Fatty Acid Profile of Fresh and Smoked Indian Scad (Decapterus russelli)

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ABSTRACT Fishery products are a high source of nutrients, especially fatty acids. The smoking technology with liquid smoke is being developed to preserve fishery products. With this processing, fish are expected to be more durable and have better nutritional content, especially polyunsaturated fatty acids (PUFA), needed in the body. For this reason, research has been carried out to see the impact of fish processing with liquid smoke technology on the fatty acid profile of smoked Indian scad. The method used is the experimental method using coconut shell liquid smoke and samples of fresh and smoked Indian scad. The results showed that the fatty acid profile of fresh and smoked Indian scad contained 27 types of fatty acids consisting of 11 saturated fatty acids and 16 unsaturated fatty acids. The content of polyunsaturated fatty acids (PUFA) in fresh and smoked Indian scad is greater than the content of saturated fatty acids (SFA) and monounsaturated fatty acids (MUFA). The high ratio of PUFA-ω3/PUF A-ω6 and the low value of Index of Atherogenic (IA) and Index of Thrombogenic (IT) of fresh and smoked Indian scad treated with coconut shell liquid smoke indicate the quality of fish fat is very good for consumption which is beneficial for health.

Keywords: Fatty acid profile; Indiana scad Decapterus russelli; smoked fish

INTRODUCTION

The Indian scad is the most common type of pelagic fish caught by purse seine fishers in Maluku, which means that the production of this fish is abundant and sometimes excessive. When the production is abundant, the price of the Indian scad becomes relatively cheap even sometimes the excess catch will be thrown back into the sea even though the Indian scad is a marine product with high nutritional value. Apart from being a source of protein, the fat contained in this fish can also make a significant contribution and play an essential role in health because of several omega-3 fatty acids such as EPA and DHA.

One of the efforts to utilize the Indian scad is to process it into smoked form. It is hoped that this smoked Indian scad will become the favourite of the Maluku people who like smoked food ingredients. This smoked fish is very popular with the people of Maluku because of the savoury taste of the meat and the specific flavour and aroma of smoke with an attractive colour combination, from yellow to reddish-brown. Smoked Indian scad produced in this study were processed using smoking technology with liquid smoke.

Fumigation with liquid smoke technology can be widely used in Maluku because of the availability of abundant raw materials, particularly raw materials derived from agricultural waste such as coconut shells. Besides, processing smoked fish with this technology is very simple and easy to apply by the community. Besides, the procedure of manufacturing smoked fish with this technology is quite simple and easy to apply by the community. The application of liquid smoke to fish meat is processed by dipping or soaking the fish in the liquid smoke and then continued with the roasting process to produce cooked fish with a specific taste and aroma of smoke.

Several studies on the application of liquid smoke technology in the processing of smoked fish have been carried out in recent years, including its use as antimicrobial spoilage and its ability to prevent oxidative damage to fish fat (Apituley et al., 2006; Sari et al., 2006; Swastawati, 2008; Yuwati, 2011; Zuraida et al., 2011; Ernawati et al., 2012). Some of these studies show increased shelf life or durability of smoked fish produced from 1-2 days to 5 days (Rumahrupute, 1998; Manuswika, 2001; Nendissa, 2004; Apituley, 2010). One of the development efforts of the above research is to conduct a study on the processing of the Indian scad using liquid smoke technology. Processing smoked Indian scad with liquid smoke is expected to maintain nutrient quality, especially fatty acids of smoked Indian scad produced. Therefore, this study aims to see the impact of fish processing with liquid smoke technology on the fatty acid profile of smoked Indian scad.

MATERIALS AND METHODS

Material

Fish used in this study were fresh Indian scad obtained directly from the Ambon “Arumbai” Traditional Market. The primary material for the manufacture of liquid smoke is a coconut shell, with a pyrolysis device found at the Fisheries Product Technology Laboratory, Pattimura University. The equipment used in this research is a pyrolizer or liquid smoke maker, a tool for redistillation, analytical balance, water bath, centrifuge, HPLC, GC and glassware for both preparation and analysis needs.

Methods

This research begins with manufacturing liquid smoke from coconut shells and then redistilled. Liquid smoke is made by pyrolysis of the raw materials mentioned above in a pyrolizer with a temperature of 400°C as done by
Tranggono et al. (1996), and the liquid smoke distillation process is carried out at temperatures between 100-125 °C. The resulting liquid smoke is then applied to process smoked tuna. The application of liquid smoke in the processing of smoked Indian scad is carried out as follows; the fresh Indian scad is weeded to remove the head, gills, and bones, then split into a butterfly shape, washed, and cleaned. Furthermore, the pieces of Indian scad are then soaked in a 5% liquid smoke solution containing 5% salt for 7 minutes. The Indian scad that has been treated is then baked in the oven at 200 °C for ± 45 minutes until cooked. After cooking, the smoked fish is packaged in vacuum plastic and stored at room temperature for later analysis.

**Fatty acid analysis**

Fatty acid analysis with gas chromatography was performed at the Laboratory Terpadu IPB Bogor and follows a procedure where the composition of fatty acids is determined as “fatty acid methyl ester” (FAME) by gas chromatography. The formation of FAME from the sample was preceded by hydrolysis followed by esterification. 20-30 mg of the sample was placed in a Teflon-covered tube. Then, 1 ml of 0.5N NaOH was added and heated in a water bath for 20 minutes. Then 2 ml of 16% BF₃ and 5 mg/ml of the internal standard were added and reheated for 20 minutes. The sample was then cooled and added 2 ml of saturated NaCl and 1 ml of Hexane. The hexane layer was then transferred with a dropper into a tube containing 0.1 g of Na₂SO₄ anhydrous and left for 15 minutes. 5 ml of the liquid phase of the FAME standard mixture sample was then injected into the gas chromatography column. Operating conditions of Gas Chromatography: capillary column (cyanopropyl methyl sil), Injector temperature 200 °C, Detector temperature 230 °C, initial column temperature 190 °/15 minutes and final column 230 °C/20 minutes with column flow rate 10 °C/minute, Carriergas H₂, gas H₂ flow rate 30 ml/minute gas and N₂ 20 ml/minute, airflow rate 200-250 mL/minute.

**Analysis of fat quality**

From the analysis of fatty acid composition data, it can be determined that the quality of fresh and smoked Indian scad fish, namely the Index of Atherogenic (IA) and Index of Thrombogenic (IT), which calculated by the equation adopted from Ghaeni et al. (2013).

\[
IA = \left( \frac{4 \times C14:0 + C16:0 + C18:0}{\Sigma MUFA + \Sigma PUFAn6 + \Sigma PUFAn3} \right)
\]

\[
IT = \left( \frac{0.5 \times MUFA + 0.5 \times PUFAn6 + 3 \times PUFAn3 + PUFA/n3/PUFA/n6} {C14:0 + C16:0 + C18:0} \right)
\]

Hypcholesterolemic and hypercholesterolemic ratios (Santos-Silva et al., 2002) can be obtained based on the following equation:

\[
h/H = \left( \frac{C18:1 + C18:2 + C18:3 + C20:3 + C20:4 + C20:5 + C22:4 + C22:6}{C14:0 + C16:0} \right)
\]

Polyene Index (PI), an indicator for the determination of lipid oxidation (Rodriguez et al., 2007; Telahigue et al., 2013; Apituley et al., 2019), can be calculated based on the following formula:

\[
PI = \frac{EPA + DHA}{C16:0}
\]

Flesh Lipid Quality Index (FLQ) as an indicator of the correlation between Omega-3 PUFA fatty acids (EPA and DHA) and total fat in fish is calculated by the equation proposed by Abrami et al. (1992).

\[
FLQ = \frac{100 \times [EPA + DHA]}{\% \text{ Total Fatty Acid}}
\]

**RESULTS AND DISCUSSION**

**Nutritional composition of fresh and smoked Indian scad**

The nutritional composition of fresh and smoked Indian scad is known by performing a proximate analysis. The proximate analysis results of fresh and smoked Indian scad can be seen in Figure 1.

From Figure 1, it can be seen that there are differences in the nutritional composition between fresh and smoked Indian scad. The moisture content in fresh Indian scad changed from 72.44% to 51.94% after a liquid smoking treatment. Moisture content is one of the principal characteristics of foodstuffs because water can affect appearance, texture, and taste. Smoked fish’s maximum moisture content quality requirement is 60% (SSN, 2009). The smoked Indian scad products produced in the study still meet the specified smoked fish quality standards. According to Hadinoto et al. (2016), changes in moisture content during the smoking process are caused by heat and the withdrawal of water from fish body tissues by the absorption the temperature and duration of heating with the oven also

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The fatty acid profile mentioned above includes omega-3 fatty acids such as linolenic acid (18:3n3), eicosapentaenoic acid/EPA (C20:5n3), and docosahexaenoic acid/DHA, indicates the high nutritional quality of fresh and smoked Indian scad. Long-chain PUFA fatty acids such as EPA and DHA show the uniqueness and characteristics that distinguish marine animal fat from land animal fat (Shahidi, 1998). Regulska-Ilow et al. (2013) stated that smoked marine fish fat is a good source of PUFA long-chain omega-3 fatty acids. The presence of PUFA is necessary for the prevention and treatment of cardiovascular disease, hypertension, arthritis, inflammation, autoimmune disorders, and cancer (Jones, 2002).

### Table 1. Fatty acids of fresh and smoked Indian scad.

<table>
<thead>
<tr>
<th>Fatty acid</th>
<th>Fresh Indian scad</th>
<th>Smoked Indian scad</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lauric Acid, C12:0</td>
<td>0.05</td>
<td>0.08</td>
</tr>
<tr>
<td>Myristic Acid, C14:0</td>
<td>2.98</td>
<td>3.03</td>
</tr>
<tr>
<td>Myristoleic Acid, C14:1</td>
<td>-</td>
<td>0.03</td>
</tr>
<tr>
<td>Pentadecanoic Acid, C15:0</td>
<td>0.48</td>
<td>0.53</td>
</tr>
<tr>
<td>Palmitic Acid, C16:0</td>
<td>15.93</td>
<td>15.87</td>
</tr>
<tr>
<td>Palmitoleic Acid, C16:1</td>
<td>2.71</td>
<td>2.91</td>
</tr>
<tr>
<td>Heptadecanoic Acid, C17:0</td>
<td>0.85</td>
<td>0.81</td>
</tr>
<tr>
<td>Cis-10,12-Heptadecanoic Acid, C17:1</td>
<td>0.17</td>
<td>0.19</td>
</tr>
<tr>
<td>Stearic Acid, C18:0</td>
<td>6.54</td>
<td>6.19</td>
</tr>
<tr>
<td>Elaidic Acid, C18:1n9t</td>
<td>0.07</td>
<td>0.05</td>
</tr>
<tr>
<td>Oleic Acid, C18:1n9c</td>
<td>4.86</td>
<td>5.96</td>
</tr>
<tr>
<td>Linoleic Acid, C18:2n6c</td>
<td>1.1</td>
<td>1.02</td>
</tr>
<tr>
<td>Arachidonic Acid, C20:4</td>
<td>0.3</td>
<td>0.28</td>
</tr>
<tr>
<td>g-Linolenic Acid, C18:3n6</td>
<td>0.1</td>
<td>0.12</td>
</tr>
<tr>
<td>Cis-11,14-Eicosadienoic Acid, C20:1</td>
<td>0.24</td>
<td>0.25</td>
</tr>
<tr>
<td>Linolenic Acid, C18:3n3</td>
<td>0.47</td>
<td>0.79</td>
</tr>
<tr>
<td>Heneicosanoic Acid, C21:0</td>
<td>0.07</td>
<td>0.05</td>
</tr>
<tr>
<td>Cis-11,14-Eicosadienoic Acid, C20:2</td>
<td>0.18</td>
<td>0.23</td>
</tr>
<tr>
<td>Behenic Acid, C22:0</td>
<td>0.21</td>
<td>0.21</td>
</tr>
<tr>
<td>Cis-8,11,14-Eicosatrienoic Acid, C20:3n6</td>
<td>0.13</td>
<td>0.14</td>
</tr>
<tr>
<td>Arachidonic Acid, C20:4n6</td>
<td>1.74</td>
<td>1.47</td>
</tr>
<tr>
<td>Tricosanoic Acid, C23:0</td>
<td>0.07</td>
<td>0.05</td>
</tr>
<tr>
<td>Cis-13,16-Docosadienoic Acid, C22:2</td>
<td>0.04</td>
<td>0.02</td>
</tr>
<tr>
<td>Lignoceric Acid, C24:0</td>
<td>0.21</td>
<td>0.15</td>
</tr>
<tr>
<td>Cis-5,8,11,14,17-Eicosapentaenoic Acid, C20:5n3</td>
<td>5.1</td>
<td>4.98</td>
</tr>
<tr>
<td>Nervonic Acid, C24:1</td>
<td>0.38</td>
<td>0.39</td>
</tr>
<tr>
<td>Cis-4,7,10,13,16,19-Docosahexaenoic Acid, C22:6n3</td>
<td>19.76</td>
<td>20.81</td>
</tr>
<tr>
<td>Fatty Acid Total</td>
<td>64.74</td>
<td>66.61</td>
</tr>
<tr>
<td>ΣSFA</td>
<td>11.55</td>
<td>11.23</td>
</tr>
<tr>
<td>ΣMUFA</td>
<td>8.43</td>
<td>9.78</td>
</tr>
<tr>
<td>ΣPUFA</td>
<td>8.86</td>
<td>8.77</td>
</tr>
<tr>
<td>PUFA/SFA</td>
<td>0.77</td>
<td>0.78</td>
</tr>
<tr>
<td>n-3 PUFA</td>
<td>25.33</td>
<td>26.58</td>
</tr>
<tr>
<td>n-6 PUFA</td>
<td>3.07</td>
<td>2.75</td>
</tr>
<tr>
<td>n3/n6</td>
<td>8.25</td>
<td>9.66</td>
</tr>
</tbody>
</table>
The content of saturated fatty acids (SFA), monounsaturated fatty acids (MUFA), and polyunsaturated fatty acids (PUFA) from fresh and smoked Indian scad can be seen in Figure 2.

![Figure 2](image)

**Figure 2.** Profile of saturated and unsaturated fatty acids fresh and smoked Indian scad.

From Figure 2, it appears that the polyunsaturated fatty acids (PUFA) content in fresh and smoked Indian scad is lower than the saturated fatty acid (SFA) and monounsaturated fatty acids (MUFA). The saturated fatty acids (SFA) content of fresh and smoked Indian scad is 11.55% to 11.23%, respectively. The monounsaturated fatty acid (MUFA) content of fresh and smoked Indian scad is 8.43% to 9.78%, respectively. The polyunsaturated fatty acids (PUFA) content is 8.86% to 8.77%.

Figure 2 shows a difference between saturated fatty acids (SFA) and unsaturated fatty acids, especially the MUFA and PUFA content of fresh and smoked Indian scad. This difference can cause by the physical properties of the fatty acids, both saturated and unsaturated fatty acids, which can change in the presence of heating during the smoking process of the smoked fish. Winarno (2008) stated that saturated fatty acids have a higher boiling point than unsaturated fatty acids with the same chain. Unsaturated fatty acids with many double bonds will have low boiling points, causing these unsaturated fatty acids to have a lower viscosity and boiling point than saturated fatty acids with the same chain.

The cause of difference in smoked Indian scad fatty acid content may also cause by the penetration rate of the components that make up liquid smoke, such as organic acids, carbonyl, and phenol and their derivatives, which affect the saturated and unsaturated fatty acid content of the smoked fish produced (Apituley et al., 2014). Several organic acid components identified in several types of liquid smoke include propanoic acid, butanoic acid, myristic acid, lauric acid, palmitic acid, and other organic acids (Kadir et al., 2010; Ratnawati & Hartanto, 2010). These organic acids can influence the fluctuating fatty acid content of the smoked Indian scad produced.

PUFA-n3 in freshwater and seawater fish, especially EPA and DHA, are fatty acids that are widely studied because of their health benefits, mainly to prevent diseases related to blood vessels or blood pressure and hypotriglyceridemia problems (Kris-Etherton et al., 2002; Wozniak et al., 2013). These fatty acids significantly affect the quality of the fat in these foodstuffs, and this can be seen clearly from several indexes of fat/lipid quality test proposed by some previous researchers such as the PUFA-n3/PUFA ratio, PUFA/SFA ratio, Index of Atherogenic (IA) and the Index of Thrombogenic (IT) as well as several other indexes (Okland et al., 2005; Popovic et al., 2012; Ghaeni et al., 2013; Cieslik et al., 2017).

The polyunsaturated fatty acid profile of PUFA-n3, PUFA-n6, the PUFA-n3/PUFA-n6 ratio, and the PUFA/SFA ratio of fresh and smoked Indian scad can be seen in Figure 3.

![Figure 3](image)

**Figure 3.** Profile of polyunsaturated fatty acid fresh and smoked Indian scad.

In Figure 3, it is shown that the PUFA-n3 content of smoked Indian scad was higher than PUFA-n3 of fresh Indian scad. Meanwhile, PUFA-n6 was lower when compared to fresh Indian scad. However, the PUFA-n3/PUFA-n6 ratio and the PUFA/SFA ratio of smoked Indian scad are higher than that of fresh Indian scad. The PUFA-n3/PUFA-n6 ratio of fresh and smoked Indian scad ranged from 8.25 to 9.67. Popovic et al. (2012) reported that the PUFA-n3/PUFA-n6 ratio of farmed and caught bluefin tuna ranged from 6.98 to 7.56. These results indicate that the fat quality of small pelagic fish such as Indian scad is no less good than that of large pelagic fish such as bluefin tuna. Mohanty et al. (2016) reported the PUFA-n3/PUFA-n6 ratio in 39 fish species, including Thunnus albacore, Rastrelliger kanagurta, Katsuonus pelamis, Euthynus affinis, and several other species ranging from 0.80 to 5.6. Øklund et al. (2005) stated that the high PUFA n3/PUFA-n6 would benefit a food ingredient. According to Osman in Zuraini et al. (2006), a good PUFA-n3/PUFA-n6 ratio for a healthy diet for humans is 1:1 – 1:5. The PUFA-n3/PUFA-n6 ratio in this study is in this comparison range. It indicates that the fat quality of smoked Indian scad and fresh Indian scad is good and will benefit health when consumed.

From Figure 3, it can also be seen that the high ratio of PUFA/SFA is in the range of 0.76 to 0.78. It indicates that the smoked Indian scad produced in this study has potential as a source of PUFA. For comparison, the minimum PUFA/SFA ratio recommended by the UK Department of Health is 0.45 (Cieslik et al., 2017). The PUFA/SFA ratio in this study was not much different from the PUFA/SFA ratio of fresh “common carp” and “rainbow trout,” which was in the range of 0.97 to 1.69 (Cieslik et al., 2017) as well as from “yellowfin tuna” and “bluefin tuna” which ranging between 0.64-0.82 (Shiming et al., 2013).

The above results are also supported by the Index of Atherogenic (IA), Index of Thrombogenic values (IT), hypocholesterolemic/hypercholesterolemic ratios (h/H), and the polyene index (PI) of the fresh and smoked Indian scad, which can be seen in Figure 4.

Figure 4 shows a change in the value of the Index of Atherogenic (IA) and Index of Thrombogenic (IT) of fresh and
smoked Indian scad, which is at the range of 0.57-0.61 and 0.26-0.28. Čiešlík et al. (2017) stated that the IA and IT values of “common carp,” “rainbow trout,” and “Northern pike,” both fresh and smoked were in the range of 0.26-0.27 for IA and 0.25-1.06 for IT. Meanwhile, Tonial et al. (2014), the IA and IT values for “Tilapia” fish ranged between 0.55 – 0.66 and 0.82 – 0.85. Kaya et al. (2008) & Apituley et al. (2019) also reported a change in the value of IA and IT in “sturgeon” fresh and smoked ranging from 0.31 to 1.01 for fresh fish and 1.24 to 1.93 for smoked fish. According to Boscaino et al. (2014), food ingredients are declared to have very high quality if they have a low Index of Atherogenic (IA) and Index of Thrombogenic values (IT).

**Figure 4.** Quality index of fresh and smoked Indian scad.

The Index of Atherogenic (IA) and Index of Thrombogenic values (IT) can be used to determine the lipid quality of a food ingredient including fish and other fishery products (Ghaeni et al., 2013). The IA value provides an overview of the relationship between the number of the primary saturated fatty acids expressed as pro-atherogenic and the unsaturated fatty acids stated as anti-atherogenic. Pro-atherogenic plays a role in the lipid adhesion process in immune cells and blood circulation, while anti-atherogenic can inhibit plaque aggregation and minimize esterified fatty acids, cholesterol, and phospholipids to prevent coronary heart disease. Moreover, the IT value provides an overview of the relationship between saturated fatty acids (pro-thrombogenic) and unsaturated fatty acids (anti-thrombogenic) in terms of their tendency to prevent the occurrence of blood clotting processes (Ghaeni et al., 2013; Boscaino et al., 2014). The low value of IA and IT of smoked Indian scad show that the fat quality of smoked Indian scad is better than that of fresh Indian scad.

In Figure 4, it can also be seen that the hypocholesterolemic/hypercholesterolemic ratio (h/H ratio) from fresh and smoked Indian scad. The h/H ratio of fresh and smoked Indian scad is in the range of 1.81-1.92. Tonial et al. (2014) reported that the h/H ratio of tilapia was 1.56-1.63. On the other hand, Czech et al. (2015) reported the h/H ratio of several frozen marine animals such as shrimp, squid, mussels, and octopus which are 2.54; 2.13; 1.71; and 2.57, respectively. Santos-Silve et al. (2002) stated that the h/H ratio also greatly determines fat quality from foodstuffs. The higher the hypocholesterolemic fatty acids than the hypercholesterolemic fatty acids, the higher the fat in the foodstuffs is good for slowing atherosclerosis.

The high h/H ratio indicates the higher content of hypocholesterolemic fatty acids in smoked Indian scad than fresh Indian scad. It shows that smoked fish fat can inhibit the occurrence of atherosclerosis. The above results show that marine animals rich in omega-3 fatty acids have the potential as anti-atherogenic and anti-thrombogenic (Hu, 2001; Henderson et al., 2008). Czech et al. (2015) stated that the lipids of several marine animals such as shrimp, squid, clams, and octopus also could reduce the risk of heart disease or high blood pressure. Rilantono & Fadillah (1987) stated that a diet containing enough marine fish, especially phytoplankton-eating fish, can reduce the risk of coronary heart disease because it inhibits the process of atherosclerosis by lowering cholesterol levels in the blood, triglycerides, LDL and increasing HDL, as well as reducing the ability of thrombocytes to form thrombus clots.

Polyene Index (Pl) is a good indicator of lipid oxidation (Telahigue et al., 2013). The index polyene was determined based on the levels of EPA and DHA compared to the levels of palmitic acid. The polyene index values of fresh and smoked Indian scad ranged from 1.56 to 1.63 (Figure 4). The Pl values in this study are higher when compared to some previous studies such as mackerel (Scomberomorus commerson) of 0.64 and sharks (Carcarhinus dussumier) of 0.45 (Apituley et al., 2019) as well as in cobia (Rachycentron caradum) of 0.27 (Apituley et al., 2019). The higher the polyene index value, the higher the food fat resistance to oxidation (Apituley et al., 2019). Therefore, the Indian scad, both fresh and smoked in this study, had excellent resistance to the oxidation process.

In Figure 5, it can be seen the FLQ (Flesh Lipid Quality) index value of fresh and smoked kites. The FLQ value indicates the correlation between omega-3 fatty acids (EPA and DHA) and the total fat contained in these foodstuffs; the higher the FLQ index, the higher the fat quality of the food source the fat (Abrami et al., 1992; Luczynska et al., 2017).

**Figure 5.** Index value FLQ (flesh lipid quality) of fresh and smoked Indian scad.

According to Figure 5, the FLQ index value of fresh Indian scad is higher than the FLQ index value of smoked Indian scad of 38.39 and 28.71, respectively. Luczynska et al. (2017) reported several FLQ index values of several types of fish, including Bream/Sparus aurata (30.14); Perch/Perca fluviatilis (33.22); Ide/Lucisculus idus (24.32); Carp/Cyprinus carpio (13.99), Rainbow trout/Oncorhyncus mykis (17.97) and vulture/Clepea harense (13.01). The FLQ value of fresh and smoked Indian scad in this study was higher than some of the fish mentioned above. It indicates the high quality of the fat of both fresh and smoked Indian scad.

Overall, the results of this study indicate that the smoking process with liquid smoke technology on Indian scad does...
not result in loss or reduction in the quality of fat or lipids from Indian scad. Based on the fat quality indexes obtained in this study (PUFA ratio n-3/PUFA n-6; PUFA/SFA IA ratio, IT, h/H, and PI ratio), fresh Indian scad and smoked Indian scad showed no significant differences. The results above show that the fat compound from fresh and smoked Indian scad is suitable for consumption because of the benefits for health. Foods with a low content of saturated fatty acids provide more benefits for health, especially the heart, than foods with a high content of saturated fatty acids (Apituley et al., 2019).

CONCLUSION

The fatty acid profile of fresh and smoked Indian scad contains 27 types of fatty acids consisting of 11 saturated fatty acids and 16 unsaturated fatty acids. Unsaturated fatty acids from fresh and smoked Indian scad are dominated by palmitic acid (C16:0) and stearic acid (C18:0), while the unsaturated fatty acids in large quantities include oleic acid (C18:1n9), arachidonic acid (C20:4n6), Eicosapentaenoic acid/EPA (C20:5n3), and docosahexaenoic acid/DHA (C22:6n3).

The content of polyunsaturated fatty acids (PUFA) in fresh and smoked Indian scad is greater than the content of saturated fatty acids (SFA) and monounsaturated fatty acids (MUFA). The high ratio of PUFA-ω3/PUFA-ω6 and the low saturated fatty acids (SFA) and monounsaturated fatty acids (MUFA). The high ratio of PUFA-ω3/PUFA-ω6 and the low

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