Are olive oil diets antithrombotic? Diets enriched with olive, rapeseed, or sunflower oil affect postprandial factor VII differently1-3

Lone Frost Larsen, Jørgen Jespersen, and Peter Marckmann

ABSTRACT

Background: The incidence of ischemic heart disease (IHD) in Crete was lower than expected on the basis of blood lipid concentrations of participants in the Seven Countries Study. A favorable effect of a high intake of olive oil on thrombogenesis may have contributed to this finding.

Objective: We compared the effects of virgin olive oil with those of rapeseed and sunflower oils on blood coagulation factor VII (FVII), a key factor in thrombogenesis.

Design: In a randomized and strictly controlled crossover study, 18 healthy young men consumed diets enriched with 5 g/MJ (19% of total energy) olive oil, sunflower oil, or rapeseed oil for periods of 3 wk. On the final day of each period, participants consumed standardized high-fat meals (42% of energy as fat). Fasting and nonfasting blood samples were collected after each period.

Results: Mean (±SEM) nonfasting peak concentrations of activated FVIIa (FVIIa) were 11.3 ± 5.1 U/L lower after olive oil than after sunflower oil, an 18% reduction (P < 0.05). Olive oil also tended to cause lower FVIIa peak concentrations than did rapeseed oil (mean difference: 8.6 U/L, a 15% reduction; P = 0.09). There were no significant differences between diets with respect to nonfasting factor VII coagulant activity (FVII), a key protein in thrombosis and an IHD risk factor (3–7). Several dietary intervention studies have shown that FVII is indeed influenced by diet (8–11). We tested our hypothesis in a controlled dietary trial in which diets enriched with olive oil, sunflower oil, or rapeseed oil were compared. Sunflower oil has a high content of the n−6 polyunsaturated fatty acid (PUFA) linoleic acid. Similarly to olive oil, rapeseed oil has a high content of oleic acid, but it contains more linoleic acid than does olive oil. The n−3 PUFA α-linolenic acid is also present in rapeseed oil.

SUBJECTS AND METHODS

Subjects

Eighteen healthy young students aged 20–28 y (x̄: 24 y) participated in the study. Subjects had a weight of 62.2–98.6 kg (x̄: 78.8 kg), a height of 1.72–1.99 m (x̄: 1.82 m), and a body mass index (kg/m²) of 18.4–27.0 (x̄: 22.9). All subjects were nonsmokers, had no history of IHD, and did not use medication regularly. Their mean fasting plasma lipid values were as follows: total cholesterol, 4.29 mmol/L (range: 2.89–5.96 mmol/L); HDL cholesterol, 1.22 mmol/L (range: 0.94–1.84 mmol/L); and triacylglycerols, 0.99 mmol/L (range: 0.41–1.67 mmol/L). The study protocol was carefully explained to the participants before they entered the study and all participants gave their written consent.

INTRODUCTION

The incidence of ischemic heart disease (IHD) on Crete was remarkably low compared with that in other European populations in the early sixties (1). The Cretan diet was characterized by a low content of saturated fatty acids (SFAs), which is known to be associated with low plasma cholesterol concentrations. However, the risk of IHD in the Cretan population was lower than expected on the basis of their plasma cholesterol concentrations, possibly because the traditional Cretan diet had beneficial effects on IHD risk factors other than blood lipids. One particular characteristic of the Cretan diet was its high content of olive oil, a dietary fat rich in monounsaturated fatty acids (MUFAs); ≈30% of all dietary energy came from olive oil (2). We hypothesized that olive oil could have beneficial effects on blood coagulation factor VII (FVII), a key protein in thrombosis and an IHD risk factor (3–7). Several dietary intervention studies have shown that FVII is indeed influenced by diet (8–11). We tested our hypothesis in a controlled dietary trial in which diets enriched with olive oil, sunflower oil, or rapeseed oil were compared. Sunflower oil has a high content of the n−6 polyunsaturated fatty acid (PUFA) linoleic acid. Similarly to olive oil, rapeseed oil has a high content of oleic acid, but it contains more linoleic acid than does olive oil. The n−3 PUFA α-linolenic acid is also present in rapeseed oil.

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TABLE 1
Mean daily macronutrient intakes at baseline and during the olive oil, sunflower-oil, and rapeseed-oil intervention periods

<table>
<thead>
<tr>
<th></th>
<th>Baseline</th>
<th>Olive oil</th>
<th>Sunflower oil</th>
<th>Rapeseed oil</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protein (% of total energy)</td>
<td>13.0</td>
<td>12.4</td>
<td>12.4</td>
<td>12.5</td>
</tr>
<tr>
<td>Fat (% of total energy)</td>
<td>32.3</td>
<td>34.5</td>
<td>34.6</td>
<td>35.4</td>
</tr>
<tr>
<td>SFA (% of total energy)</td>
<td>11.7</td>
<td>8.1</td>
<td>7.4</td>
<td>7.1</td>
</tr>
<tr>
<td>MUFA (% of total energy)</td>
<td>9.3</td>
<td>17.0</td>
<td>7.6</td>
<td>15.0</td>
</tr>
<tr>
<td>PUFA (% of total energy)</td>
<td>4.3</td>
<td>2.2</td>
<td>12.0</td>
<td>6.2</td>
</tr>
<tr>
<td>Carbohydrates (% of total energy)</td>
<td>53.8</td>
<td>53.1</td>
<td>53.0</td>
<td>52.1</td>
</tr>
<tr>
<td>Fiber (g/d)</td>
<td>30.8</td>
<td>38.5</td>
<td>37.0</td>
<td>33.9</td>
</tr>
</tbody>
</table>

1 SFA, saturated fatty acids; MUFA, monounsaturated fatty acids; PUFA, polyunsaturated fatty acids.
2 Based on data collected from a 4-d weighed food records.
3 Based on chemical analyses of duplicate portions.

TABLE 2
Fatty acid composition of the test oils

<table>
<thead>
<tr>
<th></th>
<th>Olive oil</th>
<th>Sunflower oil</th>
<th>Rapeseed oil</th>
</tr>
</thead>
<tbody>
<tr>
<td>Saturated fatty acids, total</td>
<td>14.8</td>
<td>12.1</td>
<td>7.6</td>
</tr>
<tr>
<td>Palmitic acid</td>
<td>11.2</td>
<td>6.8</td>
<td>4.8</td>
</tr>
<tr>
<td>Stearic acid</td>
<td>2.9</td>
<td>4.1</td>
<td>1.7</td>
</tr>
<tr>
<td>Monounsaturated fatty acids, total</td>
<td>78.3</td>
<td>25.4</td>
<td>62.8</td>
</tr>
<tr>
<td>Oleic acid</td>
<td>74.0</td>
<td>23.9</td>
<td>56.2</td>
</tr>
<tr>
<td>Polyunsaturated fatty acids, total</td>
<td>6.9</td>
<td>62.5</td>
<td>29.6</td>
</tr>
<tr>
<td>Linoleic acid</td>
<td>6.2</td>
<td>61.9</td>
<td>19.7</td>
</tr>
<tr>
<td>α-Linolenic acid</td>
<td>0.7</td>
<td>0.6</td>
<td>9.8</td>
</tr>
</tbody>
</table>

1 Values determined by gas-liquid chromatography.
Fat load

On day 22 of each experimental period, 2 rice dishes enriched with 15 and 55 g rapeseed oil, respectively, were served at 0900 (time 0 h) and 1045 (time 1.75 h). The 2 meals were identical to the rapeseed-oil meals used in our earlier investigation of the acute effects of eating different fats (12). Both rice meals contained 42% of energy as fat. The 15- and 55-g rapeseed-oil meals contained 1.6 and 5.8 MJ, respectively. The meals were prepared in one batch in our metabolic kitchen, weighed out in portions, and frozen until used. The meals were consumed under supervision. The first meal had to be consumed within 10 min, the second within 20 min. The participants were allowed to drink tap water and to leave the institute during the test, but they were instructed to register their level of physical activity during the day and to repeat this on each test-meal day.

Blood sampling

To characterize the participants and to determine baseline values, fasting (12 h) blood samples were collected before the study began. On days 21 and 22 of each intervention period, fasting blood samples were collected in the morning. On day 22, nonfasting blood samples were collected at 1315 (4.25 h after the first meal), 1445 (5.75 h after the first meal), and 1745 (8.75 h after the first meal).

Blood was collected with minimal stasis by venipuncture after subjects rested ≥10 min in a supine position. Factor VII (FVII) and tissue factor pathway inhibitor (TFPI) were measured in blood collected into tubes containing sodium citrate (final concentration: 0.0129 mol/L) at room temperature. Lipids were measured in blood collected into tubes containing EDTA-K3, to which 8.50 C-reactive protein (CRP), an acute phase protein. Blood for prothrombin fragment 1+2 (F1+2) analysis was collected into 3-mL citrated tubes and the tubes without additives at room temperature. FVIIa, FVIIa, FVII:Ag, F1+2, and TFPI were not determined in an acute phase protein. Blood for thrombin-antithrombin III assay (Diagnostica Stago). Concentrations of F1+2 were measured with a commercial enzyme-linked immunosorbent assay (Behringwerke AG). Plasma TFPI concentrations in samples collected during fasting and 5.75 h after the first meal were measured with an enzyme-linked immunosorbent assay as described previously (13). This assay specifically measures plasma TFPI not bound to lipoproteins. Serum CRP was measured with an immunoturbidimetric method (Roche, Basel, Switzerland). Plasma triacylglycerol, total cholesterol, and HDL cholesterol concentrations were determined with enzymatic methods on a Cobas Mira S analyzer (Boehringer Mannheim GmbH, Mannheim, Germany). Technical problems for one subject, elevated CRP values in one subject, and the inability of one subject to consume one of the fat loads necessitated the exclusion of a few observations.

Dietary compliance

To monitor dietary compliance, the fatty acid composition of plasma triacylglycerols and cholesterol esters in fasting blood samples was determined. Plasma triacylglycerols and cholesterol esters were separated by thin-layer chromatography and the fatty acid composition was determined by gas-liquid chromatography after methylation, as described previously (14).

RESULTS

Dietary compliance

Olive oil and rapeseed oil caused the expected significant elevation of oleic acid in plasma triacylglycerols and cholesterol esters compared with sunflower oil, whereas sunflower oil was associated with significantly higher linoleic acid concentrations (Table 3). α-Linolenic acid concentrations were significantly elevated by rapeseed oil.

Fasting samples

Fasting FVII:c, FVIIa, FVII:Ag, F1+2, and TFPI were not significantly different between the 3 diets (Table 4). Fasting triacylglycerol concentrations were 25% higher after the olive oil diet than after the sunflower-oil and rapeseed-oil diets. Fasting FVII:c and FVIIa with all 3 diets decreased significantly from baseline, 10% and 20%, respectively, as did the ratio of FVIIa
to FVII:Ag. There were minor (NS) decreases from baseline in fasting FVII:Ag, F1+2, and TFPI. Fasting plasma triacylglycerol concentrations increased with the olive oil diet.

**Nonfasting samples**

Irrespective of the background diets, FVIIa and triacylglycerol concentrations increased significantly after the fat load (Figures 1 and 2, respectively). Additionally, plasma TFPI concentrations 5.75 h after the first meal were ≈ 7% higher than fasting concentrations with all 3 diets. Nonfasting mean FVII:c was also slightly higher (≈ 3%) than fasting FVII:c with all 3 diets (P = 0.06, P = 0.07, and P = 0.05 for the olive oil, sunflower-oil, and rapeseed-oil diets, respectively). Plasma F1+2 concentrations did not change significantly postprandially.

The olive oil diet was associated with lower nonfasting mean and peak concentrations of FVIIa than was the sunflower-oil diet (Table 5). Nonfasting mean and peak concentrations of FVIIa also tended to be lower after the olive oil diet than after the rapeseed-oil diet (paired t test: P = 0.09). Nonfasting TFPI, FVII:c, and F1+2 did not differ significantly between the 3 diets. Nonfasting mean and peak concentrations of plasma triacylglycerol were significantly higher after the olive oil diet than after the sunflower-oil diet, but these differences were mainly due to differences in fasting concentrations (Figure 1).

**DISCUSSION**

The present study showed that consumption of a diet rich in olive oil for 3 wk was associated with markedly lower nonfasting FVIIa concentrations than was consumption of a diet rich in sunflower oil. Postprandial FVIIa concentrations also tended to be lower after the olive oil diet than after the rapeseed-oil diet, but this effect was not significant. Humans are usually in a nonfasting state, and nonfasting deviations in pathogenetic factors may be of particular importance for the risk of developing IHD. Elevated plasma concentrations of FVIIa may represent a procoagulant state. Our results indicate that diets rich in olive oil may attenuate the prothrombotic effect of fatty meals, which might contribute to the low incidence of IHD in countries where olive oil is the predominant fat consumed. However, on the basis of the present results we cannot conclude how olive oil consumption affects other determinants of thrombosis.

Several earlier studies compared the immediate effects of meals containing different edible fats and found no clear differences on postprandial FVII activation (12, 16–20). The effect of the fatty acid composition of the background diet on nonfasting FVII was also investigated previously (21–26). In a recent study (21) found that a background diet enriched with olive oil (18% of energy as MUFAs) caused similar fasting FVIIa concentrations, but less postprandial FVII activation than did a diet enriched with butter (17% of energy as SFAs). In agreement with our results, they concluded that this observation indicates the antithrombotic potential of olive oil diets, which may contribute to the lower rate of IHD observed in Mediterranean regions. A report by Mitropoulos et al (22) suggested less postprandial FVII activation with a background diet rich in n–6 PUFAs (37% of energy) than with a diet rich in SFAs (22% of energy) (22). Taken together, background diets rich in olive oil thus seem to be less

### Table 3

Fasting fatty acid composition of plasma triacylglycerols and cholesterol esters at baseline and after consumption of the olive oil, sunflower-oil, and rapeseed-oil diets for 3 wk. \(^1\)

<table>
<thead>
<tr>
<th>Fatty acid</th>
<th>Baseline (mol %)</th>
<th>Olive oil (mol %)</th>
<th>Sunflower oil (mol %)</th>
<th>Rapeseed oil (mol %)</th>
<th>P&lt;sup&gt;2&lt;/sup&gt;</th>
<th>Table 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Palmitic acid</td>
<td>27.5 ± 0.3&lt;sup&gt;a&lt;/sup&gt;</td>
<td>24.5 ± 0.1&lt;sup&gt;b&lt;/sup&gt;</td>
<td>21.8 ± 0.6&lt;sup&gt;c&lt;/sup&gt;</td>
<td>22.0 ± 0.7&lt;sup&gt;d&lt;/sup&gt;</td>
<td>0.0001</td>
<td>7% SEM</td>
</tr>
<tr>
<td>Oleic acid</td>
<td>34.5 ± 0.1&lt;sup&gt;e&lt;/sup&gt;</td>
<td>46.2 ± 0.4&lt;sup&gt;f&lt;/sup&gt;</td>
<td>29.2 ± 0.1&lt;sup&gt;g&lt;/sup&gt;</td>
<td>39.5 ± 0.7&lt;sup&gt;h&lt;/sup&gt;</td>
<td>0.0001</td>
<td>7% SEM</td>
</tr>
<tr>
<td>Linoleic acid</td>
<td>15.3 ± 0.04&lt;sup&gt;i&lt;/sup&gt;</td>
<td>10.6 ± 0.6&lt;sup&gt;j&lt;/sup&gt;</td>
<td>30.2 ± 0.1&lt;sup&gt;k&lt;/sup&gt;</td>
<td>16.7 ± 0.3&lt;sup&gt;l&lt;/sup&gt;</td>
<td>0.0001</td>
<td>7% SEM</td>
</tr>
<tr>
<td>α-linolenic acid</td>
<td>1.3 ± 0.1&lt;sup&gt;m&lt;/sup&gt;</td>
<td>0.8 ± 0.3&lt;sup&gt;n&lt;/sup&gt;</td>
<td>0.9 ± 0.01&lt;sup&gt;o&lt;/sup&gt;</td>
<td>3.1 ± 0.2&lt;sup&gt;p&lt;/sup&gt;</td>
<td>0.0001</td>
<td>7% SEM</td>
</tr>
</tbody>
</table>

<sup>a</sup>–<sup>p</sup> Values determined by gas-liquid chromatography (14). Means with different superscript letters are significantly different, P < 0.005.

### Table 4

Fasting plasma values at baseline (day 0) and after consumption of the olive oil, sunflower-oil, and rapeseed-oil diets for 3 wk. \(^1\)

<table>
<thead>
<tr>
<th></th>
<th>Baseline (n = 18)</th>
<th>Olive oil (n = 17)</th>
<th>Sunflower oil (n = 18)</th>
<th>Rapeseed oil (n = 17)</th>
<th>P&lt;sup&gt;2&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>FVII:c (IU)</td>
<td>0.88 ± 0.03&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.78 ± 0.02&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.78 ± 0.03&lt;sup&gt;c&lt;/sup&gt;</td>
<td>0.81 ± 0.04&lt;sup&gt;d&lt;/sup&gt;</td>
<td>0.0001</td>
</tr>
<tr>
<td>FVIIa (U/L)</td>
<td>63.9 ± 4.7&lt;sup&gt;e&lt;/sup&gt;</td>
<td>47.0 ± 6.4&lt;sup&gt;f&lt;/sup&gt;</td>
<td>49.5 ± 7.8&lt;sup&gt;g&lt;/sup&gt;</td>
<td>50.1 ± 7.3&lt;sup&gt;h&lt;/sup&gt;</td>
<td>0.0001</td>
</tr>
<tr>
<td>FVII:Ag</td>
<td>1.05 ± 4</td>
<td>1.02 ± 4</td>
<td>1.00 ± 5</td>
<td>1.01 ± 4</td>
<td>0.19</td>
</tr>
<tr>
<td>Ratio of FVIIa to FVII:Ag</td>
<td>60 ± 4&lt;sup&gt;i&lt;/sup&gt;</td>
<td>44 ± 3&lt;sup&gt;j&lt;/sup&gt;</td>
<td>46 ± 3&lt;sup&gt;k&lt;/sup&gt;</td>
<td>46 ± 4&lt;sup&gt;l&lt;/sup&gt;</td>
<td>0.0001</td>
</tr>
<tr>
<td>F1+2 (mmol/L)</td>
<td>0.56 ± 0.05</td>
<td>0.51 ± 0.03</td>
<td>0.50 ± 0.03</td>
<td>0.52 ± 0.02</td>
<td>0.21</td>
</tr>
<tr>
<td>TFPI (μg/L)</td>
<td>12.8 ± 1.0</td>
<td>11.4 ± 0.7</td>
<td>11.6 ± 0.4</td>
<td>10.7 ± 0.5</td>
<td>0.21</td>
</tr>
<tr>
<td>TG (mmol/L)</td>
<td>0.66 ± 0.05&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.84 ± 0.06&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.67 ± 0.04&lt;sup&gt;c&lt;/sup&gt;</td>
<td>0.68 ± 0.03&lt;sup&gt;d&lt;/sup&gt;</td>
<td>0.0002</td>
</tr>
</tbody>
</table>

<sup>a</sup>–<sup>d</sup> Values of variables in blood samples collected on days 21 and 22. \(^1\) For differences between diets (ANOVA).

\(^2\) P < 0.0001; \(^a\) and \(^c\) P < 0.0001; \(^b\) and \(^d\) P < 0.0001; \(^e\) and \(^f\) P < 0.0001; \(^h\) and \(^i\) P < 0.0001; \(^j\) and \(^k\) P < 0.0001; \(^m\) and \(^n\) P < 0.0001; \(^o\) and \(^p\) P < 0.0001.
prothrombotic than diets rich in n–6 PUFAs, which are less prothrombotic than SFA diets.

Two other studies reported contradictory findings however (23, 24). Miller et al (23) found that background diets rich in either n–6 PUFAs or SFAs had similar effects on postprandial FVII:c concentrations in 9 subjects. Sanders et al (24) reported that a background diet rich in olive oil was associated with a postprandial increase in FVII:c after a fat load, whereas no increase in FVII:c was observed after a background diet rich in SFAs. Note that background diets were fed for only 1 wk in the study by Miller et al (23). Furthermore, in the study by Sanders et al, diets were consumed in sequential order, which means that a period effect cannot be excluded (24). Note also that both studies assessed postprandial FVII activation from measurements of FVII:c, which is relatively insensitive to FVIIa, as also evidenced by our present observation of a weak postprandial increase in FVII:c despite an increase of up to 76% in FVIIa.

FIGURE 1. Mean (±SEM) concentrations of activated factor VII (FVIIa) before and after consumption of fatty test meals enriched with rapeseed oil. Diets rich in olive oil (●; n = 17), sunflower oil (□; n = 18), or rapeseed oil (■; n = 16) were consumed for 3 wk before consumption of the fatty meals. Responses after the sunflower-oil diet were significantly different from those after the olive oil diet, P < 0.05 (see Table 5). M, time at which the meals were consumed.

FIGURE 2. Mean (±SEM) concentrations of plasma triacylglycerol before and after consumption of fatty test meals enriched with rapeseed oil. Diets rich in olive oil (●; n = 17), sunflower oil (□; n = 18), or rapeseed oil (■; n = 16) were consumed for 3 wk before the fatty meals were consumed. Nonfasting mean and peak concentrations of plasma triacylglycerols were significantly higher after the olive oil than after the sunflower-oil diet, P < 0.02. M, time at which the meals were consumed.
TABLE 5
Concentrations of activated factor VII (FVIIa) before and after consumption of fatty meals enriched with rapeseed oil

<table>
<thead>
<tr>
<th>FVIIa</th>
<th>Olive oil (n = 17)</th>
<th>Sunflower oil (n = 18)</th>
<th>Rapeseed oil (n = 16)</th>
<th>P²</th>
</tr>
</thead>
<tbody>
<tr>
<td>U/L</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fasting</td>
<td>44.7 (4.3)</td>
<td>47.2 (4.7)</td>
<td>48.8 (5.3)</td>
<td>0.91</td>
</tr>
<tr>
<td>Nonfasting mean</td>
<td>65.7 (9.3)</td>
<td>79.3 (9.8)</td>
<td>76.6 (10.5)</td>
<td>0.02</td>
</tr>
<tr>
<td>Nonfasting peak</td>
<td>68.0 (9.4)</td>
<td>83.4 (9.9)</td>
<td>80.3 (10.7)</td>
<td>0.02</td>
</tr>
<tr>
<td>Postprandial increase</td>
<td>23.3 (5.7)</td>
<td>36.2 (5.8)</td>
<td>31.4 (6.0)</td>
<td>0.008</td>
</tr>
</tbody>
</table>

¹SEM. Diets rich in olive, sunflower, or rapeseed oil were consumed for 3 weeks before consumption of the fatty meals. Means with different superscript letters are significantly different (a and b, P < 0.01; a and c, P < 0.05).

²For difference between diets (ANOVA).

difference between fasting and nonfasting peak values.

Finally, the divergent findings may have been because of the different characteristics of the experimental diets. Miller et al (23) used a diet with ~14% of energy as SFAs, whereas Mitropoulos et al (22) used a diet with a much higher percentage of energy as SFAs (~22% of energy). Similarly, Miller et al’s diet had a much lower n-6 PUFA content (~21% of energy) than did the diet used by Mitropoulos et al (~37% of energy). The fatty acid composition of the experimental diets used by Roche et al (21) and Sanders et al (24) were similar, however, and it is not likely that their divergent observations can be explained by differences in the fatty acid composition of their diets (21, 24). Fish-oil supplementation of the background diet did not affect postprandial FVIIa or FVIIa concentrations significantly in 2 recent studies (25, 26).

The attenuated postprandial FVII activation after the olive oil diet may have resulted from the MUFA oleic acid, which is present in a relatively high amount in olive oil (74 mol%). As does olive oil, rapeseed oil contains a relatively high amount of oleic acid (56 mol%). However, compared with the sunflower-oil diet, no attenuated postprandial FVII activation was observed after the rapeseed-oil diet. Additionally, we observed no significant difference in postprandial FVII activation between the olive oil and rapeseed-oil diets; however, a trend was seen, possibly because of the higher content of PUFAs in rapeseed oil than in olive oil. Another possibility might be that the postprandial activation of FVII is influenced by differences in minor non-fatty acid constituents of the oils.

The hypertriglyceridemia that occurs after the consumption of high-fat meals (23, 27, 28) has been suggested to activate FVII. In the present study, fasting and nonfasting plasma triacylglycerol concentrations were higher after the olive oil diet than after the sunflower-oil and rapeseed-oil diets. Thus, our present findings contradict the assumption that the plasma triacylglycerol concentration is the primary determinant of postprandial FVIIa concentrations and are in line with our earlier observations (12, 25).

The postprandial activation of FVII was accompanied by a moderate increase in TFPI concentrations with all 3 diets, whereas the plasma concentration of F1+2, a marker of thrombin generation, was unaffected. There was no significant difference between diets with respect to postprandial TFPI and F1+2. A lack of effect of dietary FVII activation on F1+2 was observed by others (28, 29). Our observations indicate that it may have been due to enhanced inhibition of FVIIa by TFPI. Two other studies, however, showed no postprandial effects of fat loads on the activity of TFPI in healthy subjects and in hypertriglyceridemic patients (30, 31). An alternative explanation for the lack of effect of FVII activation on F1+2 is that our healthy young subjects had limited vascular expression of tissue thromboplastin factor, which would prevent FVIIa from causing F1+2 formation. In line with this thinking, we would expect that individuals with atherosclerotic vessels and augmented tissue thromboplastin factor expression (32–34) would more readily react to FVII activation with an increased plasma concentration of F1+2. The findings of an epidemiologic study by Miller et al (35) support this explanation. Another possible explanation for the lack of effect of FVII activation on F1+2 is that F1+2 was efficiently cleared from the blood in our healthy young study subjects.

Fasting concentrations of FVII were not affected differently by the 3 diets enriched with different types of fat, which agrees with earlier observations (11). The decline in fasting FVIIa and FVIIa from baseline that was seen with all 3 experimental diets suggests that the experimental diets were less thrombogenic than were the habitual diets. The macronutrient composition of the habitual and experimental diets differed only slightly, however. Therefore, we believe that seasonal variations, the fixed diet patterns during the experimental periods, or both are more likely explanations of the changes from baseline in fasting FVIIa and FVIIa.

In conclusion, the study showed that incorporation of olive oil into the diet for 3 weeks resulted in a lower postprandial FVIIa concentration than did the incorporation of sunflower oil. This finding suggests that a diet rich in olive oil reduces the thrombotic propensity associated with the consumption of fatty meals, which could partly explain the low incidence of IHD in populations with a high intake of olive oil.

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REFERENCES


