Full Length Research Paper

Describing Fatty Acid Content in Fried Foods by Using Gas Chromatography Analysis

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Abstract

Data sample of fried foods could be useful for dietary intake estimation particularly for food record. Purposive samples were taken from fried foods in Jakarta, Depok and Bogor involved street food and fast food restaurants. Analysis of fatty acids was using gas chromatography with 100 m capillary columns and standardized methodologies for food sampling, fat extraction, separation and quantification of fatty acid isomers. Laboratory analysis showed that amount of fatty acid diverse considerably among food sample reflecting heterogenous fats and oil used in foods. Lipid total (% g) highest in fried fermented soybean and the lowest is fried chicken from Y restaurant. Highest content of SAFA, MUFA, trans fatty acid and PUFA (g/100 g) for each foods are egg martabak 77,59; fried chicken from X restaurant 45,41; nut martabak 0,47; and fried tahu/tofu with some vegetables 0,27. Despite, the lowest content for each kind of fatty acid (g/100 g) is street fried chicken 24,84; egg martabak 10,57; fried gandasturi and fried soy bean 0, and they also have zero gram for PUFA. Variability of fatty acid in fried food in this study shows that Indonesian people who often consume fried food have to maintain their lipid consumption with limited amount of SAFA and trans fatty acid intake.

Key words: Fatty acid, trans, fried food, Indonesia, gas chromatography

INTRODUCTION

Changes in diet and lifestyle commonly called as nutritional transition has been determinant of non-communicable diseases nowadays. Acceleration of nutritional transition from infectious diseases to degenerative diseases mainly occurs in poor and developing countries, involved in Indonesia.

FAO reported energy need from fat, especially animal fat and vegetable oil will steadily increased until 2030. The risk of degenerative diseases in American society mentioned four out of five (80%) of adults dying from diseases is related to lifestyle and high intake of saturated fatty acids than any other determinants.

Fried food is widely preferred food of Indonesian dwellers because it can be easily sold and found in many places, included street vendors. One benefit of snacks, fried foods is generally cheap, accessible and delicious—suitable with the majority of Indonesia economic status and life style. What is more, for many people in the world, American fast food (involved deep fried foods) becomes trend-setter and innovation for meals particularly in developing countries. Fast food is the term for food processed by frying method in the simple way and short time—generally connected with simple deep frying technique.

Fried foods are becoming popular because of taste, aroma and its crunchy texture (Meulenaer et al, 2007). Excessive intake of fat-based food bring health risk. Instead, people also need essential fatty acid content in they daily consumption. During frying process, the foods will be submerged to oil that has been heated then fat replaced the water in food while the water evaporated to the air. Fat would exposed to moisture the food, oxygen from the air, and high temperature during the frying process was conducted.
Table 1. Result of Various Types Fatty Acids Analysis in Fried Foods

<table>
<thead>
<tr>
<th>Fried food</th>
<th>Code</th>
<th>Total SAFA</th>
<th>Total MUFA</th>
<th>Total trans</th>
<th>PUFA (n=2,3,4,5,6)</th>
<th>Total fatty acid</th>
<th>% fat measured</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fried banana kaki lima</td>
<td>MKN 1</td>
<td>43.63</td>
<td>37.35</td>
<td>0</td>
<td>11.31</td>
<td>92.29</td>
<td>3.82</td>
</tr>
<tr>
<td>Street foot bakwan</td>
<td>MKN 2</td>
<td>40.67</td>
<td>33.29</td>
<td>0.08</td>
<td>9.78</td>
<td>82.73</td>
<td>19.35</td>
</tr>
<tr>
<td>French fries X</td>
<td>MKN 3</td>
<td>40.65</td>
<td>28.24</td>
<td>0.08</td>
<td>6.19</td>
<td>75.08</td>
<td>9.25</td>
</tr>
<tr>
<td>Fried chicken X</td>
<td>MKN 4</td>
<td>46.22</td>
<td>45.41</td>
<td>0.26</td>
<td>0.73</td>
<td>92.36</td>
<td>13.93</td>
</tr>
<tr>
<td>Eggs Martabak</td>
<td>MKN 5</td>
<td>77.59</td>
<td>10.57</td>
<td>0.13</td>
<td>3.17</td>
<td>91.34</td>
<td>15.10</td>
</tr>
<tr>
<td>Street food – fried tofu</td>
<td>MKN 6</td>
<td>37.47</td>
<td>33.39</td>
<td>0.19</td>
<td>22.36</td>
<td>93.23</td>
<td>8.42</td>
</tr>
<tr>
<td>Gandasturi kaki lima</td>
<td>MKN 7</td>
<td>52.77</td>
<td>29.67</td>
<td>0</td>
<td>8.78</td>
<td>91.22</td>
<td>10.61</td>
</tr>
<tr>
<td>Fried Tempe kaki lima</td>
<td>MKN 8</td>
<td>34.62</td>
<td>30.32</td>
<td>0</td>
<td>0.27</td>
<td>65.20</td>
<td>32.45</td>
</tr>
<tr>
<td>Street food Fried chicken</td>
<td>MKN 9</td>
<td>24.84</td>
<td>22.42</td>
<td>0.1</td>
<td>4.71</td>
<td>51.96</td>
<td>7.58</td>
</tr>
<tr>
<td>Fried chicken Y</td>
<td>MKN 10</td>
<td>39.19</td>
<td>39.59</td>
<td>0.2</td>
<td>12.93</td>
<td>91.71</td>
<td>2.57</td>
</tr>
<tr>
<td>Peanuts Martabak</td>
<td>MKN 11</td>
<td>45.61</td>
<td>30.12</td>
<td>0.47</td>
<td>0.87</td>
<td>76.59</td>
<td>8.56</td>
</tr>
<tr>
<td>Fried Cassava</td>
<td>MKN 12</td>
<td>27.77</td>
<td>25.65</td>
<td>0.09</td>
<td>7.79</td>
<td>61.22</td>
<td>14.49</td>
</tr>
<tr>
<td>Average</td>
<td></td>
<td>42.59</td>
<td>30.50</td>
<td>0.13</td>
<td>7.41</td>
<td>80.41</td>
<td>12.18</td>
</tr>
</tbody>
</table>

Descriptive study of variations in fatty acid content was performed on 200 types of food. The results of this study showed a wide variation of trans fatty acids on daily consumption (Sartika, 2008). Typically same analysis performed by other researchers who examined the trans fatty acid content undoubtedly showed trans fatty acid’s variation in various types of commercial margarine in Indonesia. Unfortunately, descriptions of fatty acid content, particularly for local snack and indigenous food is motionlessly limited.

Frying process is best practical process of cooking, by small flame (95-120°C temperature) and oil for cooking not be used more than twice usage. It leads to changes of fatty acids structures by the oxidation process and heating (Sartika, 2008).

Types of foods containing trans fatty acids are hydrogenated oils (HVO), fried foods, group of ruminants, and margarine. Despite, the fried foods is a type of food commonly consumed by dwellers (Sartika, 2008). Preference of food fried consumption in Indonesia is relatively high. Arch-concern for this issue is the metabolic effects of various fatty acids, in particular, associated with onset of cardiovascular disease. Indeed, it is necessary to know broader picture of various fat content on a variety fried foods.

MATERIALS AND METHODS

Laboratory test used gas chromatography method to measure fatty acid contents. Fried food samples were taken from the area of Jakarta, Bogor and Depok. Furthermore, samples were tested in integrated laboratory IPB, Bogor. Twelve samples of these foods are frequently consumed by Indonesian people based on FFO data.

Twelve fried food samples were taken three times--morning, afternoon and evening on each sample and then mixed for subsequent analysis in the laboratory. Sample preparation (hydrolysis and esterification), fried food samples were weighed in sealed Teflon tube, then add 1 ml of 0.5 N NaOH in methanol and heated in a water bath for 20 minutes. Adding 2 ml of BF3 16% and 5 mg/ml of standard internal and heated again for 20 minutes was the following steps. After saturated with NaCl was added 1 ml and 2 ml of hexane. Hexane layers were separated and put into tubes containing 0.1 g of anhydrous Na2SO4 and left for 15 minutes.

Liquid phase is phase when sample separated and injected into gas chromatography using a small syringe. Analysis of fatty acid components is conducted through FAME by gas chromatography, column cyanopril methyl
sil (capillary column). Gas chromatographic column. — 0.9 m (3') X 1/s" od stainless steel tubing packed with 5% Carbowax 20M-tere- phthalic acid (TPA) on 100™ 120 mesh Chromosorb G, acid- washed and dichlorodimethylsilane-treated (Applied Science).

Reliability (constancy of measurement) and validity (accuracy of measurement) are two types of measurements that determine the quality of data. Chromatography method for analyzing fatty acid content of laboratory procedures performed in accordance referring to AOAC (2000) are expected to avoid systematic errors that probably occured.

RESULTS

Twelve samples were analyzed by gas chromatography analysis by translating the results of gas chromatography detector (chromatogram) (pic.1). The result of the analysis of fatty acids on analyzed food is shown on Table 1.

Table 1. represents the fatty acid content of 12 samples. Sample have been analyzed by gas chromatography method included the amount of total fat, total saturated fatty acids (SAFA), total unsaturated fatty acids single chain (MUFA), total trans fatty acids, total long chain of unsaturated fatty acids (PUFA) of every 100 grams of food.

The average total fat in fried food samples is 12.18%. Sample of foods contained the highest total fat is fried tempe (MKN 8) as much as 32.45%. Tempe is local food made from soy bean fermentation rich of protein. Food sample which is contained least total fatty acids is fried chicken Y (MKN10) 2.57%.

Total average SAFA 42.5 g / 100 g. Moreover, samples contained highest amount of SAFA were taken from street food, eggs martabak, with total of 77.59 SAFA g/100 g. Egg martabak is stuffed pancake or pan-fried bread fulled with egg, meat or vegetables. In the meantime, sample with lowest of the total SAFA is fried chicken vendors nine with a total of 24.84 SAFA g/100 g.

Furthermore, MUFA foods containing the highest total sample is fried chicken (MKN4) X with a total of 45.41 g/100 g, the lowest one is MKN 5 with MUFA 10.57 g/100 g. Formerly known MKN5 martabak sample is a sample of foods containing the highest total SAFA in contrast. Eggs as one of ingredient is supposedly made the MUFA became higher. The average total MUFA food samples are 30.50 g/100 g.

The average total of trans fatty acids samples of street food was 0.133 g / 100 g. Samples of foods containing total trans fatty acids is the highest of the sample was nut martabak (MKN11) with trans fatty acids total 0.47 g / 100 g; whereas, samples MKN7 and 8 have no trans fatty acids.

The average total of PUFA samples of street foods is 7.41 g/100. Samples of foods involved the major and minor PUFA are fried tofu (MKN 6) and fried tempe (MKN 8) 0.27 g / 100, respectively.

DISCUSSION

Frying is the most practical way of cooking. Fried foods are becoming popular because of taste, aroma and crunchy texture (Meulenaer et al, 2007). In the process of frying, frying oil acts as medium to transfer heat quickly and evenly on the surface of fried materials. The process of frying is one of food preparation which is broadly practiced around the world. During the frying process, heat and mass are simultaneously transfered, food are lost its moisture and converted to air bubbles in the oil. At the same time the fat will be absorbed continuously. During the frying process, food's physical and chemical form will be gradually changed.

During the process of oil cooking, new components were formed as a result of oxidation, polimeration, and hydrolysis processes that changing food composition both oil and nutritional quality (Sartika, 2009). Cooking oil will change the composition of fatty acids in food, increase energy density and decrease water. When the frying process, the food will be sinked or exposed to hot oil over 180°C. This process also changes quality of cooking oil. When contact with hot cooking oil, food will lose water, absorbs oil, and fatty changes. The amount of absorbed oil depends on its type and condition, generally food absorbed oil about 20% of the weight of food (Mehta & Swinburn, 2001). However, if the oil is heated in above range temperature range from 100°C or more, saturated fatty acids can be oxidized (Mellema, 2003).

Fried tempe is investigated as the highest fat total 32.45%. Theory that might explain this phenomenon is deep frying process. Usually fried tempe is made through deep-fat frying. During deep-fat frying, the water in skin crust will evaporate and disappear from food. Therefore, the flow of steam continues caused there is enough water moving into food from the core to the skin/crust. The reality is that the steam leaving the room and immediately replaced by fat from cooking oil. That is the reason why the absorption of fats found in fried foods (Mellema, 2003).

What is more, total fat is proportional to total water lost(mass balance) (Meulenaer et al, 2007). Direct evidence of evaporation increases as result of crust undoubtedly found through observation. Fat absorption is inversely proportional to water content at the same time in the process of deep-fat frying (Meulenaer et al, 2007). Therefore, oil can only insert in place where the water has been evaporated, the oil influx occurred only when
the temperature is high enough to create the crust. This is leading to the inclusion of excessive oil on food’s core for small structure in the crust as the entry point of fat absorption (Meulenaer et al, 2007).

This reason was proven through calorimeter usage, the bark of potato fried is oil which is six times more than the interior (Meulenaer et al, 2007). Other studies using infrared mikrospektroskop shows entry of oil into the potato as far as 300-400 pM, narrow to the area where the evaporation of water occurs (Barbanti, 2005).

View on mass balance is one of the reasons why the oil accumulated on the surface depending on basic of solid fat. Therefore, cooking oil can enter the amount of fat that hardens when cold. This solidified fat on the food will dry up. Total fat absorption is the amount of grease that enters (through condensation/capillary mechanism) in the crust and the fat that is solidified on the surface.

The high number of fats is in thin slices of fried tempeh. Pieces thickness becomes arch-factor which causes all of the fats in fried products. Pieces of thick (12 mm or more) will absorb less oil than thinner slice. Fat content in fried products decreases with increasing thickness of food pieces and fat will be limited to surface. Cracks and rough surfaces will increase in the surface area that leads reducing of fat absorption. For example in French fries, potato sticks commonly all the pieces should be cut with the same dimensions (Meulenaer et al, 2007).

Y fried chicken has a total fat at least that only lowest total fat 2.57%. Pieces of fried foods that will affect oil absorption can lead to the generalization that the dense fibrous pieces of chicken can inhibit entry of more fat.

Eggs martabak, highest SAFA contained sample with total 77.59 g/100 g supposedly came from food composition for instance wheat flour, eggs, oil/liquid margarine, meat/corned. The composition of these foods are naturally consist of unsaturated fatty acids (MUFA), especially the –cis bond. Unfortunately, when fried chain fatty acids also can be saturated due to the heat (Valantina et al, 2013). Fat from the meat is also high MUFA, but not like vegetable oils, fats from meats are also high in SAFA therefore he is not recommended as a good source of monounsaturated fatty acids.

We can assume that the total amount of saturated fatty acids in the sample MKN 5 separate because their composition can also be generated due to absorption of excess oil when frying. In the other hand, the quality of cooking oil is not known whether or not hydrogenated fats. Hydrogenated fats are not recommended for use in the cooking process. A study showed that the use of cooking oil should not exceed 2 (two) times repetition (Sartika, 2008). Meanwhile, the use of hydrogenated vegetable oils either consciously or unconsciously is found in the field. Hydrogenated cooking oil consumed in large quantities for cheap prices (de Roos et al, 2001).

The high number saturated fatty acids formed on samples MKN 5 is lauric acid (C12:0) as many as 38.85 g/100 g. Stearic acid (C18:0) and palmitic acid (C16:0) are the saturated fatty acids most commonly found in nature (Zock & Katan, 1992). Although, according to Guthrie The dominant fatty acids (at most) in the diet is palmitic acid (C16:0), in which case the chromatography test sample MKN 5 just found the number of palmitic acid (which is usually much sourced from palm oil) much less than 9.08 g/100 g of lauric acid. Lauric acid is a third set of saturated fat intake from food. Lauric acid arranged one third of the food intake of saturated fat (Bysted et al, 2009). Largely found in immense number saturated fatty acid is myristic acid (C14:0), ie 13.43 g/100 g.

Compared with other saturated fatty acid, lauric acid and myristic acid were found in samples of the most MKN 5 has a strong potential to increase serum total cholesterol, LDL and HDL concentrations. Meanwhile, lauric acid is known to increase serum HDL cholesterol more than palmitic acid (McNeill, 2009).

Indeed, samples of foods containing the highest total MUFA are MKN 4 that are fried chicken X with 45.41 g/100 g. Total MUFA content of unsaturated fatty acids is the highest type of fatty acid oleic acid (C18:1n-9c) amounted to 41.23 g/100 g sample. Most of the fried potatoes (French fries) or previously frozen potato products are really rich MUFA (Bysted et al, 2009). X fried chicken that is the result of a fast food restaurant can have the same trend.

Instead of food samples containing total MUFA MKN5 samples of eggs as much as 10.57 g/100 g. Amount of oleic acid content of MUFA also dominated 15.10% of total fat measured precisely. Martabak eggs contain more saturated fatty acids 77.59 g/100 g sample, the highest amount among the other food samples.

Nut martabak is sample containing the highest amount of trans fatty acids 0.47 g/100 g. The main composition of peanut martabak including flour, eggs processed into dough, margarine also brushed to cover the surface of food when it burns, then nuts as martabak topping. Margarine became one of the major sources of trans fatty acids in the diet (Efssa, 2004), especially if it is assumed that the street food vendors to use margarine with less good quality.

Trans fatty acids are found in large amounts is elaidat acid (MKN 11) as many as 0.47 g/100 g sample of trans fatty acids while none linoleidat types. In general, intake of trans fats on a daily intake of 6% which is a type of elaidat acid (Bysted et al, 2009).

Precisely estimate intake of PUFA is rather difficult if counted from food intake surveys. This happens because the food intake of PUFA in the range table is close to 0.1 g/100 g of food (Etheron et al, 2000). However, the recommendation to increase the intake of
polyunsaturated fatty acids (PUFA), especially EPA (C20:n5-23) and DHA (C22: 6n-23) mentioned 0.1 to 0.2 to 0.65 g / day (Etherton et al, 2000).

PUFA intakes <7% of total energy intake and 19-22% of fat intake for adults at the recommended level for men and women. Linoleic acid (C18:2n-6) is an unsaturated fatty acid chains that represent the main dual energy contributes 84-89% polyunsaturated fat. Meanwhile, linoleic acid (ALA; C18:3n-23) accounted for 9-11% of total PUFA energy (equivalent to 1.1 to 1.6 g / day) in the diet of the adult population. The main sources of unsaturated fatty acid chain are vegetable oil and fish.

Based on the results of all samples, samples can be grouped by the tendency of fried foods. First, sample that are processed by frying method using hydrogenated fats of vegetable oils with a thin piece of absorbing so much oil. Judging from the level of danger to the body, food samples that contain lots of SAFA is eggs martabak. In the other hand, decent further attention is food with the highest amount of trans fatty acids are assumed to use a lot of nut martabak margarine spread as one of the biggest sources of trans fatty acids. The amount of fat that enters the body, in principle, be regulated through diet regulation. Seeing the great opportunities the role of diet in controlling blood cholesterol levels so fat chance prevention containment through nutrition can be an alternative approach to primary prevention. If prevention was delayed until the formation of plaque in the arteries to the advanced level the risk of heart disease and blood vessels (PJPD) will increase.

Therefore, consider every purchase and consumption of snack foods (fried food) is very important to minimize greater health risks. The way to increase fat consumption quality by used unsaturated cooking oil, see the nutritional content on food labels (if packed). Consumption of adequate amounts of balance fat as recommended by the General Guidelines for Balanced Nutrition (PUGS), which is one-third of the total energy, specifically with chose moderate fat foods intake and low saturated fat.

Add information about the importance of food processing which takes into account the health and nutritional aspects of processing and practice healthy eating for example by not using cooking oil for more than two times the loop, cut food to be fried in chunks that are not too thin, modifying food processing methods other than frying, so more varied.

**REFERENCES**


Pic.1. Gas Chromatography Column

Pic.2. Gas Chromatography Instrument