Determination of Volatile Compounds on Traditional Fermentation of *Chao Teri*

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Abstract. *Chao teri* is a very popular product in Sulawesi Island, especially in South Sulawesi of Indonesia. In general, the processing method of ikan peda is divided into two stages: the first and the second fermentation. The first fermentation is to develop the characteristic flavor and texture of *chao teri*. The second fermentation is principally a maturation phase. Bacteria play an essential role in the fermentation process of *chao teri*. *Chao teri* has a thick texture such as pasta, brown or red, has a distinctive and slightly sour, salty taste. *Chao teri* is commonly consumed by the public as a complement to side dishes or used as flavor enhancers in food. Aromatic compounds that arise after the fermentation process are expected to be a reference for the industry to develop products into spices or food additives. This study aims to determine volatile aromatic components using Gas Chromatography-Mass Spectrophotometry (GC-MS) with Solid Phase Micro-Extraction (SPME). This research produced 73 aromatic compounds consisting of 12 alcohols, two organic acids, 9 aldehydes, eight ketones, four esters, one furan, 31 hydrocarbons, and six miscellaneous compounds. Most hydrocarbons of 56.48% and alcohol with the derivate compound are pentadecane and ethanol of 31.04%. This research is expected to introduce *chao teri* products as traditional products typical of Indonesia, especially South Sulawesi that can be developed as a natural flavoring in food.

1. Introduction

Indonesia, as an archipelago country, has abundant fisheries resources and a diverse range of fishing methods, including traditional processing techniques. Fermentation is one of the traditional methods of processing fish and there are many types of fermented fish products that can be found in many parts of Indonesia. The most popular fermented fish products in Indonesia include ikan peda (meat salted fish), terasi (fermented fish or shrimp paste), kecap ikan (fish sauce) and ikan jambal roti (moist salted split fish). Other fermented fish products include bekasam (fermented rice-fish) from South Sumatera, cincalok (fermented rice shrimp mixture) from West Kalimantan and Riau, wadi (fermented freshwater fish) from South Kalimantan and bekasang (fermented fissh intestines) from North Sulawesi. These products have particular consumers in Indonesia as they offer unique characteristics, including special flavors and textures [1].

Chao teri is a traditional food originating from Pangkep Regency in South Sulawesi Province, Indonesia. On Sulawesi Island, chao teri is a very popular product, particularly in South Sulawesi. This product is physically and aesthetically distinct from other fermented fish products, as well as traditional fish products such as pindang (boiled salted fish), ikan asap (smoked fish), and ikan asin (dry salted fish). The taste of chao teri can whet the appetite of most Indonesians who eat rice. Chao teri is usually

consumed in small amounts due to its high salt content. This product's consumers come from almost all layers of society, from low to high incomes.Local people generally consume chao teri as a complement to the side dishes. That is served along with pickled mango and banana-stone or used as a flavor enhancer. The flavor and taste of fermented fish products such as chao teri are essential to study because both of these components can affect consumer acceptance.

Chao teri produced from the fermentation of anchovies, rice as a source of carbohydrates and salt, occurs spontaneously through 2 stages of fermentation, namely salt fermentation (7 days) and carbohydrate fermentation (7 days), taking place in a closed container at a temperature of 30-32ºC. Early stages, salt inhibits decaying bacteria's growth, prevents ammonia from nitrogen compounds, and selects microorganisms. The salt concentration used in the fermentation of chao teri is about 20-25%. Fermentation in ikan peda is carried out mainly by halophilic bacteria—salt, which is generally used by processors and is traditionally produced by seawater evaporation [1]. Bacterial starter cultures are used to accelerate the process of fermentation of *chao teri*.In the second stage, fermentation is done with rice as a source of carbohydrates ranging from 30% and yeast as much as 1%. Carbohydrates are used as an energy source by microorganisms during the fermentation process in fish meat and aim to stimulate the growth of lactic acid bacteria. Yeast's use is generally intended to break down carbohydrates into ethyl alcohol and CO_2 [2].

Flavour arising in fish sauce could be an indicator to measure the quality of the fish sauce [3]. Research [4,5], . fermentation plays an important role are free amino acids, nucleotides, and volatile components produced. Volatile compounds formed in fish-salt and shrimp fermentation products are aldehydes, ketones, and esters which contribute to the flavor of all anchovy fermented, bigeye herring, and pasta of fishtails. During the ripening process for fish fermentation, the enzyme's biochemical processes cause changes by breaking down protein and fat. The important thing in proteolysis in flavor formation is the availability of amino acids as a substrate for transformation or the synthesis of flavor compounds by bacteria. The final product of fermentation is generally rich in free amino acids, peptides, sweets, and organic acids derived from proteins and glycogen. These contributed to the characteristics and product flavor that could be accepted by consumers [6]. The presence of a unique flavor arising after *chao teri* fermentation has not been studied, so that needed to determine the volatile compound in chao teri using gas chromatography - mass spectrophotometry (GC-MS) with Solid Phase Micro-Extraction (SPME). The volatile compounds obtained from this study are expected to be a reference for the industry to develop products into spices.

2. Methodology

2.1. Materials

Chao Teri was purchased from the local market in Labakkang, Pangkep Regency in South Sulawesi, Indonesia (Fig.1). Making chao teri in traditional processing begins with the cleaning of fresh anchovy, which includes head separation and washing. Furthermore, the washed anchovy is sprinkled with salt as much as 20-25%, then fermented in a closed container for a week (first fermentation). After the salt fermentation process is complete, anchovy is rewashed, drained for other added rice as a carbohydrates source as much as 20% and 1% yeast. This mixture is stirred evenly and put in a closed container again for 1 to 2 weeks (second fermentation).

Figure 1. Chao teri product*:* a) Chao teri before dyeing, b) Chao teri after dyeing.

2.2. Gas Chromatography-Mass Spectrophotometry (GC-MS) with Solid Phase Micro-Extraction (SPME).

The volatile compound from "Chao Teri" extracted using Solid Phase Micro-Extraction (SPME). Absorber fibers that are used are Polydimethylsyloxane-divinylbenzene (PDMS-DVB) polymer (Supelco, USA). The internal standard used dekana from PT. Sigma Aldrich. Chao teri samples of 7 g placed in a vial with a capacity of 40 mL. A vial is heated in a water bath at 70ºC for 45 min. Dekana standards are added as standard internals before extraction. The extraction results would be analyzed using GC-MS (GC 7890A and MS 5975C). Those were equipped with a split-splitless injector which was set at 250ºC. The column used HP-5MS with a length of 30 m, an inner diameter of 250 µm, and a thickness of 0.25 µm. The temperature of the MS detector is set at 230ºC. The GC-MS is programmed at an initial temperature of 35ºC for 2 min, then raised to 50ºC for 1 min (speed 4ºC per minute), and raised again 250ºC for 5 min (speed of 6ºC per min). Helium is used as a carrier gas at a rate of 0.8 mL/min. Parameters are monitored in full scanning mode with a range of 29 to 550 m/z. Volatile compounds are determined by the retention index and the Wiley Database mass spectrum-275 L [7,8].

3. Results and Discussion

3.1. Determination of volatile compounds

Identification using GC-MS detected in the traditional fermented chao teri consist are 12 alcohol, two organic acids, 9 aldehydes, eight ketones, four esters, one furan, 31 hydrocarbons, and six miscellaneous compounds (Fig.2). Based on the peak area, the most dominant types of alcohol compounds are ethanol and 2,3-butanediol. Alcohol is commonly found in fermented fish products such as fish sauce. It usually does not affect the overall taste of the fish sauce. The ethanol content detected in chao teri is produced from yeast fermentation [9,10]. Ethanol levels in chao teri are made from yeast fermentation. Ethanol is the result of primary metabolic activity by microorganisms under low oxygen conditions.

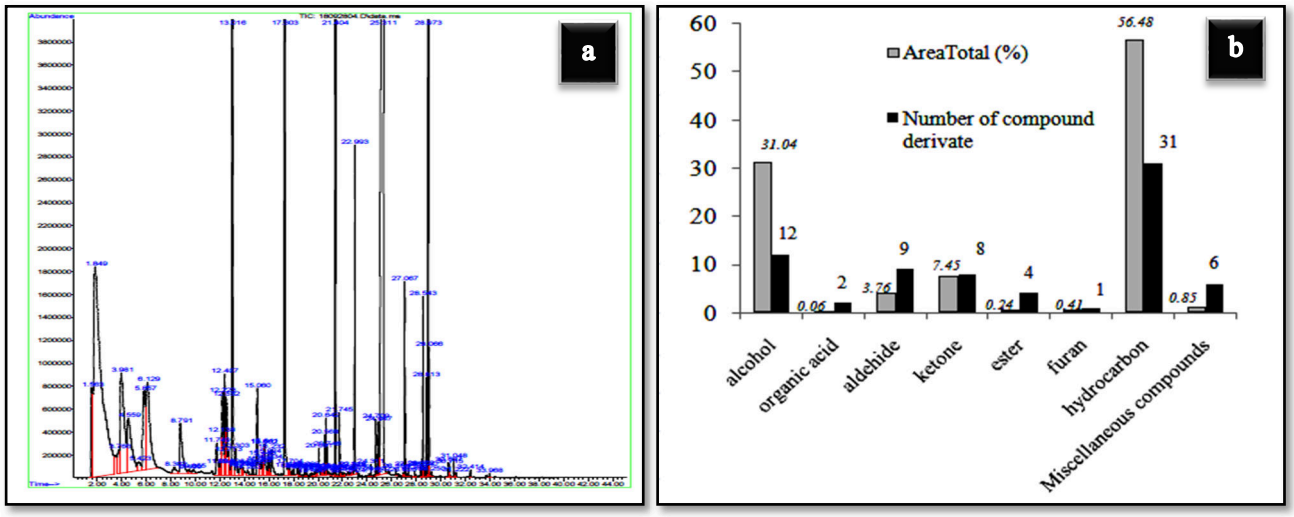

Figure 2. Chao teri product*:* a) Chao teri before dyeing, b) Chao teri after dyeing.

Most of the aldehyde compound groups, such as an alkanol, alkenyl, and alkadiene, come from lipid oxidation results [11]. Di-methyl-Butanal is the dominant aldehyde compound found in chao teri with a peak area of 2.95% (Fig. 3). Di-methyl-Butanal compound is a volatile compound and contributes to the aroma of meaty fish sauce [12]. Some aldehyde compounds, although they have low flavor thresholds, but have the potential to give flavor. In addition to contributing to flavor, aldehydes can react further with other compounds to produce flavor compounds such as formaldehyde, acetaldehyde, and malonaldehyde [11,13]. Ketone compounds were detected in chao teri in the form of asettoin (3-Hydroxybutanone) with 4.67%. According to research [14], the ketone compound is produced from the oxidative degradation of unsaturated fatty acids.

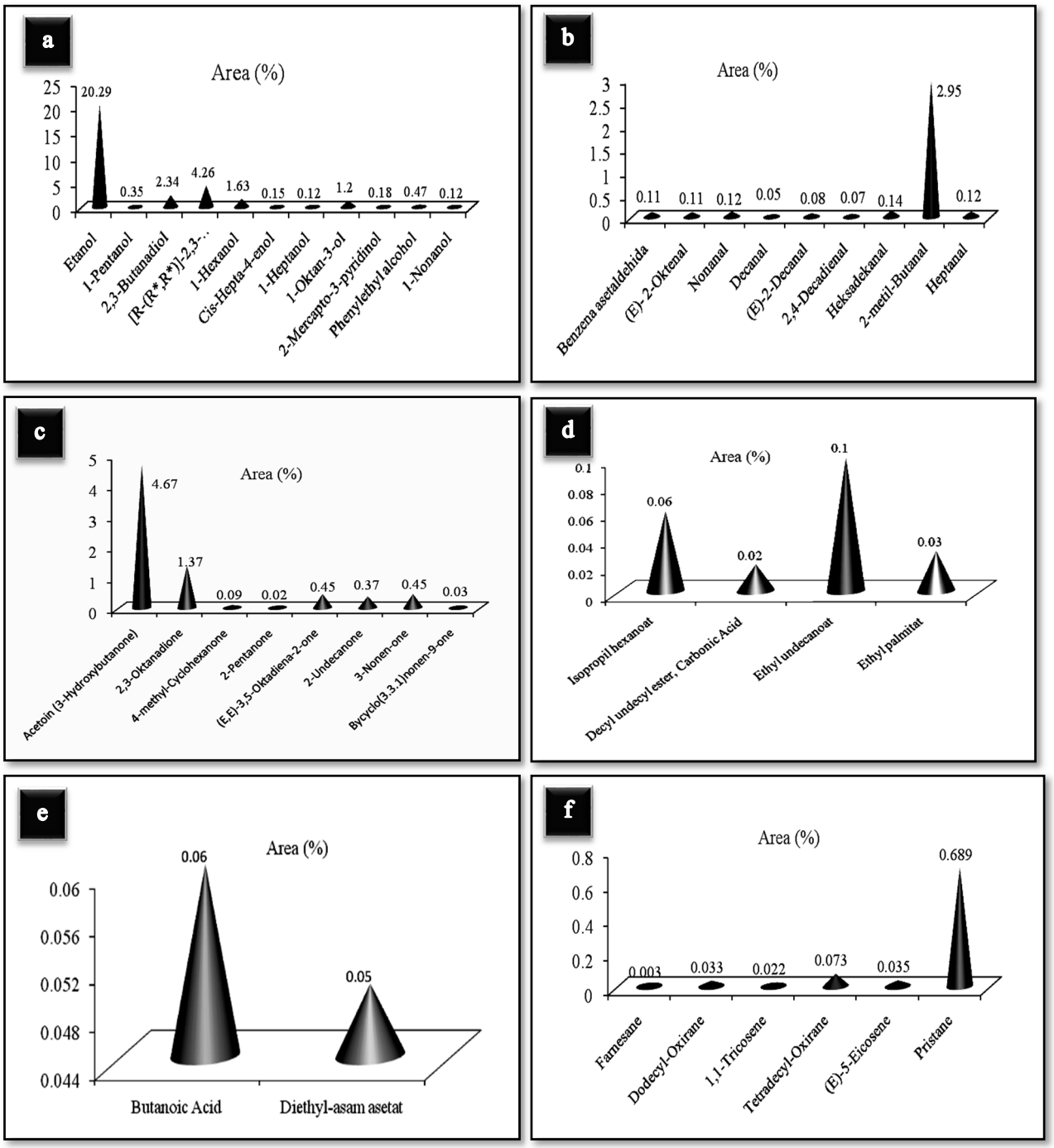

Figure 3. Volatile compounds in Chao teri: a) Alcohols, b) Aldehyde, c) Ketones, d) Ester, e) Organic acid, and f) Miscellaneous compounds

The esters in fish fermentation products are produced from alcohol and carbolic acid compounds formed from the decomposition of lipids and proteins remodeled by microorganisms during fermentation. Four ester components are detected in chao teri that gives the product a distinctive flavor [15]. Hydrocarbon compounds such as alkanes are the result of thermal-oxidative decomposition of lipids. The results showed that 31 hydrocarbon compounds were detected in chao teri. The high peak area is pentadecane of 40.63%. In addition to volatile aromatic compounds, there are also six compounds detected in chao teri.

4. Conclusion

In this study, *Saccharomyces cerevisiae* starter in fermented fish (anchovy) was investigated for the volatile flavor compounds of chao teri. The essential volatile compounds have been identified as esters, alcohols, acids, aldehydes, ketones, and hydrocarbons. Esters were found to be linked to the interaction of starter cultures. Higher ketones and alcohols in a sample have been detected. In order to evaluate the relationship between specific volatile compounds and microbial activity, more research is necessary.

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