder are shown in Table 1.

Table 1. Volatile compounds detected in conventional-dried Spanish mackerel meat flavor powder

Groups	Retention Time	Compounds	Area	Proportion (%)
Aldehyde	2.6564	Pentanal	642104213	21.16
	12.604	Nonanal	254086290	8.37
	1.9964	Butanal, 3-methyl-	175822754	5.79
	10.8737	Benzeneacetaldehyde	124169365	4.09
	5.2547	Furfural	52024731	1.71
	6.9672	Methional	49771620	1.64
	9.6013	Octanal	47359331	1.56
	11.2602	2-Octenal, (E)-	28450841	0.94
	15.5175	Decanal	25295565	0.83
	8.4656	Benzaldehyde	23220937	0.77
	17.1586	2-Decenal, (E)-	13679085	0.45
	14.0607	2,6-Nonadienal, (E,E)-	13056809	0.43
	4.5412	Hexanal	12444010	0.41
	14.2153	2-Nonenal, (E)-	11731366	0.39
	9.9045	2,4-Heptadienal, (E,E)-	8773053	0.29
	6.8126	Heptanal	8681863	0.29
	18.5143	2,4-Decadienal, (E,E)-	5950403	0.20
	13.698	2-Hexenal, 2-ethyl-	4485841	0.15
	29.0386	Octanal, 2-(phenylmethylene)-	4019889	0.13
	30.4776	Tetradecanal	2790924	0.09
	32.4219	Heptadecanal	1586095	0.05
Ketones	7.1159	Ethanone, 1-(2-furanyl)-	128577970	4.24
	11.6883	Ethanone, 1-(1H-pyrrol-2-yl)-	91360742	3.01

Groups	Retention Time	Compounds	Area	Proportion (%)
	9.1018	2,3-Octanedione	29496197	0.97
	22.1235	trans-Geranylacetone	25640794	0.84
	13.5851	1-Propanone, 1-(2-pyridinyl)-	10691723	0.35
	17.9672	2-Undecanone	9713620	0.32
	12.3661	3,5-Octadien-2-one, (E,E)-	9690696	0.32
	22.4981	Cyclohexanone, 2-ethyl-	8186820	0.27
	27.243	β-iso-Methyl ionone	4870739	0.16
	19.2635	3-Nonen-2-one	4624380	0.15
	15.1726	2-Decanone	4389269	0.14
	27.7424	1-(4-Benzylphenyl)ethanone	3775302	0.12
	20.8392	Bicyclo[3.2.1]oct-3-en-2-one, 4-methyl-	3623111	0.12
	19.1029	Pyrethrone	2617399	0.09
	26.4759	Benzophenone	2514105	0.08
	20.6429	1-Methyl-2-decalone	2095153	0.07
Alcohols	13.0856	Maltol	354106435	11.67
	5.8434	2-Furanmethanol	70517598	2.32
	10.4456	1-Hexanol, 2-ethyl-	31859483	1.05
	14.4175	1-Pentanol, 2,4,4-trimethyl-	20833259	0.69
	8.1207	Z-4-Dodecenol	11463785	0.38
	13.2402	1,3,5-Benzenetriol	11357253	0.37
	13.7991	(S)-(+)-6-Methyl-1-octanol	9758149	0.32
	23.4673	1-Decanol, 2-hexyl-	7959296	0.26
	14.7089	Levomenthol	7296968	0.24
	16.2013	4,8-Decadien-3-ol, 5,9-dimethyl-	5120577	0.17
	6.5331	2-Methylenecyclohexanol	4723412	0.16
	28.6284	Phenol, 4-(1-methyl-1-phenylethyl)-	4318297	0.14
	10.6834	3,5-Octadien-2-ol	4184061	0.14
	25.7446	Benzenemethanol, 3,4-dimethoxy-	4106075	0.14
	24.0381	Acetyleugenol	4071235	0.13
	21.2197	1-Decanol, 2-hexyl-	3974379	0.13
	24.4781	1-Octanol, 2-butyl-	3766332	0.12
	20.3337	Phenol, 2,4,6-trimethyl-	2923341	0.10
	24.3413	1-Dodecanol, 2-hexyl-	2626634	0.09
	26.3035	Epicedrol	2561284	0.08
	23.7408	2,4-Di-tert-butylphenol	2487007	0.08
	6.444	3-Furanmethanol	2140863	0.07
	24.6208	Ethanol, 2-(octadecyloxy)-	1410657	0.05
Hydrocarbons	13.4067	Cyclopropane, 1,1-diethyl-	21004600	0.69
	23.2235	Pentadecane	12278683	0.40
	13.5137	3-Dodecene, (E)-	11056447	0.36
	19.7748	Tridecane, 2-methyl-	10188297	0.34
	19.6321	Tridecane, 4-methyl-	10121438	0.33
	18.0683	Tridecane	10051741	0.33
	22.6705	Cyclopropane, nonyl-	9478263	0.31
	20.7202	Tetradecane	9272429	0.31

Groups	Retention Time	Compounds	Area	Proportion (%)
	16.897	2,6-Octadiene-1,8-diol, 2,6-dimethyl-	8729331	0.29
	19.424	Tridecane, 6-methyl-	8616653	0.28
	27.8613	Heptadecane	7442382	0.25
	27.6116	1,7-di-iso-propylnaphthalene	7248747	0.24
	14.6018	1-Nonene	7004535	0.23
	21.3981	Caryophyllene	5920589	0.20
	15.2916	Dodecane	5488048	0.18
	28.4857	2,6-Diisopropylnaphthalene	5283581	0.17
	15.8386	Cyclohexene, 1,2-dimethyl-	5259676	0.17
	24.1986	Hentriacontane	5007868	0.17
	20.5121	Cyclotetradecane	4762574	0.16
	24.7397	Dodecane	4644198	0.15
	22.3137	Undecane	4543974	0.15
	27.5046	1,3-di-iso-propylnaphthalene	4274390	0.14
	15.6721	Undecane, 2,6-dimethyl-	4197576	0.14
	28.2538	Naphthalene, 1,2,3-trimethyl-4-propenyl-, (E)-	4117946	0.14
	27.9921	Dodecane, 2,6,10-trimethyl-	4074544	0.13
	26.8862	Cyclotetradecane	3695964	0.12
	16.3559	Cyclopentane, 1-pentyl-2-propyl-	3000874	0.10
	23.8121	3-Hexene, 3,4-dimethyl-, (Z)-	2994457	0.10
	30.0078	Nonadecane	2736588	0.09
	28.557	1,4-di-iso-propylnaphthalene	2672296	0.09
	22.8311	1,2-Di-but-2-enyl-cyclohexane	2508634	0.08
	27.1656	Naphthalene, 1,2,3-trimethyl-4-propenyl-, (E)-	2262536	0.07
	26.7078	Hexadecane, 2,6,11,15-tetramethyl-	2176917	0.07
	29.217	trans-1,2-Diphenylcyclobutane	2158518	0.07
	25.1975	Cetene	2019136	0.07
	28.0695	Heptadecane, 2,6-dimethyl-	1894482	0.06
	28.7235	1,7-di-iso-propylnaphthalene	1519717	0.05
	28.8246	Octadecane	1506185	0.05
	23.6754	Butylated Hydroxytoluene	1400349	0.05
	29.3954	Hentriacontane	1378805	0.05
	32.0473	Decane	1179159	0.04
	31.9165	1-Nonadecene	446141	0.01
Organic acids	17.5689	Nonanoic acid	7406035	0.24
	24.9181	Nonahexacontanoic acid	3196750	0.11
	23.9548	Nonahexacontanoic acid	1952637	0.06
	26.1013	Cyclooctaneacetic acid, 2-oxo-	974569	0.03
Esters	27.3856	Acetic acid, trifluoro-,	2241683	0.07

Groups	Retention Time	Compounds	Area	Proportion (%)
		dodecyl ester		
	33.9678	Hexadecanoic acid, ethyl ester	1413327	0.05
	32.6062	Hexadecanoic acid, methyl ester	1323250	0.04
Others	7.5737	1H-Pyrrole, 1-ethyl-	28702399	0.95
	12.1759	2,3-Dimethyl-5-ethylpyrazine	28395175	0.94
	14.9229	Pyrazine, 2,3-dimethyl-5-(1-propenyl)-, (E)-	24954870	0.82
	18.3775	2-Acetylaniline	20456971	0.67
	17.4618	Benzeneacetaldehyde, α-ethylidene-	19512038	0.64
	16.8078	2-Isoamyl-6-methylpyrazine	16567301	0.55
	5.0288	Pyrazine, methyl-	15152803	0.50
	10.2018	Pyrazinamide	14878115	0.49
	25.6078	Diethyl Phthalate	14246174	0.47
	12.0867	Pyrazine, 2-ethyl-3,5-dimethyl-	14159479	0.47
	11.9678	Pyrazine, 3-ethyl-2,5-dimethyl-	13683778	0.45
	20.1256	Benzimidazole, 2-amino-1-methyl-	12135219	0.40
	8.7332	Dimethyl trisulfide	11832995	0.39
	16.0705	Furan, 3-phenyl-	11684061	0.39
	30.2814	2-Ethylhexyl salicylate	11047033	0.36
	9.2861	Furan, 2-pentyl-	10671521	0.35
	27.0527	1,1'-Biphenyl, 2,2',5,5'-tetramethyl-	10343289	0.34
	21.1008	2-Dodecen-4-yne, (E)-	7832402	0.26
	19.1921	5-Ethyl-2-furaldehyde	7821008	0.26
	19.9532	Disulfide, di-tert-dodecyl	6954544	0.23
	18.9662	2-Oxo-1-methyl-3-isopropylpyrazine	5833295	0.19
	21.951	2,6-Dodecadien-1-al	5732658	0.19
	11.4683	3-Hydroxypyridine-N-oxide	5543833	0.18
	11.8905	Pyrazine, 2,6-diethyl-	5357488	0.18
	17.7948	Benzenamine, N,N-diethyl-3-methyl-	5335358	0.18
	19.5072	Pyridine, 2-(1-methyl-2-pyrrolidinyl)-	4521113	0.15
	21.737	3,3'-Bis(1,2,4-oxadiazolyl)-5,5'-diamine	4466739	0.15
	10.0532	Pyrazine, 2-ethenyl-6-methyl-	3993731	0.13
	22.9797	1,3,5-Triazine-2,4-diamine, 6-phenoxy-	3538546	0.12
	30.5667	Isopropyl myristate	3076339	0.10
	31.2922	Galoxolide	2902051	0.10
	25.4354	3-Methyl-4-phenyl-1H-pyrrole	2773115	0.09
	17.8602	Dihydrocarveole	2453674	0.08
	25.9467	2-(5-Aminohexyl)furan	2138865	0.07

Groups	Retention Time	Compounds	Area	Proportion (%)
	26.6305	3-Hydroxypyridine monoacetate	1695734	0.06
	26.9754	Methyl dihydrojasmonate	1692540	0.06
	31.536	1-Butyl 2-isobutyl phthalate	1595556	0.05
	25.2927	Diethyltoluamide	1393855	0.05
	33.403	Butyl 2-ethylhexyl phthalate	641737	0.02

Identification analysis of volatile compounds derived from mackerel meat flavor powder samples succeeded in detecting as many as 21 compounds in the aldehyde group, with pentanal, nonanal and 3-methyl- butanal, are the top three which have the largest proportion value compared to other groups and compounds. Research by [8] also found pentanal compound in the aldehyde group. This compounds were known to have "green" flavor characteristics [18]. Most of the aldehyde class compounds detected in fish meat come from the oxidation of double carbon bonds from unsaturated fatty acids found in fish meat or saturated fatty acids [19]. Aldehydes are found in various shellfish and fresh fish with distinctive aromas such as nutty, melon-like, green plant, sweet floral, fruity, dark chocolate, apple-like, grassy, malty and fatty with various concentrations (Buttford et al 1998). Aldehydes play a role in the formation of surface colors of processed meat and other foods [15], [20, [21].

There were 16 ketone compounds detected in the sample, where the 1- (2- furanyl) - ethanone compound had the highest proportion value in the ketone group, namely 4.24%. These types of compounds contribute to the aroma of many foods and beverages. The second largest compound in the ketone group is 1- (H-pyrrol-2-yl) - ethanone. [12] research on volatile components of smoked salmon showed that 1- (2- furanyl) – ethanone compound was also detected in high levels. Flavor characteristics of this compound types are present in ripe apples, cherries, grapes, strawberries and bakery products [22]. These ketone compounds are likely formed from the oxidation of lipids (especially fatty acids) during the cooking process. According to [8] ketone group compounds can be produced from thermal oxidation (steaming), degradation of unsaturated fatty acids and degradation of amino acids or oxidation by microorganisms.

The alcohols group according to [23] is formed from the oxidation of fats, fatty acids and degradation of amino acids. [12] stated that some alcohol compounds have a lower threshold of odor characteristic than aldehydes and ketones. According to [24] most alcohol has a rancid odor for flavors that contain lipids. Alcohols are not considered as an important contributor because of its relatively high odor threshold. Alcohol compounds generally provide fruity, floral and grassy notes to fish [8]. The type of maltol compound was identified as having the highest proportion value in the alcohol group, namely 11.67%, then the next compound which has high proportion is 2-furanmethanol (2.32%). The type of maltol compound is a natural organic compound that is used primarily as a flavor enhancer. The compound maltol has a sweet caramel aroma. The 2-furanmethanol compound is a flavoring ingredient found in the aroma of coffee, tea, wheat bread, soybeans, cocoa, starch chips and other sources, besides this compound also knowns as a Maillard reaction product [25].

The results of the volatile compounds identification had detected 42 compounds from the hydrocarbon group where this amount was the largest number of compounds detected compared to the number of compounds in other groups. The highest compound proportion among these hydrocarbon is 1,1-diethyl-cyclopropane 0.69%. The volatile hydrocarbons identified in the flavor powder samples are a number of homologous compounds from straight and cyclic hydrocarbons. Alkanes groups, which have a saturated chain, generally resulted from a decarboxylation reaction and separation of carbon chains from fatty acids [26]. According to [8], some of the cyclic hydrocarbons identified in fish are the result of a secondary reaction from thermal oxidation (caused by heating) of carotenoids and other unsaturated fats.

The group of organic acid compounds had succesfully detected in the sample as many as 4 compounds. Nonanoic acid with the proportion of 0.24% was the compound with the largest proportion value among other organic acid compounds. This compound has a fatty and coconut aroma [27]. Organic acids directly contribute to flavor and taste and can be a substances or raw materials for aromatic components [28]. The ester compound in this sample generally comes from the acid and alcohol esterification process which was previously formed from the results of fat metabolism [18], [26], [29]. The compound that has the highest proportion value in the ester group is dedocyl ester trifluoro acetid acid with a proportion value of 0.07% and in total there are three esters compound detected from the samples.

Group of other compounds consists of several of compound which are not incluled in previously mentioned groups. There are 39 compounds categorized in this group which detected from flavor powder sample. Some of the compound which included in this group are nitrogenous and sulphurous compounds. The compound which had the largest proportion (0.95%) is 1-ethyl-1H-pyrrole. The second largest compound in the other class of compounds is 5-ethylpyrazine-2,3 dimethyl with a proportion of 0.94%. This compound is previously associated in herbs and spices and various peppers, has a popcorn, greenbean and burnt flavor and has a deep roasted cocoa-like aroma [30].

Conclusion

According the results of the study, it can be concluded that the number of volatile compounds in the sample of mackerel flavor powder is 148 compounds. The volatile flavor compounds detected in the sample came from the aldehyde, ketone, alcohol, hydrocarbons, organic acids, esters, and others. Sample has the highest number of compounds in the hydrocarbon group. Compounds that have the largest proportion of mackerel meat flavor powder samples come from the pentanal (21.19%) which derived from aldehyde group.

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