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EFFECT OF DIETARY FATTY ACID INTAKES ON SERUM LIPOPROTEIN LEVELS
AND ESSENTIAL FATTY ACID STATUS IN HEALTHY MEN

SAVANIT ONGROONGRUANG
2

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**EFFECT OF DIETARY FATTY ACID INTAKES ON SERUM LIPOPROTEIN LEVELS
AND ESSENTIAL FATTY ACID STATUS IN HEALTHY MEN**

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AND ESSENTIAL FATTY ACID STATUS IN HEALTHY MEN**

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for the degree of Doctor of Science (Nutrition)

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Savanit Ongroongruang

ชื่อวิทยานิพนธ์ ผลของการดัดไขมันในอาหารที่รับประทานต่อระดับไลโปโปรตีนในซีรัม
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บทคัดย่อ

น้ำมันถั่วเหลืองมีปริมาณกรดไขมันไม่อิ่มตัว-ไลโนเลนิก โอเลอิก และพาล์มิติก ร้อยละ 53.0, 7.0 26.5 และ 9.2 ของกรดไขมันทั้งหมด ส่วนน้ำมันปาล์มมีส่วนประกอบ ของกรดไขมันดังกล่าวร้อยละ 12.0, 0.4, 42.5 และ 38.2 การศึกษานี้มีวัตถุประสงค์ เพื่อเปรียบเทียบน้ำมันพืช 2 ชนิดนี้ ต่อระดับไลโปโปรตีนในซีรัม ระดับกรดไขมันชนิดต่างๆใน ซีรัมและไนเมตเลือดแดง และการจับตัวของเกล็ดเลือด ผู้ได้รับการศึกษาเป็นชายไทยปกติ จำนวน 12 คน อายุ 28-39 ปี และมีดัชนีมวลกายของร่างกาย 19.1-25.2 กก./ม.² แบ่งออกเป็น 2 กลุ่มๆ ละ 6 คน ใช้เวลาในการศึกษา 24 สัปดาห์ กลุ่มที่ 1 เริ่มต้นด้วย รับประทานอาหารตามที่เคยเป็นอยู่ 4 สัปดาห์ ต่อด้วยการรับประทานอาหารที่ปรุงด้วยน้ำมัน- ถั่วเหลือง 8 สัปดาห์ แล้วให้รับประทานอาหารตามที่เคยเป็นอยู่ 4 สัปดาห์ และต่อด้วยการ รับประทานอาหารที่ปรุงโดยน้ำมันปาล์ม 8 สัปดาห์ กลุ่มที่ 2 ให้มีการต่างจากกลุ่มที่ 1 คือ รับประทานอาหารที่ปรุงโดยน้ำมันปาล์มก่อนน้ำมันถั่วเหลือง อาหารที่จัดให้ในช่วงที่ใช้ น้ำมัน- ปาล์มก่อนน้ำมันถั่วเหลือง อาหารที่จัดให้ในช่วงที่ใช้ น้ำมันถั่วเหลือง และน้ำมันปาล์ม กำหนด ให้มีโปรตีนร้อยละ 15 ไขมันร้อยละ 30 และคาร์โบไฮเดรตร้อยละ 55 ของพลังงานทั้งหมด ที่ได้รับต่อวัน

การศึกษานพบว่าในช่วงที่ใช้ น้ำมันถั่วเหลืองได้กรดไขมันไม่อิ่มตัว กรดโอเลอิก กรดพาล์มิติก กรดโอเลอิก และกรดพาล์มิติก มีค่าเฉลี่ย ร้อยละ 13.73, 1.78, 8.11 และ 3.34 ของพลังงานทั้งหมดที่ได้รับต่อวัน ในช่วงที่ใช้ น้ำมันปาล์มได้รับกรดไขมันดังกล่าวร้อยละ 3.46,

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Thesis Title Effect of Dietary Fatty Acid Intakes on
 Serum Lipoprotein Levels and Essential
 Fatty Acid Status in Healthy Men

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ABSTRACT

Fatty acid compositions of soybean and palm oils. and different. Linoleate, alpha-linolenate, oleate and palmitate contents in soybean oil (SB) are 53.0, 7.0, 26.5 and 9.2% of total fatty acids, whereas those in palm oil (PO) are 12.0, 0.4, 42.5 and 38.2%. The objectives of this study are to compare the effect of SB and PO intakes on serum lipoprotein levels; in serum and erythrocyte total lipids, and platelet function. The study included 12 healthy men with the age of 28-39 years and body mass index of 19.1-25.2 kg/m². They were divided into two groups. Total study period was 24 weeks consisting of 4 weeks of baseline period, 8 weeks of the first vegetable oil period, 4 weeks of washout period and 8 weeks of the second vegetable oil period. The first and second vegetable oils consumed by group I were SB and PO,

respectively, whereas the reverse sequence was carried out in group II. Each vegetable oil contributed 25% of total energy intake. The dietary energy distribution was 15% from protein, 30% from fat and 55% from carbohydrate throughout the study.

At SB period, linoleate, alpha-linolenate, oleate and palmitate intakes were 13.73, 1.78, 8.11 and 3.34% of total calories whereas at PO period, these values were 3.46, 0.12, 12.48 and 10.47%. Fatty acid intakes and their levels in serum and erythrocyte indicate the compliance of the subjects to the assigned diets. Their linoleate status were adequate before entering and during the study. During the SB period, there was significant increases in serum and erythrocyte linoleate and alpha-linolenate levels and the levels declined in the PO period. In group I; serum total cholesterol and LDL-C levels during the SB period decreased from the initial levels 30 and 40%, respectively. The change was detected at the first week of the SB period. In group II, the levels of total cholesterol and LDL-C levels during the PO period decreased from the initial levels 9 and 8% whereas the net decreases in serum total cholesterol, LDL-C, and triglyceride levels were 3, 16 and 39% during SB period. No striking change was found in platelet count and platelet aggregation due to different fatty acid intake.

In conclusion, SB is better than PO to maintain the adequacy of linoleate and alpha-linolenate status with concomitant decrease in serum total cholesterol, LDL-C and triglyceride levels.



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LIST OF ABBREVIATIONS

BL	Baseline period
SB	Soybean oil
PO	Palm oil
TC	Total cholesterol
LDL-C	Low density lipoprotein-cholesterol
HDL-C	High density lipoprotein-cholesterol
TG	Triglyceride

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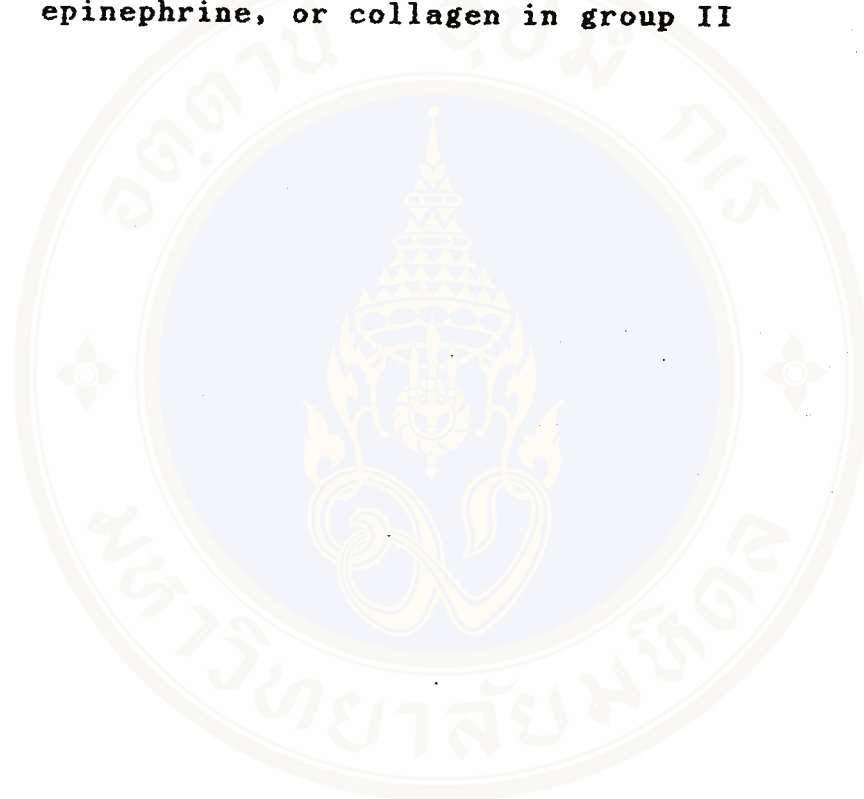
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CHAPTER I

STATEMENT OF THE PROBLEM AND OBJECTIVES

Statement of the problem

Coronary heart disease (CHD) is the leading cause of death in the affluent societies of both developed and developing countries including Thailand (1-4). It has a complex etiology in which blood lipids and arterial thrombosis are involved (5-24). Present evidence indicates that hypercholesterolemia is the significant risk factor. Numerous studies have been carried out to investigate the influence of dietary fats on blood lipids and lipoprotein levels (25-38).

Recent study on the prevalence of hyperlipidemia in 4,495 officials of the Electricity Generating Authority of Thailand (EGAT), representing urban Thais, showed that 53% of 3,548 men had serum total cholesterol (TC) of 200-260 mg/dL and 18% had serum TC higher than 260 mg/dL. The corresponding figures in 947 women were 50.1% and 15.3% (39).

Epidemiological studies together with dietary studies in individual lead to the new concept in nutritional practices relating dietary lipid for reducing blood cholesterol content and consequently reduce the risk of atherosclerosis. The recommendations are:

reducing dietary cholesterol to less than 300 mg/day, reducing dietary fat to 30% or less of total dietary energy, reducing saturated fatty acid (SFA) intake to less than 10% of total dietary intake, increasing polyunsaturated fatty acids (PUFA), especially linoleic and oleic acids to 20% of total dietary intake. Exercise is also suggested to increase serum high density lipoprotein cholesterol (HDL-C) level.

Objectives

Soybean and palm oils are common vegetable oils consumed by Thais. However, the fatty acid composition of these two vegetable oils are different (Table 1). It is the purpose of this study to compare the effect of soybean and palm oil intakes on

1. serum lipoprotein levels,
2. serum fatty acid composition,
3. erythrocyte fatty acid composition, and
4. platelet function

in healthy men.

Table 1. Fatty acid composition of soybean oil and palm oil

Fatty acid	Soybean oil	Palm oil
<--- % of total fatty acids --->		
Saturated, total	12.9	43.7
12:0	—	0.5
14:0	0.2	1.3
16:0	9.2	38.2
18:0	3.4	3.4
20:0	0.1	0.3
Monounsaturated, total	26.8	43.2
16:1	0.1	0.5
18:1	26.5	42.5
20:1	0.2	0.2
Polyunsaturated, total	60.0	12.4
18:2	53.0	12.0
18:3	7.0	0.4
P/S	4.6	0.3

CHAPTER II

MATERIALS AND METHODS

Subjects

Twelve healthy men, aged ranging from 28 to 39 yr. were recruited in this study. Their initial characteristics are shown in Table 2. Their weight ranged from 54.0 to 70.9 kg and their height ranged from 1.63 to 1.80 m. Their mean($\pm$ SEM) body mass index (BMI) was $22.05 \pm 0.53 \text{ kg/m}^2$. All of them were free from diseases judged by medical history, physical examination, and daily physical activity. They showed a considerable interest in the study and were informed in details about the objective of the study.

During the study, all of the subjects maintained their routine daily activities but they were instructed to adhere strictly to the experimental diets during the metabolic period, recorded their daily activities in the given notebooks which were checked periodically, and refrained from any competitive sport requiring strenuous physical activities.

Experimental design

Subjects were divided equally into two groups; group I and group II according to types of vegetable oil intake. The total study period was 24 wks consisting of 4

Table 2. Initial characteristics and occupation of 12 subjects

Subject	Age	Height	Weight	BMI	Occupation
	yr	m	kg	kg/m ²	
Group I					
A.Ko	29	1.67	61.8	22.2	Laboratory technician
B.Ji	37	1.66	69.5	25.2	Security guard
C.Ch	38	1.63	63.8	24.0	Laboratory technician
N.Su	33	1.80	70.9	21.9	Security guard and physical education teacher
P.Jo	37	1.70	68.5	23.7	Clerk
S.Pr	28	1.72	63.7	21.5	Laboratory technician
Mean±SEM	33.67±1.78	1.70±0.02	66.37±1.52	23.08±0.59	
Group II					
C.Ki	30	1.68	55.8	19.8	Clerk
C.Pe	31	1.70	66.0	22.8	Clerk
P.Lo	37	1.66	61.0	22.3	Security guard
S.Na	36	1.70	64.9	22.5	Security guard
S.Pa	39	1.68	54.0	19.1	Security guard
S.Pu	31	1.74	59.5	19.7	Clerk
Mean±SEM	34.00±1.55	1.69±0.01	60.2±1.96	21.03±0.68	

wks of baseline (BL) period, 8 wks of first vegetable oil period, 4 wks of washout (WO) period, and 8 wks of second vegetable oil period (Figure 1). Either soybean oil (SB) or palm oil (PO) was consumed during the vegetable oil period.

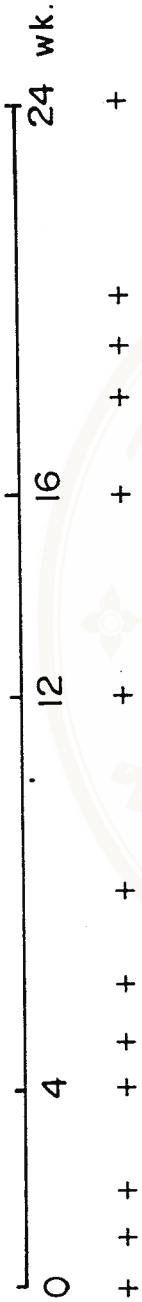
During BL and WO periods, the subjects consumed their habitual diets and monitored for day-to-day variations in energy and nutrient intake. Average energy intake of each subject during the BL was used to standardize energy intake during the first and the second vegetable oil periods which were carried out at the Clinical Research Ward, Ramathibodi Hospital. Energy distribution of diets served during SB or PO were 15, 30 and 55% derived from protein, fat and carbohydrate, respectively.

During the vegetable oil periods, protein sources consumed by the subjects were pork, chicken, and rice with the proportion of 1 : 1 : 2.5. The first and second vegetable oils consumed by group I were SB and PO, respectively, whereas the reverse sequence was carried out in group II. Each vegetable oil contributed 25% of total energy intake (Table 3).

Tables 4 shows menus served at various days during the SB and PO periods of group I and group II.

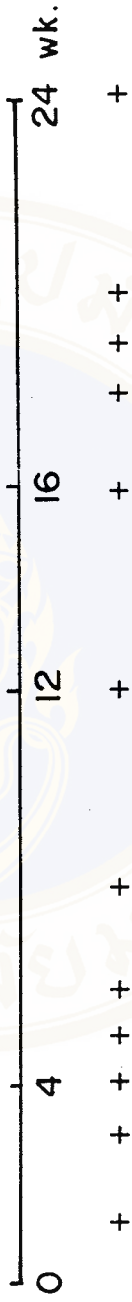
Baseline	Soybean oil	Washout	Palm oil
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Group I



Baseline	Palm oil	Washout	Soybean oil
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Group II



+ Anthropometric assessment and blood collection

Fig. I EXPERIMENTAL DESIGN

Table 3. Energy distribution of diets during SB and P0 periods

Energy source	Percentage of total calorie	
	SB period	P0 period
Protein ^a	15	15
Carbohydrate	55	55
Total fat	30	30
Vegetable oil	25	25

^a37.8% of total protein intake was derived from pork, 37.2% from chicken and 25% from rice and vegetable.

Table 4. Menus served at various days during SB and PO periods of group I and II

Day	Breakfast	Lunch	Supper
1	Rice, gravy chicken	Rice, fried ground pork with sweet basil	Rice, sour curry with pork and mixed vegetables, fried chicken with baby corn
2	Fried rice with chicken and mushroom	Rice, fried pork with ginger	Rice, chinese cabbage soup with pork, fried chicken with ginger and jelly mushroom
3	Rice, fried pork with sweet basil and pepper	Rice, fried chicken with green pepper	Rice, pork curry without coconut milk, fried cabbage with chicken
4	Rice, fried collard greens with chicken	Fried rice with pork	Rice, sour and spicy chicken soup with mushroom, fried pork with onion and chilli
5	Rice, fried egg plant with chicken	Fried rice with shrimp paste, sweet fried pork	Rice, chinese green vegetable soup with pork, fried chicken with bamboo shoot
6	Rice, chicken stew	Fried rice with sweet and sour chicken	Rice, fried pork, spicy vegetable soup with pork
7	Fried rice with chicken and soy sauce	Rice, pork stew, chilli paste	Rice, cucumber soup with pork, sweet and sour chicken

Dietary assessment

During the BL period, dietary intake in each subject was assessed by the 24-hr dietary record. During the SB and PO periods, daily dietary intake in each subject was assessed by weighing all of the foods consumed. Daily energy, protein, fat, carbohydrate, fatty acid and cholesterol intakes in each subject were then calculated using published references (40-45).

Anthropometric measurement

Body weight, height, triceps (TSF), biceps (BSF), subscapula (SSF), and suprailiac (SISF) skinfold thicknesses, in each subject were measured by using the standard techniques (46,47). Standard of TSF was taken from the standard source (46). Standard of weight for height was based on Metropolitan Life Insurance Company (48). Body mass index (BMI) was derived from weight in kg divided by height in m^2 (49). Percentage of body fat was estimated by the sum of the 4 skinfold thicknesses described by Durnin and Womersley (50). Height was measured at day 1 of the BL period. Body weight was recorded daily before breakfast whereas the remaining measurements were carried out on the same day of the blood collection (Fig 1).

Blood collection

Venous blood was obtained from each subject after a 12-14 hr fast at day 1 of each week of the study periods. In group I, venous blood was obtained at wks 0, 1, 2, and 4 of the BL period; wks 1, 2, 4, and 8 of the SB period; wk 4 of the W0 period; and wks 2, 3, 4, and 8 of PO period. In group II, venous blood collection was obtained at wks 0, 2, and 3 of the BL period; wks 1, 2, 4, and 8 of the PO period; wk 4 of the W0 period; and wks 2, 3, 4 and 8 of the SB period (Fig 1). Whole blood, plasma, serum, and red blood cells were properly prepared for further analysis.

Hematological parameters

Hemoglobin (Hb), hematocrit (Hct), red blood cell (Rbc), white blood cell (Wbc), and platelet cell counts were measured by Hemalog 8 and Hemalog D (Technicon Instruments Corp, Tarrytown). The mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), mean corpuscular hemoglobin concentration (MCHC), and total lymphocyte count were calculated as follows:

$$\text{MCV (fL)} = \frac{\text{Hct (\%)} \times 10}{\text{Rbc (10}^{12}\text{/L)}}$$

$$\text{MCV (pg)} = \frac{\text{Hb (g/dL)} \times 10}{\text{Rbc (10}^{12}\text{/L)}}$$

$$\text{MCHC (g/L)} = \frac{\text{Hb (g/dL)} \times 1000}{\text{Hct (\%)}}$$

Total lymphocyte count ($10^9/\text{L}$)

$$= \frac{\text{Wbc (}10^9/\text{L)} \times \text{lymphocyte (\%)}}{100}$$

Nephelometric analysis of lipoproteins

The Thorp micro-nephelometer was developed principally for the quantitative measurement of serum lipoprotein (51). The serum was diluted 10 times with physiological saline and then the light scattering intensity was read by the Thorp micro-nephelometer (LSIA). The solution was then filtered through Sartorius membrane MF 12 (Cat. No. 11328) and was read again (LSI B). The response of the light scattering intensity depended upon the particle size of the suspension.

Calculation: $\text{LSI} = \text{A} - \text{LSI B}$

1. For $\text{LSI B} < 50$

$$\text{L-particle} = \text{LSI} \times 0.9 \text{ mg/dl}$$

$$\text{M-particle} = (\text{LSI B} \times 11.2) - 58 \text{ mg/dl}$$

$$\text{S-particle} = (2.1 \times \text{TC}) - 0.19 \times \text{M-particle} - 10 \text{ mg/dl}$$

2. For $\text{LSI B} > 50$

$$\text{L-particle} = \text{LSI} \times 0.9 \text{ mg/dl}$$

$$\text{M-particle} = (\text{LSI B} \times 5.7) + 210 \text{ mg/dl}$$

a. If TC < 350

$$S\text{-particle} = (2.1 \times TC) - 0.19 \times M\text{-particle} - 10 \text{ mg/dl}$$

b. If TC > 350

$$S\text{-particle} = (1.4 \times TC) - 0.14 \times M\text{-particle} \text{ mg/dl}$$

Where, L-particle = chylomicron

M-particle = very low density lipoprotein (VLDL)

S-particle = low density lipoprotein (LDL)

TC = total cholesterol

Nephelometric measurement of plasma fibrinogen

Plasma which was separated from whole blood anticoagulated with EDTA was analyzed immediately after blood collection by diluted with 0.2% MES [2-(N-morpholino) ethane sulphonic acid] buffered saline pH 6.3 and the light scattering intensity was read on the Thorp micronephelometer (LB). The solution was then heated in a water bath at 56°C for 15 minutes and was read again after cooling to room temperature (LT).

The dilution of plasma used for normal levels of fibrinogen (200-400 mg/dl) is preferably about 1/40, 1/20 dilution for lower concentration (<200 mg/dl), and 1/100 dilution for higher concentration (>400 mg/dl) (29).

$$\text{Calculation : Fibrinogen (mg/dl)} = (LT - LB) \times \frac{a+b}{a} \times 0.054$$

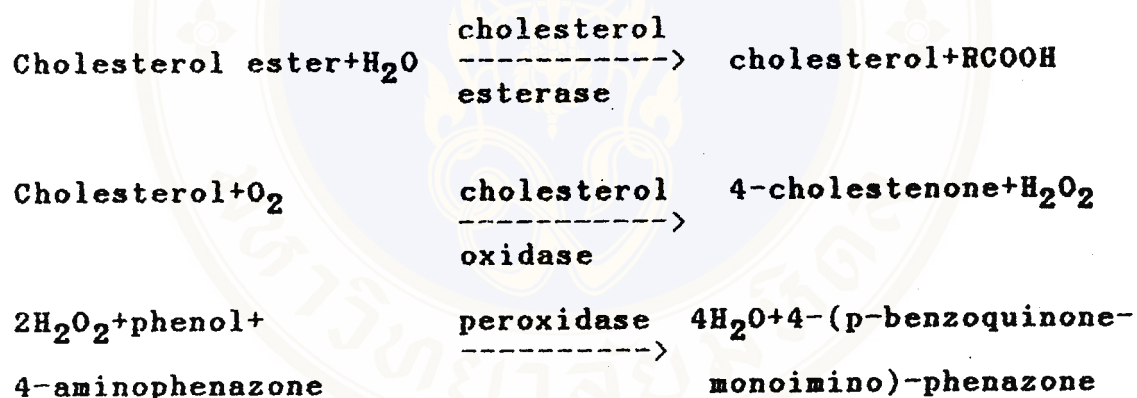
where, a = volume of plasma

b = volume of MES-buffered saline

Determination of serum cholesterol

Serum total cholesterol

Enzymatic-colorimetric method was used to measure serum total cholesterol by using Boehringer Mannheim Monotest Cholesterol Kit (Cat. No. 236691). The optical densities of samples and cholesterol standard were measured against reagent blank with spectrophotometer at wavelength 500 nm (52). The enzymatic reactions were as follows:

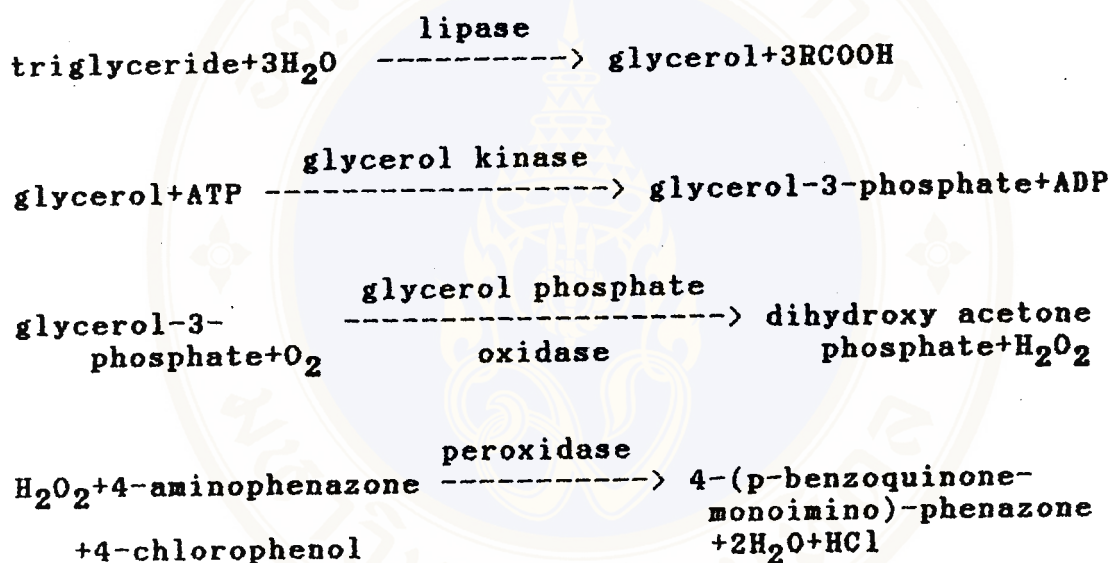


Serum high density lipoprotein-cholesterol (HDL-C)

Chylomicron, VLDL, and LDL were precipitated by adding phosphotungstic acid and magnesium chloride to the sample by the methods of Burstein (53) and Lopes-Virella (54). HDL was left in the supernatant after centrifugation and cholesterol content of HDL was determined enzymatically by the aforesaid method for total cholesterol determination.

Determination of serum triglyceride

Enzymatic hydrolysis of triglyceride (TG) with subsequent determination of the liberated glycerol by Boehringer mannheim Triglycerides GPO-PAP Kit (Cat. No. 701912) was used to measure serum triglyceride (55). The enzymatic reactions were as follows:



The optical densities of sample and glycerol standard were measured against reagent blank by spectrophotometer at 500 nm.

Estimation of LDL-C concentration

LDL-C levels were calculated from Friedewald's formula (56):

$$\text{LDL-C} = \text{total cholesterol} - \text{HDL-C} - \text{TG}/5$$

Analysis of serum fatty acid pattern

Fatty acids in total serum lipids

Five hundred μ l of serum were added to screw-cap tubes containing 200 μ l of C-15 (1 mg/ml of hexane), which was used as the internal standard. Two ml of methanol-hexane 4:1 (v/v) was added to the serum samples which were then mixed in Vortex vigorously. The amount of 0.2 ml of acetyl chloride was slowly added to the stirring tube over the period of 1 min. Tubes were tightly closed with Teflon-lined caps and subjected to methanolysis at 100°C for 1 hr. After tubes had been cooled at room temperature, 5 ml of 6% K_2CO_3 solution was slowly added to stop reaction and neutralize the mixture. The tubes were then shaken vigorously and centrifuged at 2000 rpm for 5 min, and an aliquot of the hexane upper phase was injected into capillary gas chromatograph (GLC) (57).

Analysis of erythrocyte fatty acid pattern

EDTA blood were centrifuged at 800 g for 5 min to remove plasma and buffy coat. Red blood cells were washed 3 times in ice-cold isotonic NaCl solution and centrifuged at 800 g for 3 min for each washing. Then red blood cells were suspended in an equal volume to isotonic NaCl solution.

The amount of 500 μ l of the suspension were added to screw-cap tubes containing 100 μ l of C-15 (1 mg/ml of hexane), which was used as the internal standard. Samples were transesterified by heating the tubes under nitrogen at 90°C for 2.5 hr after adding 2 ml of methanol in 6N HCl (v/v, 4:1) and were mixed vigorously in Vortex. Lipids were extracted by shaking with 4 ml of hexane with butyrate hydroxytoluene (BHT, 50 mg/l of hexane) and 100 μ l of amyl alcohol followed by centrifugation for 2 min at 2500 g. After evaporation under nitrogen the fatty acids were methylated by heating with 0.5 ml of 140 g/l boron trifluoride in methanol for 10 min at 60°C. The fatty acid methyl esters were extracted into 5 ml of hexane with BHT, washed twice in saturated NaCl solution dried with anhydrous sodium sulphate. After evaporation under nitrogen, resuspended in 100 μ l of hexane and stored in sealed ampoules at -20°C until analysis was performed by capillary GLC (58).

Determination of fatty acid pattern by GLC

The fatty acid methyl ester residue was dissolved with a small amount of hexane and separated by GLC (Model 5890 Hewlette Packard) with a 12 m x 0.2 mm x 0.33 mm film thickness of fused-silica capillary column and a flame ionization detector. Nitrogen was used as a carrier gas at the rate of 39 ml per minute. The column temperature

was programmed from 150°C to 170°C at 2°C per minute, from 170°C to 192°C at 1°C per minute, and from 192°C to 200°C at 10°C per minute with a final hold of 15 minutes. The detector temperature was 250°C.

The emergent peaks were identified by comparing their retention time with the standard fatty acid methyl esters. The relative proportion of fatty acid was derived by determining the area under each peak divided by the total area under peak of all fatty acids appeared in the chromatogram. The value was expressed as percent of total fatty acids.

Determination of serum apoprotein A-I and apoprotein B

Serum apoprotein A-I and apoprotein B were measured by the immunochemical reaction with specific antibodies. The turbidity developing on mixing of serum and reagent (Turbiquant) was measured by Turbitimer (Behring, Marburg, W. Germany).

Platelet aggregation test

Blood was collected in plastic tubes containing 3.8% sodium citrate (9:1) as an anticoagulant, centrifuged for the preparation of platelet rich plasma (PRP) and platelet poor plasma (PPP). The platelet number in PRP was adjusted to $200-300 \times 10^9/L$ by diluting with PPP. Aggregation was determined by Born turbidimetric technique

(59). The extent of aggregation was measured as the maximal transmission of light (in percent) in a Daiichi aggregometer using epinephrine, collagen, and ADP as aggregating agents. The instrument was adjusted so that the light transmission in PRP was registered as zero and that in PPP as 100%. The samples were aggregated for 4 min.

Statistical analysis

The data of each study period were reported as individual and mean($\pm$ SEM) values. Significant differences among each study period in each group were determined by student's paired t test. Significant differences between the two groups were determined by analysis of variance. All statistical differences were based on two-tailed tests (60,61).

CHAPTER III

RESULTS

Dietary assessment

Rice, pork, chicken and vegetable oil, were the main food sources consumed by the subjects during the vegetable oil period (Table 5).

Table 6 shows individual and means $\pm$ SEM of daily energy, protein, fat and carbohydrate intake in groups I and II during the vegetable oil periods. The mean energy distribution of these diets were 15, 30 and 55% of total calories derived from protein, fat and carbohydrate, respectively. Eighty percent of their fat intake was derived from the vegetable oils and 20% from the structural fat.

Table 1 shows fatty acid composition of SB and PO consumed by the subjects. The polyunsaturated/saturated fatty acid (P/S) ratio of SB is 4.6 whereas that of PO is 0.3. The mean($\pm$ SEM) fatty acid and cholesterol intakes of group I and II are shown in Table 7,8. The P/S ratio during the SB period ranged from 3.21-3.24 and that during the PO period was 0.29. The cholesterol intake in group I ranged from 132 to 215 mg/day whereas that in group II ranged from 147 to 214 mg/day.

Table 5. Main food sources consumed by the subjects during the vegetable oil periods

Subjects	Rice	Pork	Chicken	Vegetable oil
<----- g/day ----->				
Group I				
A.Ko	359.0	165.4	163.3	75.3
B.Ji	354.2	141.0	139.3	64.9
C.Ch	371.4	147.6	145.7	67.6
N.Su	423.5	166.8	164.6	76.0
P.Jo	276.8	112.5	110.6	52.3
S.Pr	465.9	183.2	180.8	82.9
Mean±SEM	375.1±26.4	152.8±10.1	150.7±10.0	69.8±4.4
Group II				
C.Ki	414.8	163.8	161.7	74.5
C.Pe	465.9	183.2	180.2	82.9
P.Lo	380.0	150.8	148.9	69.0
S.Na	311.2	125.0	123.4	57.9
S.Pa	311.2	125.0	123.4	57.9
S.Pu	362.8	143.9	142.3	66.2
Mean±SEM	374.3±24.6	148.6±9.2	146.6±9.0	68.1±4.0

Table 6. Daily energy, protein, fat and carbohydrate intake in subjects during the vegetable oil periods

Subjects	Energy	Protein	Fat	Carbohydrate
	kcal/day	<-----	g/day	----->
Group I				
A.Ko	2725	102.2	90.8	374.7
B.Ji	2342	87.8	78.1	322.0
C.Ch	2442	91.6	81.4	335.8
N.Su	2726	101.5	90.1	377.3
P.Jo	1897	70.8	63.2	261.2
S.Pr	2993	112.2	99.8	411.5
Mean±SEM	2521±156	94.4±5.9	83.9±5.2	347.1±21.6
Group II				
C.Ki	2671	100.2	89.2	366.9
C.Pe	2841	106.6	94.7	390.5
P.Lo	2504	93.8	83.3	344.7
S.Na	2100	78.8	70.0	288.8
S.Pa	2100	78.8	70.0	288.8
S.Pu	2386	89.4	79.6	328.1
Mean±SEM	2433±123	91.3±4.6	81.1±4.1	334.6±16.8

Table 7. Fatty acid and cholesterol intakes during SB and PO periods in group I

Subject	Period	Saturated fatty acid					Monounsaturated fatty acids				
		Total	12:0	14:0	16:0	18:0	20:0	Total	16:1	18:1	20:1
← g/day →											
A.Ko	SB	14.57		0.32	10.03	4.08	0.14	26.26	0.52	25.51	0.23
	PO	37.76	0.38	1.14	31.87	4.08	0.29	38.61	0.82	37.55	0.23
B.Ji	SB	12.51		0.27	8.62	3.50	0.12	22.58	0.44	15.90	0.20
	PO	32.50	0.32	0.98	27.44	3.50	0.25	33.22	0.70	32.32	0.20
C.Ch	SB	13.05		0.28	8.99	3.65	0.13	23.54	0.47	22.87	0.21
	PO	33.87	0.34	1.03	28.59	3.65	0.26	34.63	2.74	33.68	0.21
N.Su	SB	14.70		0.32	10.12	4.12	0.14	26.50	0.52	25.74	0.24
	PO	38.11	0.38	1.15	32.16	4.12	0.29	38.96	0.83	37.90	0.24
P.Jo	SB	10.05		0.22	6.92	2.81	0.10	18.15	0.36	17.64	0.16
	PO	26.16	0.26	0.79	22.09	2.81	0.20	26.73	0.56	26.00	0.16
S.Pr	SB	16.07		0.35	11.07	4.50	0.16	28.95	0.58	28.12	0.26
	PO	41.61	0.41	1.26	35.11	4.50	0.32	42.55	0.91	41.38	0.26
Mean	SB	13.49		0.29	9.29	3.78	0.13	24.33	0.48	22.63	0.22
+		+		+	+	+	+	+	+	+	+
SEM		0.86		0.02	0.59	0.24	0.01	1.54	0.03	1.99	0.01
%of total calorie		4.82		0.10	3.32	1.35	0.05	8.68	0.17	8.08	0.08
Mean	PO	35.00	0.35	1.06	29.54	3.78	0.27	35.78	0.76	34.80	0.22
+		+	+	+	+	+	+	+	+	+	+
SEM		2.21	0.02	0.07	1.86	0.24	0.02	2.26	0.05	2.20	0.01
%of total calorie		12.50	0.12	0.38	10.54	1.35	0.10	12.77	0.27	12.42	0.08

Table 7. . . . continued

Subject	Period	Polyunsaturated fatty acids						P/S	P/M/S	Cholesterol
		Total	18:2 n-6	18:3 n-3	20:4 n-6	22:5 n-3	22:6 n-3			
		g/day								
A.Ko	SB	46.90	41.28	5.35	0.21	0.02	0.03	3.22	3.22:1.80:1	194
	PO	11.05	10.41	0.38	0.21	0.02	0.03	0.29	0.29:1.02:1	194
B.Ji	SB	40.40	35.56	4.61	0.18	0.01	0.03	3.23	3.23:1.80:1	165
	PO	9.51	8.96	0.33	0.18	0.01	0.03	0.29	0.29:1.02:1	165
C.Ch	SB	42.09	37.05	4.81	0.19	0.02	0.03	3.22	3.22:1.80:1	173
	PO	9.91	9.33	0.34	0.19	0.02	0.03	0.29	0.29:1.02:1	173
N.Su	SB	47.33	41.66	5.40	0.22	0.02	0.03	3.22	3.24:1.81:1	195
	PO	11.15	10.50	0.39	0.22	0.02	0.03	0.29	0.29:1.02:1	195
P.Jo	SB	32.54	28.65	3.72	0.14	0.01	0.02	3.24	3.24:1.81:1	132
	PO	7.65	7.21	0.26	0.14	0.01	0.02	0.29	0.29:1.02:1	132
S.Pr	SB	51.64	45.46	5.89	0.24	0.02	0.04	3.21	3.21:1.80:1	215
	PO	12.14	11.46	0.42	0.24	0.02	0.04	0.29	0.29:1.02:1	215
Mean	SB	43.48	38.28	4.96	0.20	0.017	0.03	3.22	3.22:1.80:1	179
+			+	+	+	+	+			+
SEM		2.73	2.40	0.31	0.01	0.002	0.002			12
%of total calorie		15.52	13.67	1.77	0.07	0.006	0.01			
Mean	PO	10.24	9.64	0.35	0.20	0.017	0.03	0.29	0.29:1.02:1	179
+			+	+	+	+	+			+
SEM		0.65	0.61	0.02	0.01	0.002	0.002			12
%of total calorie		3.66	3.44	0.12	0.07	0.006	0.01			

Table 8. Fatty acid and cholesterol intakes during SB and PO periods in group II

Subject	Period	Saturated fatty acid					Monounsaturated fatty acids				
		Total	12:0	14:0	16:0	18:0	20:0	Total	16:1	18:1	20:1
$\leftarrow$ g/day $\rightarrow$											
C.Ki	PO	37.36	0.37	1.13	31.53	4.04	0.29	38.21	0.81	37.16	0.23
	SB	14.42		0.31	9.93	4.04	0.14	25.99	0.52	25.24	0.23
C.Pe	PO	41.60	0.41	1.26	35.10	4.50	0.32	42.55	0.91	41.38	0.26
	SB	16.07		0.35	11.06	4.50	0.16	28.29	0.58	28.12	0.26
P.Lo	PO	34.58	0.34	1.05	25.19	3.73	0.27	35.35	0.75	34.39	0.21
	SB	13.26		0.29	9.18	3.73	0.13	24.04	0.48	23.35	0.21
S.Na	PO	28.97	0.29	0.88	24.46	3.12	0.22	29.61	0.63	28.80	0.18
	SB	11.14		0.24	7.67	3.12	0.11	20.11	0.40	19.54	0.18
S.Pa	PO	28.97	0.29	0.88	24.46	3.12	0.22	29.61	0.63	28.80	0.18
	SB	11.14		0.24	7.67	3.12	0.11	20.11	0.40	19.54	0.18
S.Pu	PO	33.16	0.33	1.00	27.99	3.57	0.26	33.89	0.72	32.97	0.20
	SB	12.77		0.28	8.79	3.57	0.12	23.03	0.45	16.44	0.20
Mean	PO	34.11	0.34	1.03	28.12	3.68	0.26	34.87	0.74	33.92	0.21
+		+	+	+	+	+	+	+	+	+	+
SEM		2.00	0.02	0.06	1.79	0.22	0.02	2.05	0.04	2.00	0.01
%of total calorie		12.62	0.12	0.38	10.40	1.36	0.10	12.90	0.27	12.55	0.08
Mean	SB	13.13		0.28	9.05	3.68	0.13	23.70	0.47	22.04	0.21
+		+	+	+	+	+	+	+	+	+	+
SEM		0.78		0.02	0.54	0.22	0.01	1.40	0.07	1.76	0.01
%of total calorie		4.86		0.10	3.35	1.36	0.05	8.77	0.17	8.15	0.08

Table 8. ...continued

Subject	Period	Polyunsaturated fatty acids						P/S	P/M/S	Cholesterol	
		Total	18:2 n-6	18:3 n-3	20:4 n-6	22:5 n-3	22:6 n-3				
		g/day									
----->											
C.Ki	PO	10.94	10.30	0.38	0.21	0.02	0.03	0.29	0.29:1.02:1	192	
	SB	46.40	40.84	5.30	0.21	0.02	0.03	3.22	3.22:1.80:1	192	
C.Pe	PO	12.18	11.46	0.42	0.24	0.02	0.04	0.29	0.29:1.02:1	214	
	SB	51.64	45.45	5.89	0.24	0.02	0.04	3.21	3.21:1.80:1	214	
P.Lo	PO	10.12	9.51	0.35	0.20	0.02	0.03	0.29	0.29:1.02:1	177	
	SB	42.96	37.82	4.90	0.20	0.02	0.03	3.24	3.24:1.81:1	177	
S.Na	PO	8.48	7.98	0.29	0.16	0.01	0.02	0.29	0.29:1.02:1	147	
	SB	36.04	31.72	4.12	0.16	0.01	0.02	3.24	3.24:1.80:1	147	
S.Pa	PO	8.48	7.98	0.29	0.16	0.01	0.02	0.29	0.29:1.02:1	147	
	SB	36.04	31.72	4.12	0.16	0.01	0.02	3.24	3.24:1.80:1	147	
S.Pu	PO	9.70	9.14	0.34	0.19	0.01	0.03	0.29	0.29:1.02:1	169	
	SB	41.21	36.28	4.71	0.19	0.01	0.03	3.23	3.23:1.80:1	169	
Mean	PO	9.98	9.40	0.34	0.19	0.015	0.028	0.29	0.29:1.02:1	174	
+			+	+	+	+	+			+	
SEM		0.59	0.55	0.02	0.012	0.022	0.003			11	
%of total calorie		3.69	3.48	0.12	0.07	0.006	0.01				
Mean	SB	42.38	37.30	4.84	0.19	0.015	0.028	3.23	3.23:1.80:1	174	
+		+	+	+	+	+	+			+	
SEM		2.48	2.18	0.28	0.012	0.022	0.003			11	
%of total calorie		15.68	13.80	1.79	0.07	0.006	0.01				

Anthropometric measurement

There were no significant changes in body weight, BMI and body fat in group I (Table 9). In group II, their body fat at wks 2 of the SB period was significantly higher than that at wks 4 of the W0 period (Table 10).

Hematological status

Tables 11 and 12 shows means $\pm$ SEM of hematological status in groups I and II, respectively. In group I, at wks 4 of the BL period RBC, platelet and total lymphocyte counts were not available. When comparisons were made between wks 4 of the BL period vs wk1 of the soybean period (BL4 VS SB1), BL4 VS SB8, W04 VS P02, W04 VS P08 and SB8 VS P08, significant differences were observed for the following parameters: Hct between SB1 and BL4; Hct, MCV, MCH, and WBC between SB8 and BL4; RBC and platelet counts between SB8 and BL2; Hct, MCV, and MCHC between P02 and W04; MCH between P08 and W04; and MCV, MCH, MCHC and platelet count between P08 and SB8 (Table 11).

In group II when comparisons were made between BL3 VS P01, BL3 VS P08, W04 VS SB2, W04 VS SB8 and P08 VS SB8, there were significant differences in Hct, RBC, MCV, MCH, and MCHC between P01 and BL3, in MCV, MCH, WBC, and total lymphocyte count between P08 and BL3, in Hct between SB8

Table 9. Means±SEM of body weight, body mass index (BMI) and body fat in group I

Period	Body weight		BMI		Body fat		
	Oil	Wk	kg	%std	kg/m ²	kg	% of total body weight
BL	0		66.37±1.52	104.70±2.62	23.1±0.6	14.42±1.11	21.72±1.55
	1		66.18±1.52	104.39±2.45	23.0±0.6	13.00±1.05	19.62±1.66
	2		66.30±1.65	104.54±2.35	23.0±0.5	14.07±1.12	21.18±1.56
	4		66.40±1.59	104.69±2.40	23.1±0.5	13.85±1.13	20.85±1.59
SB	1		66.08±1.45	104.21±2.11	23.0±0.5	13.65±1.04	20.53±1.50
	2		66.32±1.32	104.60±2.16	23.1±0.5	13.95±0.97	21.05±1.42
	4		66.23±1.02	104.37±2.02	23.0±0.5	13.55±1.03	20.45±1.52
	8		66.60±1.14	105.05±1.90	23.2±0.5	13.72±0.95	20.68±1.43
WO	4		66.47±1.46	104.84±2.35	23.1±0.5	13.65±0.94	20.58±1.41
PO	2		66.77±1.47	105.30±2.20	23.2±0.5	13.62±1.00	20.55±1.53
	3		66.75±1.51	105.27±2.31	23.2±0.5	13.67±1.02	20.60±1.51
	4		66.47±1.38	104.84±2.22	23.1±0.5	13.35±1.02	20.15±1.57
	8		66.53±1.35	104.94±2.11	23.1±0.5	13.22±1.09	19.97±1.66
BL4 VS SB1: ns; BL4 VS SB8: ns; WO4 VS PO2: ns; WO4 VS PO8: ns; SB8 VS PO8: ns.							

BL4 VS SB1: ns; BL4 VS SB8: ns; WO4 VS SB8: ns; WO4 VS PO2: ns; WO4 VS PO8: ns; SB8 VS PO8: ns.

Table 10. Means±SEM of body weight, body mass index (BMI) and body fat in group II

Period	Body weight		BMI	Body fat		
Oil	Wk					
		kg	%std	kg/m ²	kg	% of total body weight
BL	0	60.20±1.96	95.56±3.09	21.03±0.68	10.23±1.39	16.83±1.51
	2	60.60±1.99	96.18±3.08	21.13±0.67	10.40±1.23	17.02±1.71
	3	60.17±1.78	95.51±2.88	21.00±0.63	10.37±1.24	17.03±1.69
PO	1	60.37±1.98	95.83±3.16	21.05±0.69	10.52±1.40	17.25±2.02
	2	60.25±1.93	95.63±3.00	21.03±0.66	10.53±1.34	17.30±1.84
	4	60.40±1.95	95.84±2.90	21.08±0.63	10.62±1.20	17.47±1.70
	8	60.22±1.91	95.56±2.84	21.02±0.61	9.93±0.94	16.40±1.19
WO	4	59.35±2.21	94.16±3.27	20.72±0.71	9.62±0.85	16.12±1.02
SB	2	60.32±1.84	95.05±2.80	21.05±0.60	10.02±0.88	16.50±1.09
	3	59.92±1.67	95.09±2.55	20.92±0.55	9.87±0.79	16.37±0.95
	4	59.88±1.74	95.04±2.62	20.90±0.57	10.03±0.86	16.64±1.01
	8	60.07±1.76	95.33±2.66	20.97±0.58	9.97±0.90	16.50±1.12

BL3 VS PO1: ns; BL3 VS PO8: ns; WO4 VS SB2: e; WO4 VS SB8: ns; SB8 VS PO8: ns.

BL3 VS PO1: ns; BL3 VS PO8: ns; WO4 VS SB2: e; WO4 VS SB8: ns; SB8 VS PO8: ns.

Table 11. Means±SEM of hematological status in group I

Period	Hb	Hct	RBC	MCV	MCH	MCHC	WBC	Platelet count	Total lymphocyte count
Oil Wk	g/dL	%	10 ¹² /L	fL	pg	g/L	<----- 10 ⁹ /L ----->		
BL 0	14.6±0.3	46.1±0.9	4.84±0.08	95.3±1.9	30.2±0.6	317.2±4.0	6.82±0.25	234.0±13.3	2.42±0.17
1	14.5±0.3	44.4±0.8	4.71±0.08	94.3±2.2	30.8±0.6	327.7±3.6	6.53±0.28	226.8±9.7	2.09±0.17
2	14.4±0.3	45.5±0.6	4.70±0.09	97.0±1.5	30.7±0.6	316.5±4.1	7.07±0.42	231.0±10.2	1.90±0.20
4	13.7±0.4	41.8±1.1	-	97.1±2.1	30.3±0.6	313.5±5.2	6.95±0.37	-	-
SB 1	14.0±0.2	45.1±0.5	4.61±0.12	98.2±2.3	30.3±0.7	309.0±3.5	6.44±0.56	234.3±11.0	2.11±0.09
2	13.9±0.3	44.3±0.9	4.65±0.08	95.4±2.0	30.0±0.6	314.2±3.8	6.28±0.48	224.3±9.2	1.08±0.14
4	14.4±0.3	45.8±0.6	4.80±0.10	95.7±2.0	30.0±0.6	313.8±3.2	7.22±1.13	247.2±15.2	-
8	14.1±0.4	44.9±0.9	4.86±0.14	92.6±1.7	29.0±0.5	313.5±4.4	5.89±0.50	218.5±9.1	1.90±0.14
WO 4	14.3±0.3	41.3±0.9	4.65±0.09	89.0±1.3	30.7±0.5	345.8±3.8	5.66±0.39	248.7±10.5	1.78±0.14
PO 2	14.3±0.3	44.6±1.1	4.72±0.12	94.4±1.6	30.3±0.3	321.2±3.5	5.84±0.51	233.5±8.0	1.60±0.18
3	14.3±0.4	45.2±1.0	4.75±0.12	95.4±1.9	30.0±0.4	315.2±5.8	6.37±0.40	251.0±14.0	2.00±0.10
4	14.5±0.4	45.3±1.1	4.83±0.16	94.0±1.7	30.0±0.5	318.8±5.9	6.25±0.64	243.0±13.0	1.90±0.10
8	14.7±0.3	42.6±0.6	4.89±0.09	87.3±1.2	30.1±0.4	345.0±4.5	6.16±0.55	242.7±13.9	1.84±0.13

BL3 VS SB8: f*, e*; BL4 VS SB1: f; BL4 VS SB8: a, e, f; WO4 VS PO2: a, e; WO4 VS PO8: c†; SB8 VS PO8: a, c, e, a=P<0.001, c=P<0.005, e=P<0.025, f=P<0.05

Table 12. Means±SEM of hematological status in group II

Period	Hb	Hct	RBC	MCV	MCH	MCHC	WBC	Platelet count	Total lymphocyte count
Oil Wk	g/dL	%	10 ¹² /L	fL	pg	g/L	<----- 10 ⁹ /L ----->		
BL 0	14.2±0.4	46.0±2.5	4.91±0.23	94.3±5.6	29.1±2.1	308.3±6.1	6.33±0.52	241.3±13.1	1.77±0.40 ^e
2	14.2±0.6	47.2±2.7	5.09±0.14	93.3±5.9	28.2±1.5	302.7±4.2	7.16±0.47	230.0±16.1	2.15±0.19
3	14.4±0.6	46.4±2.4	5.12±0.14	90.8±5.4	28.1±1.5	310.5±3.1	6.37±0.46	241.5±10.3	1.91±0.21
PO 1	14.2±0.6	41.3±1.9 ^d	4.75±0.22 ^f	87.9±5.3 ^d	30.1±1.7 ^a	343.2±3.9 ^a	6.18±0.23	231.8±13.4	1.95±0.19
2	13.7±0.9	38.1±3.1	4.72±0.19	80.3±4.9	28.9±1.5	361.2±6.3	6.54±0.39	266.7±25.7	2.11±0.25 ^e
4	14.3±0.6	46.3±2.0	5.30±0.14	87.9±5.0 ^f	27.1±1.6 ^d	308.3±3.2	8.08±0.67 ^d	296.8±27.1	2.19±0.26 ^d
8	14.4±0.7	42.4±2.8	5.00±0.14	93.1±5.9	29.0±1.6	312.2±4.6	7.62±0.41	274.3±22.7	2.57±0.18
WO 4	14.5±0.6	42.6±1.8	5.03±0.16	85.2±4.6	29.0±1.6	340.0±3.2	7.26±0.25	238.8±17.4	2.58±0.25 ^e
SB 2	14.7±0.7	44.1±1.9	5.15±0.12	85.9±4.5	28.8±1.7	334.2±3.6	7.88±0.51	262.2±15.3	2.74±0.11 ^e
3	14.2±0.9 ^e	42.6±2.9	4.87±0.11	87.4±5.2	29.2±1.6 ^e	334.3±4.0 ^e	7.60±1.09	248.3±14.8	2.99±0.29 ^e
4	12.7±1.0 ^e	44.4±2.6 ^{b,e*}	5.11±0.16 ^f	87.2±5.3 ^a	25.5±2.2 ^a	319.2±4.2 ^b	7.32±0.71	238.8±17.6	2.47±0.30 ^e
8	13.9±0.7 ^e	40.3±2.2	4.81±0.13	84.0±5.0	29.0±1.7	345.7±3.6	8.01±0.71	246.5±14.5	2.49±0.16

BL3 VS PO1:a,d,f; BL3 VS PO8:d,f; WO4 VS SB2:ns; WO4 VS SB8:e*; PO8 VS SB8:a,b,e,f.
^eno. of cases = 5
a=P<0.001, b=P<0.0025, d=P<0.01, e=P<0.025, f=P<0.05

and W04 and in Hb, Hct, RBC, MCV and MCHC between SB8 and P08 (Table 12).

Serum apoproteins, lipoproteins and plasma fibrinogen

Tables 13 and 14 shows means($\pm$ SEM) of apoprotein A-I and apoprotein B in groups I and II, respectively. In group I when comparisons were made between BL4 VS SB1, BL4 VS SB8, W04 VS P02, W04 VS P08 and SB8 VS P08, it was found that serum apo B levels at SB1 and SB8 were significantly lower than those at BL4, whereas serum apo A-I and apo B levels at P08 were significantly higher than those at SB8 (Table 13). In group II when comparisons were made between BL3 VS P01, BL3 VS P08, W04 VS SB2, W04 VS SB8 and P08 VS SB8, it was found that serum apo B level at P08 was significantly lower than that of BL3 whereas serum apo A-I and apo B levels at SB8 were significantly lower than those at W04 and P08 (Table 14).

Tables 15 and 16 show means($\pm$ SEM) of serum lipoprotein and plasma fibrinogen levels in groups I and group II, respectively. In group I when comparisons were made between BL4 VS SB1, BL4 VS SB8, W04 VS P02, W04 VS P08 and SB8 VS P08, it was found that serum S-particle level at SB1 and SB8 were significantly lower than those at BL4 whereas serum S-particle at P08 was significantly higher than that at SB8 (Table 15).

Table 13. Means±SEM of apoprotein A-I and B in group I

Period		Mean±SEM	
Oil	Wk	Apo A-I	Apo B
←————— mg/dL —————→			
BL	0	135±10	91.4±18.5
	1	142±4	94.2±15.0
	2	128±5	87.0±13.7
	4	112±4	94.0±13.3
SB	1	104±3	73.5±12.8
	2	101±2	65.6±11.6
	4	102±4	67.6±14.8
	8	111±5	65.8±12.1
WO	4	146±8	94.2±16.1
PO	2	153±11	91.3±15.3
	3	144±6	87.2±15.2
	4	144±4	86.2±10.4
	8	158±7	94.8±15.0

BL4 VS SB1:d; BL4 VS SB8:b; WO4 VS PO2:ns;
 WO4 VS PO8:ns; SB8 VS PO8:a.
 a=P<0.001, e=P<0.0025, d=P<0.01

Table 14. Means $\pm$ SEM of apoprotein A-I and B in group II

Period		Mean $\pm$ SEM	
Oil	Wk	Apo A-I	Apo B
<----- mg/dL ----->			
BL	0	112 $\pm$ 8	92.8 $\pm$ 9.2
	2	146 $\pm$ 8	116.7 $\pm$ 9.7
	3	147 $\pm$ 15	117.2 $\pm$ 9.8
PO	1	140 $\pm$ 12	108.2 $\pm$ 11.9
	2	145 $\pm$ 11	116.0 $\pm$ 7.2
	4	140 $\pm$ 9	112.2 $\pm$ 10.2
	8	128 $\pm$ 8	100.5 $\pm$ 8.8 ^e
WO	4	132 $\pm$ 9	106.0 $\pm$ 11.2
SB	2	132 $\pm$ 7	107.8 $\pm$ 12.9
	3	123 $\pm$ 12	93.0 $\pm$ 10.5
	4	133 $\pm$ 26	73.3 $\pm$ 5.6
	8	107 $\pm$ 8 ^{d,e}	74.3 $\pm$ 6.2 ^f

BL3 VS PO1:ns; BL3 VS PO8:e; WO4 VS SB2:ns;
 WO4 VS SB8:e,f; PO8 VS SB8:d,f.
 d=P<0.01, e=P<0.025, f=P<0.05

Table 15. Means±SEM of serum lipoprotein and plasma fibrinogen levels in group I

Period		Lipoprotein			Fibrinogen
Oil	Wk	L-particle	M-particle	S-particle	
<----- mg/dl ----->					
BL	0	8.7±1.8	78.3±14.0	344.9±30.6	125.3±13.4
	1	8.2±1.7	74.4±9.9	367.6±37.0	147.2±15.6
	2	15.6±4.9	87.6±19.2	361.0±36.0	145.8±17.1
	4	9.6±2.4	91.3±22.5	382.4±32.7	114.5±8.8
SB	1	9.3±3.0	98.8±13.6	312.6±34.7 ^e	118.8±6.5
	2	10.8±3.4	89.5±20.3	264.7±35.0	168.1±12.3
	4	11.4±3.8	166.0±37.3	253.2±25.7	168.8±17.6
	8	5.7±1.1	65.2±23.3	260.6±32.5 ^c	141.5±21.2
	4	9.6±1.1	78.3±15.1	346.2±37.8	176.8±14.8
PO	2	6.6±1.4	87.6±20.4	327.9±27.2	164.9±21.3
	3	9.9±2.7	87.6±25.5	347.4±32.9	145.1±15.5
	4	6.4±2.2	119.3±33.3	311.0±25.3	129.2±21.1
	8	7.5±1.1	93.2±18.7	348.4±24.0 ^c	159.8±14.2

BL4 VS SB1:e; BL4 VS SB8:c; WO4 VS PO2:ns; WO4 VS PO8:ns;
 SB8 VS PO8:c.
 c=P<0.005, e=P<0.025

Table 16. Means±SEM of serum lipoprotein and plasma fibrinogen levels in group II

Period		Lipoprotein			Fibrinogen
Oil	Wk	L-particle	M-particle	S-particle	
←----- mg/dl ----->					
EL	0	34.4±14.4	123.1±38.2	320.2±28.6	234.0±23.7
	2	11.1±4.3	167.9±69.2	344.8±25.8	246.6±13.8
	3	13.2±4.4	106.3±25.3	388.3±12.6	297.0±14.9
PO	1	7.0±1.0	100.7±22.1	350.7±22.9	290.5±8.9
	2	11.4±2.5	119.3±33.8	358.6±19.7	200.9±3.5
	4	11.6±2.2	130.5±22.5	358.0±9.2	223.2±11.0
	8	23.6±11.0	106.3±33.4	350.0±15.8 ^e	180.7±5.2 ^a
WO	4	11.3±4.7	116.7±16.5	328.5±17.3	210.2±22.6
SB	2	8.7±1.4	100.7±10.6	344.2±16.8	182.7±17.9
	3	10.2±1.3	104.4±29.5	324.7±24.7	171.4±14.5
	4	10.8±4.2	82.0±6.3	311.3±13.6	274.0±8.3
	8	7.4±1.0	65.2±16.9 ^c	322.2±10.0 ^e	220.7±15.3 ^e

BL3 VS PO1:ns; BL3 VS PO8:a,e; WO4 VS SB2:ns; WO4 VS SB8:c;
 PO8 VS SB8:e.
 a=P<0.001, c=P<0.005, e=P<0.025

In group II, when comparisons were made between BL3 VS P01, BL3 VS P08, W04 VS SB2, W04 VS SB8 and P08 VS SB8, it was found that serum S-particle level at P08 was significantly lower than that at BL3, serum M-particle level at SB8 was significantly lower than that at W04, and serum S-particle level at SB8 was significantly lower than that at P08 (Table 16).

Tables 17-19 show serum TC, LDL-C, HDL-C, TG levels and TC/HDL-C and LDL-C/HDL-C ratios in each subject of group I whereas Tables 21-23 show these parameters in each subject of group II. Tables 20 and 24 show the means($\pm$ SEM) of these parameters in groups I and II, respectively. In group I, when comparisons were made between BL4 VS SB1, BL4 VS SB8, W04 VS P02, W04 VS P08 and SB8 VS P08, it was found that: serum TC and LDL-C levels and TC/HDL-C and LDL-C/HDL-C ratios at SB1 were significantly lower than those at BL4 and at SB8, serum HDL-C level at P02 was significantly lower than that at W04, and serum TC, LDL-C, HDL-C levels at P08 were significantly higher than those at SB8.

In group II, when comparisons were made between BL3 VS P01, BL3 VS P08, W04 VS SB2, W04 VS SB8 and P08 VS SB8, it was found that serum TC level at P08 was significantly lower than that at BL3, serum HDL-C and TG levels at SB2 were significantly lower than those at W04 but opposite result was observed for serum TC/HDL-C ratio.

Table 17. Serum lipid levels in A.Ko and B.Ji

Subject	Period		TC	LDL-C	HDL-C	TG	TC	LDL-C
	Oil	Wk					HDL-C	HDL-C
<----- mmol/L ----->								
A.Ko	BL	0	4.08	2.33	1.20	1.19	3.40	1.95
		1	4.40	2.48	1.52	0.88	2.90	1.64
		2	4.31	2.67	1.29	0.76	3.34	2.07
		4	4.55	2.62	1.57	0.80	2.90	1.67
	SB	1	3.61	1.75	1.47	0.85	2.45	1.19
		2	3.06	1.41	1.17	1.06	2.62	1.21
		4	3.56	2.02	1.02	1.13	3.50	1.99
		8	2.44	1.04	1.08	0.70	2.26	0.96
	WO	4	4.29	2.39	1.64	0.57	2.61	1.45
	PO	2	3.91	1.99	1.55	0.80	2.52	1.28
		3	4.09	2.07	1.65	0.59	2.34	1.18
		4	3.67	1.54	1.89	0.52	1.94	0.81
		8	4.16	2.22	1.68	0.57	2.48	1.32
B.Ji	BL	0	3.85	1.75	1.44	1.43	2.67	1.21
		1	3.85	1.99	1.42	0.96	2.71	1.40
		2	3.88	2.38	1.20	0.65	3.24	1.99
		4	4.15	2.43	1.31	0.89	3.17	1.86
	SB	1	3.74	1.86	1.67	0.45	2.24	1.12
		2	2.90	1.16	1.46	0.61	1.99	0.80
		4	2.95	1.67	1.00	0.62	2.96	1.68
		8	3.27	1.43	1.52	0.70	2.15	0.94
	WO	4	3.73	1.79	1.63	0.69	2.29	1.10
	PO	2	3.46	1.51	1.66	0.62	2.08	0.90
		3	3.72	1.51	1.90	0.68	1.95	0.79
		4	3.77	1.64	1.91	0.48	1.98	0.86
		8	4.10	2.14	1.70	0.56	2.41	1.26

Table 18. Serum lipid levels in C.Ch and N.Su

Subject	Period		TC	LDL-C	HDL-C	TG	TC	LDL-C
	Oil	Wk					HDL-C	HDL-C
<----- mmol/L ----->								
C.Ch	BL	0	3.59	1.94	1.25	0.86	2.86	1.55
		1	3.66	2.12	1.23	0.66	2.97	1.73
		2	3.54	1.89	1.29	0.79	2.74	1.46
		4	3.63	1.88	1.25	1.08	2.90	1.51
	SB	1	2.96	1.29	1.31	0.78	2.26	0.98
		2	2.73	1.08	1.38	0.58	1.98	0.78
		4	3.06	1.46	1.34	0.56	2.29	1.07
		8	2.48	0.91	1.26	0.68	1.97	0.72
	WO	4	3.34	1.56	1.40	0.81	2.38	1.11
	PO	2	3.71	2.04	1.34	0.70	2.76	1.52
		3	3.51	1.80	1.47	0.51	2.39	1.23
		4	3.62	1.54	1.57	1.10	2.30	0.98
		8	3.93	2.08	1.34	1.12	2.93	1.55
N.Su	BL	0	4.43	2.87	1.17	0.85	3.79	2.46
		1	4.62	2.88	1.09	1.42	4.24	2.65
		2	4.72	2.98	1.09	1.40	4.33	2.74
		4	5.25	3.44	1.10	1.55	4.79	3.14
	SB	1	4.08	2.35	1.14	1.28	3.56	2.05
		2	3.18	1.58	1.11	1.07	2.85	1.41
		4	2.70	1.12	1.24	0.73	2.17	0.90
		8	3.29	1.84	0.92	1.13	3.56	2.00
	WO	4	4.68	2.96	1.28	0.97	3.80	2.31
	PO	2	4.29	2.54	1.13	1.37	3.80	2.24
		3	4.52	2.73	1.42	0.80	3.18	1.92
		4	4.10	2.09	1.32	1.50	3.11	1.59
		8	4.48	2.63	1.08	1.66	4.12	2.42

Table 19. Serum lipid levels in P.Jo and S.Pr

Subject	Period		TC	LDL-C	HDL-C	TG	TC	LDL-C
	Oil	Wk					HDL-C	HDL-C
<----- mmol/L ----->								
P.Jo	BL	0	6.07	4.49	1.24	0.75	4.90	3.63
		1	6.43	4.94	1.13	0.78	5.68	4.36
		2	6.35	4.83	1.29	0.51	4.92	3.74
		4	5.92	4.41	1.16	0.76	5.10	3.80
	SB	1	5.95	4.11	1.59	0.53	3.73	2.58
		2	5.54	3.79	1.51	0.54	3.67	2.50
		4	4.75	3.11	1.32	0.70	3.61	2.36
		8	5.03	3.56	1.22	0.52	4.11	2.92
	WO	4	6.73	4.65	1.74	0.74	3.86	2.66
	PO	2	5.62	3.76	1.58	0.60	3.55	2.38
		3	6.15	4.28	1.70	0.38	3.63	2.52
		4	5.60	3.73	1.63	0.52	3.44	2.29
		8	5.92	4.12	1.54	0.57	3.85	2.68
S.Pr	BL	0	5.35	3.78	0.91	1.44	5.86	4.14
		1	6.03	4.32	1.15	1.22	5.23	3.74
		2	5.89	4.26	1.06	1.25	5.56	4.02
		4	6.57	4.76	1.22	1.27	5.39	3.91
	SB	1	4.92	3.19	1.08	1.42	4.55	2.95
		2	4.20	2.40	1.11	1.48	3.77	2.16
		4	4.79	2.90	1.19	1.53	4.02	2.43
		8	4.43	2.88	0.77	1.70	5.77	3.76
	WO	4	4.68	3.02	1.10	1.24	4.27	2.75
	PO	2	5.26	3.67	1.05	1.18	5.02	3.50
		3	5.69	3.78	1.22	1.50	4.66	3.09
		4	4.68	2.68	1.34	1.44	3.50	2.00
		8	5.24	3.35	1.19	1.54	4.42	2.82

Table 20. Means±SEM of serum lipids in group I

Period	Oil Wk	mmol/L					TC		LDL-C	
		TC	LDL-C	HDL-C	TG	HDL-C	LDL-C			
BL	0	4.56±0.39	2.86±0.44	1.20±0.07	1.14±0.12	3.91±0.51		2.49±0.48		
	1	4.83±0.47	3.12±0.50	1.26±0.07	0.93±0.08	3.96±0.53		2.59±0.50		
	2	4.78±0.46	3.17±0.46	1.20±0.04	0.84±0.11	4.02±0.45		2.67±0.42		
	4	5.01±0.45	3.26±0.47	1.27±0.07	0.98±0.08	4.04±0.48		2.65±0.45		
SB	1	4.21±0.44 ^e	2.43±0.43 ^d	1.38±0.10	0.86±0.15	3.13±0.39 ^b		1.81±0.34 ^b		
	2	3.60±0.44	1.90±0.42	1.29±0.07	0.90±0.16	2.81±0.32		1.48±0.29		
	4	3.63±0.38 ^b	2.05±0.33 ^b	1.18±0.06	0.96±0.16	3.09±0.31 ^c		1.74±0.26 ^c		
	8	3.49±0.43	1.94±0.43	1.13±0.01	0.89±0.17	3.30±0.60		1.88±0.51		
WO	4	4.58±0.48	2.73±0.45	1.47±0.10	0.89±0.12	3.18±0.35		1.90±0.31		
PO	2	4.37±0.36	2.58±0.38	1.39±0.10 ^f	0.84±0.10	3.29±0.43		1.97±0.38		
	3	4.61±0.44	2.70±0.46	1.56±0.10	0.85±0.20	2.02±0.41		1.79±0.36		
	4	4.24±0.32 ^b	2.20±0.35 ^b	1.61±0.10 ^e	0.90±0.18	2.71±0.30		1.42±0.26		
	8	4.64±0.32	2.76±0.33	1.42±0.10	0.91±0.17	3.37±0.36		2.01±0.29		

BL4 VS SB1:b,d,e; BL4 VS SB8:b,c; WO4 VS PO2:f; WO4 VS PO8:ns; SB8 VS PO8:b,e.

b=P<0.0025, c=P<0.005, d=P<0.01, e=P<0.025, f=P<0.05

Table 21. Serum lipid levels in C.Ki and C.Pe

Subject	Period		TC	LDL-C	HDL-C	TG	TC	LDL-C	
	Oil	Wk					HDL-C	HDL-C	
<----- mmol/L ----->									
C.Ki	BL	0	4.17	2.40	1.05	1.57	3.96	2.27	
		2	4.78	2.42	1.10	2.74	4.35	2.20	
		3	5.38	3.08	1.22	2.35	4.40	2.52	
	PO	1	4.04	2.20	1.17	1.46	3.44	1.87	
		2	4.58	1.77	1.56	2.74	2.94	1.13	
		4	4.53	2.14	1.39	2.20	3.27	1.54	
		8	4.59	2.27	1.02	2.84	4.49	2.22	
	WO	4	4.13	1.27	1.43	-	2.89	0.89	
	SB	2	5.08	3.57	1.06	0.97	4.77	3.35	
		3	4.09	2.47	1.03	1.31	3.99	2.40	
		4	4.17	2.59	1.12	1.00	3.72	2.32	
		8	4.00	2.62	0.85	1.14	4.71	3.09	
	C.Pe	BL	0	5.27	2.80	1.83	1.40	2.88	1.52
			2	5.99	4.08	1.53	0.84	3.92	2.67
			3	5.27	3.20	1.66	0.87	3.17	1.93
		PO	1	5.71	3.87	1.45	0.85	3.94	2.67
2			5.57	3.76	1.46	0.75	3.80	2.57	
4			4.92	2.63	1.65	1.40	2.99	1.60	
8			5.08	3.37	1.41	0.64	3.60	2.39	
WO		4	4.44	2.32	1.36	1.65	3.26	1.70	
SB		2	5.49	3.78	1.21	1.10	4.55	3.13	
		3	5.86	3.91	1.60	0.76	3.67	2.45	
		4	4.87	3.06	1.43	0.85	3.42	2.14	
		8	4.87	3.02	1.18	1.48	4.14	2.56	

Table 22. Serum lipid levels in P.Lo and S.Na

Subject	Period		TC	LDL-C	HDL-C	TG	TC	LDL-C
	Oil	Wk					HDL-C	HDL-C
<----- mmol/L ----->								
P.Lo	BL	0	5.43	3.76	0.93	1.60	5.84	4.05
		2	4.60	2.94	0.84	1.78	5.45	3.48
		3	5.82	4.45	0.88	1.08	6.62	5.06
	PO	1	4.97	3.51	0.84	1.35	5.90	4.17
		2	4.67	3.40	0.81	0.99	5.74	4.18
		4	5.20	3.42	1.07	1.53	4.87	3.21
		8	5.31	3.92	0.85	1.19	6.25	4.61
	WO	4	5.27	3.76	1.04	1.01	5.06	3.61
	SB	2	4.12	2.96	0.75	0.91	5.52	1.42
		3	4.14	2.94	0.77	0.94	5.39	3.82
		4	4.46	3.34	0.74	0.82	6.01	4.50
		8	4.40	3.36	0.79	0.53	5.58	4.27
S.Na	BL	0	3.58	2.02	0.99	1.25	3.62	2.04
		2	4.51	2.91	0.99	1.33	4.56	2.94
		3	4.73	3.15	1.10	1.02	4.28	2.86
	PO	1	4.90	3.21	1.18	1.11	4.15	2.72
		2	5.24	3.57	1.32	0.78	3.98	2.71
		4	4.86	3.14	1.26	1.02	3.85	2.48
		8	4.43	2.82	1.26	0.76	3.51	2.23
	WO	4	4.00	2.44	1.10	1.01	3.64	2.22
	SB	2	4.20	2.96	0.98	0.56	4.28	2.30
		3	3.91	2.48	1.14	0.62	3.43	2.18
		4	3.77	2.26	1.16	0.77	3.26	1.95
		8	4.00	2.63	1.11	0.56	3.59	2.36

Table 23. Serum lipid levels in S.Pa and S.Pu

Subject	Period		TC	LDL-C	HDL-C	TG	TC	LDL-C
	Oil	Wk					HDL-C	HDL-C
<----- mmol/L ----->								
S.Pa	BL	0	4.25	2.36	1.53	0.78	2.77	1.54
		2	4.79	3.09	1.36	0.74	3.53	2.27
		3	5.01	3.12	1.56	0.72	3.22	2.01
	FO	1	4.40	2.51	1.59	0.65	2.77	1.53
		2	4.60	2.62	1.66	0.69	2.78	1.59
		4	4.50	2.50	1.71	0.64	2.63	1.46
		8	4.68	2.95	1.40	0.72	3.34	2.11
	WO	4	4.30	2.18	1.32	1.77	3.27	1.66
	SB	2	4.34	2.83	1.23	0.60	3.52	2.08
		3	3.92	2.39	1.26	0.60	3.11	1.90
		4	3.89	2.33	1.19	0.79	3.26	1.96
		8	4.24	2.60	1.36	0.62	3.11	1.90
S.Pu	BL	0	3.46	1.76	1.03	1.47	3.36	1.70
		2	3.93	2.11	1.37	0.96	2.86	1.54
		3	4.76	2.32	2.12	0.69	2.24	1.09
	PO	1	4.07	2.12	1.58	0.82	2.58	1.34
		2	4.29	2.04	1.37	1.92	3.13	1.49
		4	5.04	2.84	1.46	1.61	3.45	1.94
		8	4.05	2.39	1.27	0.84	3.18	1.88
	WO	4	4.22	2.45	1.24	1.15	3.40	1.97
	SB	2	4.40	3.00	1.13	0.60	3.89	2.19
		3	4.31	2.47	1.30	1.19	3.32	1.90
		4	3.89	2.33	1.90	0.79	3.26	1.96
		8	3.98	2.47	1.27	0.53	3.14	1.94

Table 24. Means±SEM of serum lipids in group II

Period Oil Wk	mmol/L					
	TC	LDL-C	HDL-C	TG	TC HDL-C	LDL-C HDL-C
BL	0	4.36±0.34	2.52±0.29	1.34±0.12	3.74±0.46	2.19±0.39
	2	4.77±0.28	2.93±0.28	1.40±0.31	4.11±0.36	2.52±0.27
	3	5.16±0.17	3.22±0.28	1.12±0.25	3.99±0.62	2.58±0.55
PO	1	4.68±0.26	2.90±0.30	1.04±0.13	3.80±0.49	2.39±0.42
	2	4.82±0.20	2.86±0.19	1.31±0.34	3.73±0.45	2.28±0.46
	4	4.84±0.11	2.78±0.19	1.40±0.22	3.51±0.32	2.04±0.28
	8	4.69±0.18 ^d	2.95±0.25	1.16±0.34	4.06±0.48	2.57±0.41
WO	4	4.39±0.19	2.40±0.32	1.32±0.16	3.59±0.31	2.01±0.37
SB	2	4.60±0.22	3.18±0.16	0.79±0.09 ^f	4.42±0.29 ^e	2.41±0.29
	3	4.37±0.30	2.78±0.24	0.90±0.12	3.82±0.34	2.44±0.29
	4	4.17±0.17	2.65±0.18	0.84±0.03	3.82±0.44	2.47±0.41
	8	4.25±0.14 ^e	2.78±0.14	0.81±0.16 ^{e*}	4.04±0.40	2.69±0.36

BL3 VS PO1:ns; BL3 VS PO8:d; WO4 VS SB2:e,f; WO4 VS SB8:e*; PO8 VS SB8:e.
d=P<0.01, e=P<0.025, f=P<0.05

Serum TG level at SB8 was significantly lower than that at W04 and serum TC and TG levels at SB8 was significantly lower than those at P08.

Fatty acid composition of total serum lipids

Tables 25-30 show the relative EFA composition of total serum lipids in each subject of group I whereas Tables 31-36 show their relative NEFA composition of total serum lipids. The means($\pm$ SEM) of these parameters in group I are shown in Tables 37 and 38. For EFA composition, when comparisons were made between BL4 VS SB1, BL4 VS SB8, W04 VS P02, W04 VS P08 and SB8 VS P08, it was found that serum 18:2 n-6 and 18:3 n-3 levels of SB1 were significantly higher than those at BL4, serum 18:2 n-6, 18:3 n-3 levels and 20:3 n-9/20:4 n-6 ratio at SB8 were significantly higher than those at BL4, but the opposite result was observed for serum 20:4 n-6 level, serum 18:2 n-6 level at P08 was significantly higher than that at W04, and serum 18:3 n-3 level at P08 was significantly lower than that at SB8 but opposite result was observed for serum 22:6 n-3 level. For NEFA composition, it was found that serum 16:0 level at SB1 was significantly lower than that at BL4, serum 16:0 and 20:0 levels at SB8 were significantly lower than those at BL4 but opposite results were observed for serum 20:1 and 20:3 n-9 levels, serum 18:1 level at P02 was significantly higher than that at

W04, serum 18:0 level at P08 was significantly lower than those at W04 and SB8 but serum 20:0 level at P08 was significantly higher than that at SB8.

Tables 39-44 show the relative EFA composition of total serum lipids in each subject of group II whereas Tables 45-50 show their relative NEFA composition of total serum lipids. The means($\pm$ SEM) of these parameters in Group II are shown in Tables 51 and 52. For EFA composition, when comparisons were made between BL3 VS P01, BL3 VS P08, W04 VS SB2, W04 VS SB8 and P08 VS SB8, it was found that serum 18:3 n-3, and 20:5 n-3 levels at SB2 were significantly higher than those at W04, serum 20:4 n-6, 20:5 n-3 and 22:6 n-3 levels at SB8 were significantly higher than those at W04 and serum 20:4 n-6 and 20:5 n-3 levels were significantly higher than those at P08. For NEFA composition, serum 14:0 level at P01 was significantly lower than that at BL3, serum 18:0 level at P08 was significantly lower than that at BL3 but opposite result was observed for serum 18:1 level, serum 14:0, 16:1, and 18:1 at SB8 were significantly lower than those at W04, and serum 14:0, 16:1 and 18:1 levels at SB8 were significantly lower than those at P08 but opposite result was observed for serum 18:0.

Fatty acid composition of total erythrocyte lipids

Tables 53-58 show the relative EFA composition of total erythrocyte lipids in each subject of group I whereas Tables 59-64 show their relative NEFA Composition of total erythrocyte lipids. The means($\pm$ SEM) of these parameters in group I are shown on Tables 65 and 66. For EFA Composition, when comparisons were made between BL4 VS SB1, BL4 VS SB8, W04 VS P02, W04 VS P08, AND SB8 VS P08, it was found that erythrocyte 18:2 n-6 and 22:6 n-3 levels at SB1 were significantly higher than those at BL4 but opposite result was observed for erythrocyte 20:3 n-9/20:4 n-6 ratio, erythrocyte 18:2 n-6 level at SB8 was significantly higher than that at BL4, erythrocyte 18:2 n-6 and 20:5 n-3 levels at P02 were significantly lower than those at W04 but opposite result was observed for erythrocyte 22:5 n-3 level erythrocyte 18:2 n-6 level at P08 was significantly lower than that at W04 but opposite result was observed for erythrocyte 18:2 n-6 and 18:3 n-3 levels were significantly lower than those at SB8 but opposite results were observed for erythrocyte 20:3 n-6 and 22:6 n-3 levels. For NEFA composition, it was found that erythrocyte 14:0, 16:0, 18:1 and 20:3 n-9 levels at SB1 were significantly lower than those at BL4, erythrocyte 14:0 at P02 was significantly lower than that at W04 but opposite result

was observed for erythrocyte 20:1 level, erythrocyte 18:0 at P08 was significantly lower than that at W04.

Tables 67-72 show the relative EFA of total erythrocyte lipids in each subject of group II whereas Tables 73-78 show their relative NEFA compositions of total erythrocyte lipids. The means($\pm$ SEM) of these parameters are shown in Tables 79 and 80. For EFA compositions, when comparisons were made between BL3 VS P01, BL3 VS P08, W04 VS SB2, W04 VS SB8 and P08 VS SB8, it was found that erythrocyte 20:4 n-6 level at P01 was significantly lower than that at BL3 but opposite result was observed for erythrocyte 22:6 n-3 level, erythrocyte 18:2 n-6, 20:4 n-6, and 20:5 n-3 at P08 were significantly lower than those at BL3, erythrocyte 18:2 n-6 level SB2 was significantly higher than that at W04, erythrocyte 18:2 n-6 and 20:3 n-6 levels at SB8 were significantly higher than those at W04 but opposite result was observed for erythrocyte 22:6 n-3 level, erythrocyte 18:2 n-6, and 20:4 n-6 at SB8 were significantly higher than those at P08. For NEFA composition, it was found that erythrocyte 14:0 and 18:0 levels at P01 and at P08 were significantly lower than those at BL3, erythrocyte 16:0 and 18:1 levels at SB2 were significantly lower than those at W04, erythrocyte 18:0 level at SB8 was significantly higher than that at W04 but opposite result was observed for erythrocyte 18:1 level, and erythrocyte 14:0 and 18:0

Table 25. Relative EFA composition of total serum lipids in A.Ko

Period		Fatty acid									
Oil	Wk	18:2 n-6	20:3 n-6	20:4 n-6	18:3 n-3	20:5 n-3	22:5 n-3	22:6 n-3	20:3 n-9	20:4 n-6	
<----- % of total fatty acids ----->											
BL	0	22.66	1.76	8.92	2.10	0.62	0.47	5.63	0.028		
	1	23.47	1.66	8.67	2.05	0.76	0.69	5.54	0.038		
	2	24.49	1.86	9.40	1.90	0.80	0.66	5.07	0.031		
	4	24.24	2.21	8.69	2.34	0.94	0.57	3.82	0.029		
SB	1	28.52	2.35	9.82	2.46	0.74	0.55	5.22	0.038		
	2	27.86	2.33	9.41	2.50	0.94	0.41	5.05	0.048		
	4	25.79	2.41	9.70	2.48	0.73	0.57	4.52	0.039		
	8	25.19	2.22	10.11	2.63	0.71	0.50	4.62	0.028		
WO	4	20.24	1.26	10.60	2.20	1.16	0.71	6.34	0.026		
PO	2	24.56	1.96	9.77	2.03	0.69	0.72	5.02	0.030		
	3	21.39	1.87	8.00	2.20	0.75	0.51	4.88	0.031		
	4	23.96	1.50	9.11	2.17	0.76	0.58	5.00	0.026		
	8	23.27	1.82	10.55	1.99	1.48	0.67	5.06	0.025		

Table 28. Relative EFA composition of total serum lipids in N.Su

Period		Fatty acid								
Oil	Wk	18:2 n-6	20:3 n-6	20:4 n-6	18:3 n-3	20:5 n-3	22:5 n-3	22:6 n-3	20:3 n-9	20:4 n-6
<----- % of total fatty acids ----->										
BL	0	20.17	1.65	10.80	2.04	1.27	0.97	6.36	0.044	0.044
	1	21.77	1.53	10.83	1.73	1.41	0.75	6.08	0.044	0.044
	2	23.24	1.37	10.91	1.89	1.40	0.59	5.70	0.033	0.033
	4	21.84	1.16	10.92	1.86	1.29	0.79	6.85	0.036	0.036
SB	1	25.05	1.13	9.30	2.28	1.11	0.68	5.05	0.043	0.043
	2	24.99	1.16	8.19	2.12	0.97	0.80	6.22	0.049	0.049
	4	21.49	2.28	10.03	2.19	0.97	0.53	5.58	0.043	0.043
	8	24.66	1.42	8.50	2.10	0.95	0.71	5.55	0.051	0.051
WO	4	22.26	1.64	10.77	1.55	1.40	0.80	5.99	0.041	0.041
PO	2	23.06	1.83	9.50	1.77	1.24	0.72	5.52	0.049	0.049
	3	21.88	1.63	10.70	2.02	1.31	0.72	6.16	0.029	0.029
	4	22.12	2.02	9.43	2.14	1.21	0.85	5.92	0.041	0.041
	8	24.27	1.83	9.69	1.70	1.20	0.85	5.72	0.043	0.043

<----- % of total fatty acids ----->

Table 29. Relative EFA composition of total serum lipids in P.Jo

Period		Fatty acid									
Oil	Wk	18:2 n-6	20:3 n-6	20:4 n-6	18:3 n-3	20:5 n-3	22:5 n-3	22:6 n-3	20:3 n-9	20:4 n-6	
BL	0	22.83	0.98	9.69	2.22	1.00	0.50	5.30	0.021		
	1	24.69	1.13	9.32	1.76	0.92	0.55	5.89	0.038		
	2	21.28	0.96	11.17	1.88	1.38	0.54	5.12	0.030		
	4	22.56	0.65	10.76	2.08	0.87	0.40	5.58	0.020		
SB	1	26.61	1.10	8.84	2.57	0.72	0.41	4.48	0.033		
	2	24.79	0.75	8.07	2.27	0.59	0.44	4.90	0.031		
	4	26.80	1.23	7.08	2.38	0.58	0.33	3.99	0.045		
	8	24.39	1.27	8.39	2.35	0.68	0.77	5.06	0.045		
WO	4	22.50	1.54	10.23	1.63	1.22	0.91	5.10	0.044		
PO	2	21.46	1.20	11.36	2.31	1.14	0.88	5.74	0.025		
	3	22.79	1.24	8.45	2.14	0.79	0.79	5.20	0.033		
	4	23.02	1.03	7.95	2.03	0.61	0.67	5.20	0.034		
	8	22.54	1.07	8.23	1.88	0.66	0.72	5.40	0.034		

Table 30. Relative EFA composition of total serum lipids in S.Pr

Period		Fatty acid									
Oil	Wk	18:2 n-6	20:3 n-6	20:4 n-6	18:3 n-3	20:5 n-3	22:5 n-3	22:6 n-3	20:3 n-9	20:4 n-6	
								</			

<----- % of total fatty acids ----->

Table 31. Relative NEFA composition of total serum lipids in A.Ko

Period		Fatty acid							
Oil	Wk	14:0	16:0	18:0	20:0	16:1	18:1	20:1	20:3 n-9
		< % of total fatty acids >							
BL	0	0.66	28.12	11.83	0.30	1.14	12.06	0.30	0.25
	1	0.68	26.54	12.04	0.42	1.06	12.06	0.17	0.33
	2	0.38	27.49	11.34	0.31	0.68	11.23	0.12	0.29
	4	0.32	27.51	11.49	0.33	0.91	12.69	0.11	0.25
SB	1	0.38	23.55	12.26	0.46	0.65	9.67	0.17	0.37
	2	0.44	24.53	13.52	0.38	0.54	7.55	0.23	0.45
	4	0.62	25.91	13.35	0.28	0.81	7.75	0.14	0.38
	8	0.42	26.52	12.72	0.28	1.01	9.85	0.14	0.28
WO	4	0.41	26.93	10.66	0.32	1.10	11.70	0.20	0.28
PO	2	0.94	27.80	10.58	0.41	0.99	11.74	0.18	0.29
	3	0.45	29.04	11.46	0.44	1.27	13.71	0.16	0.25
	4	0.48	28.14	9.11	0.47	1.34	12.70	0.18	0.24
	8	0.70	28.13	10.93	0.39	0.78	9.23	0.20	0.26

Table 33. Relative NEFA composition of total serum lipids in C.Ch

Period		Fatty acid							
Oil	Wk	14:0	16:0	18:0	20:0	16:1	18:1	20:1	20:3 n-9
< ----- % of total fatty acids ----- >									
BL	0	0.56	26.65	12.40	0.40	0.73	14.06	0.15	0.27
	1	1.15	29.78	13.65	0.39	0.73	9.73	0.17	0.38
	2	0.48	26.26	13.17	0.38	0.76	9.62	0.11	0.26
	4	0.59	28.76	13.25	0.35	0.97	12.31	0.11	0.24
SB	1	0.54	24.75	12.28	0.37	0.94	10.31	0.16	0.38
	2	0.48	25.40	12.80	0.32	0.85	9.95	0.18	0.45
	4	0.57	25.60	13.94	0.34	0.74	9.42	0.18	0.46
	8	0.45	26.00	12.94	0.30	0.76	10.12	0.17	0.33
WO	4	0.55	27.31	12.63	0.42	0.77	10.23	0.23	0.36
PO	2	0.56	28.98	10.58	0.40	1.31	14.50	0.15	0.40
	3	0.61	28.92	10.65	0.28	0.90	15.18	0.14	0.31
	4	0.70	28.60	9.95	0.31	1.53	15.45	0.16	0.33
	8	0.48	29.85	11.12	0.42	1.40	13.21	0.17	0.38

Table 34. Relative NEFA composition of total serum lipids in N.Su

Period		Fatty acid							
Oil	Wk	14:0	16:0	18:0	20:0	16:1	18:1	20:1	20:3 n-9
< ----- % of total fatty acids ----- >									
BL	0	0.70	24.26	12.04	0.41	0.83	12.01	0.24	0.47
	1	0.73	25.53	12.82	0.44	0.63	10.11	0.22	0.48
	2	0.74	24.86	11.88	0.27	0.74	11.62	0.22	0.36
	4	0.33	26.36	13.37	0.28	0.47	9.46	0.14	0.39
SB	1	0.43	25.37	13.05	0.43	0.78	10.33	0.21	0.40
	2	0.53	25.79	13.15	0.38	0.81	9.80	0.18	0.40
	4	0.35	26.93	14.38	0.27	0.50	8.57	0.13	0.43
	8	0.57	26.84	12.27	0.28	0.98	10.30	0.22	0.47
WO	4	0.66	26.00	12.10	0.31	0.64	10.37	0.22	0.44
PO	2	0.58	25.87	11.67	0.40	0.76	11.39	0.21	0.47
	3	0.40	26.27	12.77	0.45	0.63	10.41	0.18	0.31
	4	0.36	25.54	12.37	0.33	0.66	11.66	0.18	0.39
	8	0.43	25.74	11.31	0.38	0.88	10.88	0.23	0.42

Table 35. Relative NEFA composition of total serum lipids in P.Jo

Period		Fatty acid								
Oil	Wk	14:0	16:0	18:0	20:0	16:1	18:1	20:1	20:3 n-9	
<----- % of total fatty acids ----->										
BL	0	0.42	26.60	10.52	0.49	0.79	13.24	0.12	0.20	
	1	0.38	25.71	10.80	0.43	0.89	12.56	0.19	0.35	
	2	0.47	27.68	10.95	0.51	0.93	11.89	0.15	0.34	
	4	0.42	29.35	10.96	0.39	0.62	9.76	0.08	0.21	
SB	1	0.47	25.93	11.34	0.39	1.12	11.14	0.20	0.29	
	2	0.55	28.25	10.78	0.41	1.17	12.65	0.11	0.25	
	4	0.45	28.86	11.72	0.50	0.98	9.95	0.21	0.32	
	8	0.42	28.79	10.03	0.38	0.89	11.57	0.22	0.38	
WO	4	0.63	27.35	12.40	0.52	0.56	9.29	0.17	0.45	
PO	2	0.34	27.96	9.41	0.51	0.90	13.63	0.25	0.28	
	3	0.32	28.47	9.12	0.50	0.89	13.39	0.24	0.28	
	4	0.36	28.94	9.28	0.45	0.83	13.84	0.21	0.27	
	8	0.43	28.96	9.06	0.54	1.12	14.74	0.19	0.28	

Table 36. Relative NEFA composition of total serum lipids in S.Pr

Period		Fatty acid							
Oil	Wk	14:0	16:0	18:0	20:0	16:1	18:1	20:1	20:3 n-9
< ----- % of total fatty acids ----- >									
BL	0	0.62	29.26	13.03	0.44	0.92	11.21	0.14	0.43
	1	0.80	28.37	13.30	0.41	0.90	12.15	0.16	0.44
	2	0.53	25.49	11.85	0.38	0.88	12.13	0.11	0.30
	4	0.54	28.67	13.58	0.42	0.83	10.69	0.18	0.45
SB	1	0.67	27.40	11.78	0.50	1.05	10.83	0	0.44
	2	0.50	24.70	12.98	0.34	0.74	10.64	0.16	0.48
	4	0.57	25.47	12.94	0.43	0.83	9.97	0.22	0.40
	8	0.37	24.73	14.38	0.29	0.48	8.05	0.20	0.47
WO	4	0.48	30.08	12.18	0.52	0.95	10.78	0.17	0.39
PO	2	0.52	29.05	12.16	0.52	0.94	12.69	0.17	0.43
	3	0.48	30.43	10.85	0.46	0.97	14.58	0.21	0.36
	4	0.57	28.19	10.58	0.35	1.21	15.13	0.15	0.34
	8	0.52	27.41	10.76	0.43	1.09	12.43	0.16	0.36

Table 37. Relative EFA composition of total serum lipids in group I

Period	Mean±SEM									
	Oil	18:2 n-6	20:3 n-6	20:4 n-6	18:3 n-3	20:5 n-3	22:5 n-3	22:6 n-3	20:3 n-9	20:4 n-6
← % of total fatty acids →										
BL	0	20.97±0.81	1.57±0.14	9.35±0.34	2.07±0.07	0.82±0.11	0.63±0.08	5.66±0.24	0.028±0.007	
	1	22.07±0.75	1.40±0.08	9.31±0.35	1.88±0.05	0.90±0.10	0.62±0.04	5.60±0.20	0.040±0.002	
	2	23.64±0.56	1.32±0.12	10.11±0.47	1.96±0.07	1.07±0.12	0.56±0.03	5.56±0.24	0.030±0.001	
	4	21.34±0.78	1.58±0.23	10.12±0.38	2.00±0.11	0.86±0.10	0.65±0.07	5.63±0.41	0.030±0.003	
SB	1	28.21±0.95 ^d	1.40±0.22	8.23±0.71	2.45±0.06 ^e	0.77±0.08	0.57±0.06	4.50±0.38	0.046±0.008	
	2	26.98±0.87	1.34±0.25	7.99±0.51	2.29±0.08	0.76±0.07	0.56±0.07	5.16±0.26	0.049±0.008	
	4	26.23±1.09 ^e	1.92±0.23	8.21±0.68 ^f	2.40±0.06 ^d	0.68±0.08	0.55±0.07	4.39±0.26	0.048±0.006	
	8	26.19±0.99 ^e	1.77±0.16	8.42±0.52 ^f	2.45±0.11	0.75±0.04	0.70±0.08	4.86±0.20	0.045±0.005	
WO	4	21.64±0.59	1.72±0.16	9.69±0.42	1.99±0.13	0.94±0.15	0.73±0.07	5.84±0.37	0.041±0.003	
PO	2	22.58±0.54	1.99±0.19	9.07±0.68	1.90±0.11	0.81±0.12	0.73±0.03	5.31±0.16	0.042±0.006	
	3	22.41±0.60	1.87±0.17	8.48±0.53	2.03±0.07	0.76±0.12	0.59±0.05	5.03±0.28	0.035±0.004	
	4	23.25±0.26 ^f	1.84±0.22	8.38±0.47	2.01±0.07 ^c	0.71±0.11	0.66±0.04	5.21±0.15	0.036±0.004	
	8	23.53±0.34 ^f	1.97±0.29	8.81±0.57	1.75±0.07 ^c	0.84±0.16	0.66±0.06	5.16±0.21	0.039±0.005	

BL4 VS SB1:d,e; BL4 VS SB8:d,e,f; WO4 VS PO2:ns; WO4 VS PO8:f; SB8 VS PO8:c.

c=P<0.005, d=P<0.01, e=P<0.025, f=P<0.05

Table 38. Relative NEFA composition of total serum lipids in group I

Period		Mean±SEM							
Oil	Wk	14:0	16:0	18:0	20:0	16:1	18:1	20:1	20:3 n-9
← % of total fatty acids →									
BL	0	0.63±0.05	27.82±1.09	11.89±0.35	0.39±0.03	0.94±0.08	12.91±0.57	0.16±0.04	0.27±0.07
	1	0.73±0.10	27.38±0.70	12.33±0.46	0.41±0.01	0.90±0.08	11.71±0.61	0.18±0.01	0.37±0.03
	2	0.53±0.05	26.38±0.45	11.59±0.40	0.36±0.03	0.84±0.05	11.40±0.38	0.14±0.02	0.30±0.02
	4	0.46±0.05	28.37±0.50	12.40±0.46	0.35±0.02	0.83±0.10	11.02±0.54	0.13±0.02	0.31±0.04
SB	1	0.48±0.05	25.48±0.53	11.92±0.32	0.41±0.03	0.93±0.07	10.43±0.21	0.14±0.03	0.35±0.03
	2	0.48±0.03	26.08±0.65	12.04±0.72	0.38±0.02	0.86±0.09	10.40±0.72	0.17±0.02	0.38±0.04
	4	0.50±0.04	26.67±0.53	13.01±0.46	0.34±0.04	0.79±0.07	9.30±0.39	0.17±0.02	0.38±0.02
	8	0.44±0.03	26.63±0.54	12.20±0.64	0.30±0.02	0.86±0.08	10.19±0.51	0.19±0.01	0.38±0.03
WO	4	0.54±0.04	27.51±0.56	12.08±0.30	0.40±0.04	0.85±0.10	10.67±0.38	0.20±0.01	0.39±0.03
	2	0.57±0.08	27.94±0.47	10.79±0.40	0.44±0.02	1.01±0.08	12.78±0.47	0.19±0.01	0.36±0.04
PO	3	0.45±0.04	28.46±0.58	10.82±0.50	0.40±0.04	0.91±0.09	13.46±0.67	0.18±0.02	0.29±0.02
	4	0.47±0.06	28.06±0.52	10.12±0.50	0.38±0.03	1.10±0.13	13.50±0.64	0.17±0.01	0.30±0.03
	8	0.49±0.04	28.21±0.60	10.46±0.38	0.42±0.02	1.06±0.09	12.00±0.78	0.19±0.01	0.33±0.03

BL4 VS SB1:c; BL4 VS SB8:f; WO4 VS SB8:f; WO4 VS PO2:f; WO4 VS PO8:d; SB8 VS PO8:a,f.
a=P<0.001, c=P<0.005, d=P<0.01, f=P<0.05



Table 40. Relative EFA composition of total serum lipids in C.Pe

Period		Fatty acid									
Oil	Wk	18:2 n-6	20:3 n-6	20:4 n-6	18:3 n-3	20:5 n-3	22:5 n-3	22:6 n-3	20:3 n-9	20:4 n-6	
BL	0	24.11	2.09	8.84	1.72	0.71	0.75	4.81	0.034	0.034	
	2	20.46	2.22	10.45	1.56	1.18	0.84	5.61	0.025	0.025	
	3	23.50	2.05	8.53	1.49	0.62	0.55	4.45	0.033	0.033	
PO	1	18.83	2.57	10.06	1.40	1.05	0.75	5.46	0.034	0.034	
	2	22.95	2.26	9.11	1.55	0.83	0.71	4.95	0.025	0.025	
	4	22.43	2.46	8.06	1.81	0.60	0.53	4.33	0.036	0.036	
	8	22.68	2.12	8.70	1.72	0.74	0.53	4.29	0.030	0.030	
WO	4	21.72	1.90	8.68	1.37	0.69	0.52	4.53	0.039	0.039	
SB	2	24.23	1.62	6.28	2.53	0.99	0.31	2.35	0.046	0.046	
	3	24.03	1.73	8.75	2.03	0.96	0.49	4.34	0.033	0.033	
	4	21.90	2.16	8.26	2.24	0.78	0.51	4.23	0.031	0.031	
	8	20.37	2.48	9.12	2.21	0.86	0.62	4.57	0.038	0.038	

<----- % of total fatty acids ----->

Table 42. Relative EFA composition of total serum lipids in S.Na

Period		Fatty acid									
Oil	Wk	18:2 n-6	20:3 n-6	20:4 n-6	18:3 n-3	20:5 n-3	22:5 n-3	22:6 n-3	20:3 n-9	20:4 n-6	
<----- % of total fatty acids ----->											
BL	0	17.28	2.64	9.68	2.33	0.47	0.61	5.17	0.032		
	2	20.24	3.00	9.21	1.74	0.57	0.68	5.00	0.053		
	3	23.23	2.61	7.90	1.74	0.41	0.66	4.59	0.040		
PO	1	18.63	2.39	8.29	1.73	0.63	0.67	4.85	0.046		
	2	20.17	2.39	8.06	1.95	0.51	0.78	5.04	0.037		
	4	21.52	2.35	8.59	1.92	0.46	0.75	5.46	0.040		
	8	18.43	1.80	7.97	2.12	0.44	0.61	4.55	0.054		
WO	4	21.61	2.04	7.39	1.96	0.33	0.66	4.59	0.046		
SB	2	26.34	2.11	7.72	2.34	0.39	0.85	3.98	0.057		
	3	22.04	1.56	9.71	2.35	0.56	0.63	5.01	0.035		
	4	20.42	2.53	8.98	2.51	0.47	0.77	5.30	0.054		
	8	21.35	2.12	9.52	2.63	0.67	0.56	4.69	0.050		

Table 43. Relative EFA composition of total serum lipids in S.Pa

Period		Fatty acid									
Oil	Wk	18:2 n-6	20:3 n-6	20:4 n-6	18:3 n-3	20:5 n-3	22:5 n-3	22:6 n-3	20:3 n-9	20:4 n-6	
BL	0	19.05	1.93	10.54	1.81	1.00	0.84	6.80	0.040		
	2	21.86	1.68	8.23	1.88	0.87	0.99	7.37	0.064		
	3	20.11	1.50	8.44	1.76	0.76	0.76	6.50	0.052		
PO	1	18.39	1.22	6.84	1.48	0.74	0.66	5.73	0.050		
	2	23.90	1.38	7.73	1.68	0.98	0.51	5.19	0.036		
	4	26.09	0.95	7.01	1.95	0.53	0.42	4.82	0.040		
	8	23.72	1.56	6.47	1.92	0.61	0.42	4.00	0.050		
WO	4	26.38	0.97	7.25	1.98	0.78	0.55	4.99	0.040		
SB	2	24.17	1.47	7.82	2.30	0.85	0.79	5.41	0.054		
	3	24.87	1.54	7.71	2.37	0.70	0.68	5.72	0.056		
	4	24.57	1.55	7.37	2.36	0.76	0.71	5.72	0.057		
	8	24.56	1.54	8.18	2.33	0.72	0.68	5.97	0.050		

Table 44. Relative EFA composition of total serum lipids in S.Pu

Period		Fatty acid									
Oil	Wk	18:2 n-6	20:3 n-6	20:4 n-6	18:3 n-3	20:5 n-3	22:5 n-3	22:6 n-3	20:3 n-9	20:4 n-6	
< ----- % of total fatty acids ----- >											
BL	0	22.29	1.97	12.35	1.68	0.61	0.51	4.91	0.027		
	2	23.24	1.92	10.52	1.65	0.67	0.46	3.86	0.028		
	3	23.70	1.64	12.22	1.73	0.58	0.56	4.18	0.028		
PO	1	20.26	1.98	11.27	2.10	0.58	0.57	4.67	0.028		
	2	18.21	2.24	10.03	1.09	0.58	0.62	4.19	0.028		
	4	23.11	2.28	8.84	1.39	0.46	0.31	3.45	0.028		
	8	24.65	1.45	9.61	1.79	0.48	0.40	3.41	0.021		
WO	4	24.63	2.05	10.50	1.98	0.35	0.38	3.68	0.027		
SB	2	24.90	1.57	9.52	2.26	0.61	0.37	3.16	0.032		
	3	25.69	2.12	10.32	1.74	0.47	0.52	3.65	0.033		
	4	23.76	1.86	9.70	1.98	0.46	0.41	3.42	0.028		
	8	24.69	1.65	11.34	1.89	0.61	0.46	4.12	0.029		

Table 45. Relative NEFA composition of total serum lipids in C.Ki

Period		Fatty acid							
Oil	Wk	14:0	16:0	18:0	20:0	16:1	18:1	20:1	20:3 n-9
		<----- % of total fatty acids ----->							
BL	0	0.79	26.38	12.93	0.41	0.80	9.40	0.18	0.36
	2	0.81	27.32	12.00	0.25	1.30	11.81	0.13	0.32
	3	0.53	27.11	13.00	0.37	1.14	12.19	0.16	0.33
PO	1	0.45	28.49	11.12	0.20	1.17	13.50	0.15	0.27
	2	0.58	28.85	11.61	0.32	1.13	14.55	0.11	0.25
	4	0.62	27.51	10.00	0.32	1.71	15.13	0.17	0.28
	8	0.86	30.01	10.84	0.29	1.66	14.84	0.16	0.24
WO	4	0.94	30.23	12.11	0.26	1.17	15.04	0.15	0.27
SB	2	0.53	28.27	12.75	0.41	0.44	8.94	0.14	0.31
	3	0.44	27.13	12.87	0.36	1.03	10.59	0.15	0.31
	4	0.44	25.99	10.80	0.33	1.32	12.24	0.12	0.27
	8	0.38	27.74	12.22	0.39	0.44	9.33	0.13	0.27

Table 46. Relative NEFA composition of total serum lipids in C.Pe

Period		Fatty acid							
Oil	Wk	14:0	16:0	18:0	20:0	16:1	18:1	20:1	20:3 n-9
<----- % of total fatty acids ----->									
BL	0	0.55	28.42	10.79	0.36	1.01	11.52	0.13	0.30
	2	0.48	27.51	12.38	0.37	0.84	10.47	0.11	0.26
	3	0.77	28.55	10.41	0.23	1.55	13.42	0.14	0.28
PO	1	0.41	29.75	11.70	0.42	0.73	11.51	0.16	0.34
	2	0.47	28.11	9.74	0.38	1.20	13.38	0.11	0.23
	4	0.70	27.26	9.92	0.28	2.09	15.74	0.17	0.29
	8	0.74	27.79	9.34	0.32	1.60	15.64	0.16	0.26
WO	4	1.21	29.51	11.89	0.29	1.28	12.18	0.17	0.34
SB	2	1.02	29.26	12.28	0.33	1.16	13.18	0.15	0.29
	3	0.59	27.05	10.20	0.30	1.77	13.22	0.15	0.29
	4	0.79	27.71	9.30	0.28	2.22	15.42	0.15	0.26
	8	0.64	29.00	12.19	0.39	1.06	11.57	0.16	0.35

Table 47. Relative NEFA composition of total serum lipids in P.Lo

Period		Fatty acid							
Oil	Wk	14:0	16:0	18:0	20:0	16:1	18:1	20:1	20:3 n-9
<----- % of total fatty acids ----->									
BL	0	0.52	28.18	14.18	0.42	0.50	9.16	0.11	0.25
	2	1.49	26.08	13.31	0.41	0.40	9.72	0.21	0.37
	3	0.57	27.22	13.13	0.44	0.83	11.32	0.18	0.36
PO	1	0.44	30.11	12.52	0.44	0.79	13.14	0	0.16
	2	0.54	29.43	11.95	0.38	0.73	13.10	0.13	0.26
	4	0.56	28.34	10.75	0.52	1.34	14.57	0.16	0.30
	8	0.62	27.52	10.58	0.48	0.70	13.79	0	0.19
WO	4	0.60	25.71	9.92	0.56	1.28	14.58	0.38	0.59
SB	2	0.38	25.69	11.00	0.35	1.08	12.23	0.14	0.28
	3	0.51	27.09	12.26	0.48	0.95	10.81	0.16	0.30
	4	0.46	26.15	10.09	0.38	1.08	12.36	0.14	0.27
	8	0.42	26.94	12.72	0.47	0.52	10.10	0.18	0.30

Table 48. Relative NEFA composition of total serum lipids in S.Na

Period	Fatty acid									
	Oil	Wk	14:0	16:0	18:0	20:0	16:1	18:1	20:1	20:3 n-9
			<----- % of total fatty acids ----->							
BL	0		1.01	30.42	10.51	0.34	1.79	14.41	0.11	0.31
	2		1.16	29.00	12.61	0.42	1.30	10.61	0.16	0.49
	3		1.23	28.94	12.25	0.46	1.02	11.00	0.09	0.32
PO	1		0.74	31.57	10.60	0.46	1.43	13.83	0.18	0.38
	2		0.82	30.29	8.68	0.44	1.74	15.39	0.20	0.30
	4		0.36	29.93	9.23	0.38	0.80	14.36	0.20	0.34
	8		1.18	30.32	8.78	0.41	2.04	17.62	0.31	0.43
WO	4		0.98	29.98	9.57	0.31	1.46	15.55	0.16	0.34
SB	2		0.97	26.34	8.96	0.27	1.34	14.28	0.23	0.44
	3		0.59	27.52	9.48	0.33	1.51	14.60	0.21	0.34
	4		0.79	29.17	11.02	0.40	1.07	12.09	0.23	0.49
	8		0.81	28.39	10.50	0.32	1.17	12.96	0.25	0.48

Table 49. Relative NEFA composition of total serum lipids in S.Pa

Period		Fatty acid							
Oil	Wk	14:0	16:0	18:0	20:0	16:1	18:1	20:1	20:3 n-9
----- % of total fatty acids ----->									
BL	0	0.47	27.54	14.26	0.60	0.73	9.14	0.20	0.41
	2	0.59	26.18	13.84	0.31	1.06	10.23	0.20	0.53
	3	0.77	28.47	14.30	0.43	1.42	10.52	0.20	0.44
PO	1	0.38	25.67	9.73	0.33	0.89	11.06	0.20	0.34
	2	0.44	28.46	10.56	0.55	1.00	13.25	0.16	0.28
	4	0.45	28.77	10.01	0.27	1.22	14.67	0.14	0.28
	8	0.64	28.55	10.45	0.18	1.48	16.05	0.16	0.34
WO	4	0.71	26.63	9.99	0.27	1.61	14.06	0.16	0.29
SB	2	0.64	27.17	12.35	0.30	0.80	11.12	0.19	0.42
	3	0.60	26.16	11.76	0.33	1.58	11.45	0.18	0.43
	4	0.68	26.86	11.93	0.32	1.48	11.29	0.16	0.42
	8	0.42	27.35	11.85	0.33	0.95	10.58	0.18	0.41

Table 50. Relative NEFA composition of total serum lipids in S.Pu

Period		Fatty acid							
Oil	Wk	14:0	16:0	18:0	20:0	16:1	18:1	20:1	20:3 n-9
<----- % of total fatty acids ----->									
BL	0	0.34	28.34	12.58	0.45	0.70	9.41	0.23	0.33
	2	1.08	28.50	13.26	0.29	0.71	9.86	0.13	0.29
	3	0.33	27.48	12.91	0.46	0.89	9.65	0.17	0.34
PO	1	0.33	29.81	10.65	0.44	0.64	11.93	0.17	0.31
	2	1.20	30.12	11.91	0.30	0.92	14.53	0.15	0.28
	4	0.77	28.88	10.49	0.32	1.28	15.01	0.12	0.25
	8	1.00	29.05	9.96	0.30	0.93	13.81	0.14	0.20
WO	4	0.62	27.33	11.87	0.30	0.62	12.21	0.13	0.28
SB	2	0.60	27.58	9.99	0.35	1.19	14.24	0.19	0.31
	3	1.14	27.35	11.22	0.29	0.98	10.74	0.17	0.34
	4	0.43	26.98	10.92	0.30	1.30	13.93	0.14	0.27
	8	0.45	27.39	11.94	0.39	0.61	10.44	0.16	0.33

Table 51. Relative EFA composition of total serum lipids in group II

Period		Mean±SEM							
Oil	Wk	18:2 n-6	20:3 n-6	20:4 n-6	18:3 n-3	20:5 n-3	22:5 n-3	22:6 n-3	20:3 n-9 20:4 n-6
< % of total fatty acids >									
BL	0	21.11±1.22	2.14±0.14	10.33±0.67	1.79±0.12	0.74±0.08	0.68±0.05	5.72±0.45	0.032±0.002
	2	21.41±0.48	1.99±0.23	10.09±0.50	1.67±0.05	0.85±0.09	0.71±0.08	5.56±0.47	0.039±0.006
	3	22.32±0.87	1.92±0.17	9.44±0.75	1.71±0.06	0.60±0.05	0.66±0.04	5.16±0.37	0.037±0.004
PO	1	19.49±0.56	2.08±0.22	9.13±0.64	1.62±0.11	0.76±0.08	0.62±0.04	5.23±0.17	0.035±0.005
	2	20.64±1.04	2.13±0.15	8.93±0.41	1.56±0.12	0.70±0.07	0.66±0.04	5.09±0.26	0.030±0.002
	4	22.86±0.68	2.03±0.23	8.31±0.34	1.80±0.09	0.56±0.05	0.50±0.06	4.59±0.27	0.034±0.003
	8	22.57±1.13	1.70±0.13	8.17±0.44	1.76±0.10	0.58±0.04	0.53±0.04	4.25±0.20	0.035±0.006
WO	4	22.88±1.18	1.66±0.19	8.74±0.51	1.73±0.11	0.57±0.08	0.53±0.04	4.51±0.18	0.041±0.006
SB	2	24.47±1.18	1.70±0.11	8.56±0.83	2.37±0.04	0.72±0.09	0.58±0.09	4.30±0.60	0.042±0.005
	3	23.60±0.76	1.70±0.09	9.29±0.50	2.16±0.14	0.73±0.09	0.66±0.09	4.94±0.34	0.036±0.004
	4	23.68±1.21	1.87±0.18	8.82±0.51	2.27±0.07	0.67±0.09	0.58±0.06	4.70±0.34	0.039±0.005
	8	23.39±0.83	1.81±0.17	9.68±0.44	2.15±0.17	0.77±0.05	0.58±0.03	4.92±0.26	0.037±0.004

BL3 VS PO1:ns; BL3 VS PO8:ns; WO4 VS SB2:g,i; WO4 VS SB8:i,k; PO8 VS SB8:b,e.
b=P<0.0025, c=P<0.005, d=P<0.01, e=P<0.025, f=P<0.05

Table 52. Relative NEFA composition of total serum lipids in group II

Period		Mean±SEM							
Oil	Wk	14:0	16:0	18:0	20:0	16:1	18:1	20:1	20:3 n-9
← % of total fatty acids →									
BL	0	0.61±0.10	28.21±0.54	12.54±0.66	0.43±0.04	0.92±0.19	10.51±0.86	0.16±0.02	0.33±0.02
	2	0.94±0.16	27.43±0.48	12.90±0.28	0.34±0.03	0.94±0.14	10.45±0.31	0.16±0.02	0.38±0.04
	3	0.70±0.13	27.96±0.32	12.66±0.53	0.40±0.04	1.14±0.12	11.35±0.54	0.16±0.02	0.34±0.02
PO	1	0.46±0.06 ^k	29.23±0.82	11.05±0.40	0.38±0.04	0.94±0.12	12.50±0.47	0.14±0.03	0.30±0.03
	2	0.68±0.12	29.21±0.36	10.74±0.54	0.40±0.04	1.12±0.14	14.03±0.38	0.14±0.01	0.27±0.01
	4	0.58±0.06	28.45±0.40	10.07±0.21 ^b	0.35±0.04	1.41±0.18	14.91±0.20	0.16±0.01	0.29±0.01
	8	0.84±0.09	28.87±0.47	9.96±0.32	0.33±0.04	1.40±0.20	15.29±0.60 ^e	0.16±0.04	0.28±0.04
WO	4	0.84±0.10	28.23±0.78	10.89±0.48	0.33±0.05	1.24±0.14	13.94±0.59	0.19±0.04	0.35±0.05
SB	2	0.69±0.10	27.38±0.53	11.19±0.63	0.34±0.02	1.00±0.13	12.33±0.84	0.17±0.02	0.34±0.03
	3	0.64±0.10	27.05±0.19	11.30±0.52	0.35±0.03	1.30±0.15	11.90±0.67	0.17±0.01	0.34±0.02
	4	0.60±0.07 ^{g*}	27.14±0.48	10.68±0.36	0.34±0.02	1.41±0.17	12.89±0.67	0.16±0.02	0.33±0.04
	8	0.52±0.07	27.80±0.31	11.90±0.31 ^a	0.38±0.02	0.79±0.12 ⁱ	10.83±0.52 ^{a,g}	0.18±0.02	0.36±0.03

BL3 VS P01:k; BL3 VS P08:b,e; W04 VS SB2:ns; W04 VS SB8:g*,g*,i; P08 VS SB8:a,g*,i.
a=P<0.001, b=P<0.0025, c=P<0.005, d=P<0.01, e=P<0.01, f=P<0.025, g=P<0.05

Table 53. Relative EFA composition of total erythrocyte lipids in A.Ko

Period		Fatty acid									
Oil	Wk	18:2 n-6	20:3 n-6	20:4 n-6	18:3 n-6	20:5 n-3	22:5 n-3	22:6 n-3	20:3 n-9	20:4 n-6	
<----- % of total fatty acids ----->											
BL	0	7.50	1.20	15.36	1.94	4.41	1.51	7.08	0.023		
	1	7.68	1.13	15.62	2.00	4.15	1.97	7.03	0		
	2	7.41	1.78	12.37	2.64	3.99	1.49	3.15	0.015		
	4	6.43	1.60	11.32	2.59	4.09	1.21	2.69	0.019		
SB	1	9.25	1.15	13.42	1.61	4.41	0.78	4.14	0.019		
	2	9.77	1.27	13.24	2.24	4.31	1.66	4.15	0.021		
	4	7.67	0.93	13.51	1.58	3.38	2.23	5.57	0.029		
	8	10.62	1.41	12.67	2.20	3.75	1.28	3.39	0		
WO	4	8.62	1.35	14.06	1.50	3.84	1.56	6.61	0.021		
PO	2	8.59	1.44	13.57	1.48	3.85	1.62	6.80	0.017		
	3	8.01	1.16	15.46	2.04	3.71	1.17	5.18	0.010		
	4	8.24	1.42	13.62	1.51	3.79	1.75	6.68	0.026		
	8	8.38	1.42	13.36	1.62	4.13	1.66	7.30	0.014		

Table 54. Relative EFA composition of total erythrocyte lipids in B.Ji

Period		Fatty acid									
Oil	Wk	18:2 n-6	20:3 n-6	20:4 n-6	18:3 n-3	20:5 n-3	22:5 n-3	22:6 n-3	20:3 n-9	20:4 n-6	
$\langle \text{--- \% of total fatty acids ---} \rangle$											
BL	0	7.20	1.47	14.37	1.82	4.00	1.93	7.07	0.022		
	1	7.71	1.76	15.59	2.01	3.85	1.68	7.04	0.023		
	2	8.25	1.68	14.37	2.25	4.04	1.40	4.49	0.023		
	4	8.06	1.60	14.46	2.33	4.12	2.07	3.58	0.028		
SB	1	8.43	1.31	13.08	2.36	4.02	1.71	4.47	0		
	2	9.32	1.22	13.08	2.15	4.04	1.42	4.33	0		
	4	-	-	-	-	-	-	-	-		
	8	-	-	-	-	-	-	-	-		
WO	4	9.49	1.30	12.46	1.65	3.45	1.68	6.42	0.022		
PO	2	7.99	1.03	13.67	1.89	3.23	2.19	6.40	0.017		
	3	7.76	1.15	11.15	1.44	3.41	1.35	8.08	0.019		
	4	9.04	1.40	15.00	2.09	3.44	1.96	6.58	0.24		
	8	8.38	1.15	13.38	1.31	3.39	1.35	6.46	0.016		

Table 55. Relative EFA composition of total erythrocyte lipids in C.Ch

Period		Fatty acid									
Oil	Wk	18:2 n-6	20:3 n-6	20:4 n-6	18:3 n-3	20:5 n-3	22:5 n-3	22:6 n-3	20:3 n-9	20:4 n-6	
<----- % of total fatty acids ----->											
BL	0	9.28	1.08	13.79	1.74	4.55	1.69	6.83	0.025		
	1	8.50	0.58	11.83	1.72	4.27	1.79	2.55	0.030		
	2	8.28	0.66	9.60	2.55	3.49	0.84	2.72	0		
	4	9.19	0.96	13.44	2.45	3.78	0.92	4.14	0		
SB	1	10.67	1.27	12.83	2.33	3.94	1.35	4.47	0		
	2	11.04	1.20	12.70	2.46	3.84	1.30	4.54	0		
	4	11.06	1.31	12.91	2.24	3.69	1.58	4.08	0.019		
	8	12.60	1.42	12.02	2.34	3.75	1.60	3.68	0.037		
WO	4	10.98	1.23	14.02	1.71	3.31	0.99	6.36	0.015		
PO	2	9.63	1.65	12.52	1.48	3.04	1.59	6.53	0.034		
	3	9.30	1.99	14.24	2.06	3.18	1.86	6.66	0.014		
	4	9.53	1.64	15.31	1.33	3.21	1.59	6.54	0.021		
	8	9.51	1.66	13.00	1.47	3.34	1.26	6.24	0.017		

Table 56. Relative EFA composition of total erythrocyte lipids in N.Su

Period		Fatty acid									
Oil	Wk	18:2 n-6	20:3 n-6	20:4 n-6	18:3 n-3	20:5 n-3	22:5 n-3	22:6 n-3	20:3 n-9	20:4 n-6	
<----- % of total fatty acids ----->											
BL	0	8.61	1.33	16.30	2.66	3.92	1.75	6.79	0.010		
	1	9.81	1.56	14.37	2.30	3.90	2.02	7.53	0.029		
	2	10.04	1.60	14.83	2.03	4.06	1.04	5.01	0.030		
	4	9.08	1.64	14.19	2.20	3.97	0.96	4.39	0.031		
SB	1	10.04	1.45	13.47	2.31	3.96	1.34	4.55	0		
	2	10.57	1.35	13.08	2.35	3.93	1.72	4.30	0		
	4	10.31	1.03	13.02	1.75	4.09	0.59	3.33	0.022		
	8	11.66	1.01	14.20	1.84	3.69	1.04	5.66	0.015		
WO	4	10.94	1.21	14.41	1.68	3.61	1.09	6.34	0.014		
PO	2	8.23	1.72	14.96	2.10	3.38	2.04	6.47	0.015		
	3	8.94	0.95	10.80	2.17	2.93	1.84	6.53	0.048		
	4	10.02	1.00	13.35	1.44	3.29	1.77	7.73	0.022		
	8	9.31	1.55	13.54	1.40	3.27	2.28	8.28	0.016		

Table 57. Relative EFA composition of total erythrocyte lipids in P.Jo

Period		Fatty acid									
Oil	Wk	18:2 n-6	20:3 n-6	20:4 n-6	18:3 n-3	20:5 n-3	22:5 n-3	22:6 n-3	20:3 n-9	20:4 n-6	
<----- % of total fatty acids ----->											
BL	0	7.34	1.56	12.79	2.20	4.06	1.97	7.38		0.034	
	1	7.76	1.13	13.11	2.71	3.73	1.95	7.18		0.016	
	2	7.13	1.34	11.56	2.44	3.67	1.18	2.49		0.048	
	4	6.50	1.34	11.45	2.52	3.76	1.31	2.30		0.039	
SB	1	8.08	1.61	13.66	2.22	4.02	1.41	4.51	0		
	2	8.84	0.84	12.20	2.48	3.94	1.56	4.36	0.016		
	4	-	-	-	-	-	-	-	-	-	
	8	10.00	0.50	15.41	2.17	3.83	2.35	7.31	0.014		
WO	4	9.94	1.04	13.25	2.06	3.14	1.01	5.84	0.017		
PO	2	10.07	1.30	13.65	1.49	3.18	1.45	6.94	0.018		
	3	7.79	0.62	13.86	2.10	3.02	1.06	4.86	0.012		
	4	8.65	0.95	11.12	1.44	3.51	0.93	4.69	0.014		
	8	7.44	1.15	12.54	1.26	3.20	1.83	7.31	0.018		

Table 58. Relative EFA composition of total erythrocyte lipids in S.Pr

Period		Fatty acid									
Oil	Wk	18:2 n-6	20:3 n-6	20:4 n-6	18:3 n-3	20:5 n-3	22:5 n-3	22:6 n-3	20:3 n-9	20:4 n-6	
$\langle \text{--- \% of total fatty acids ---} \rangle$											
BL	0	8.11	1.36	14.56	1.98	4.33	1.95	7.81	0.021		
	1	8.34	1.58	14.89	2.03	3.80	1.99	7.97	0.011		
	2	8.80	1.43	14.66	1.99	3.93	1.42	4.11	0.022		
	4	8.43	1.52	15.24	1.71	4.18	1.93	3.73	0.025		
SB	1	9.84	1.18	13.07	2.22	4.08	1.25	3.93	0		
	2	10.96	0.73	13.37	2.36	4.14	1.22	4.17	0		
	4	11.98	0.67	11.94	2.11	4.12	0.60	3.53	0.027		
	8	12.83	1.07	12.17	2.11	3.97	1.07	5.05	0.016		
WO	4	10.62	1.21	13.85	1.66	3.51	0.90	5.57	0.027		
PO	2	9.04	1.50	13.31	1.20	3.28	1.64	7.38	0.027		
	3	9.09	1.09	9.02	1.40	3.45	0.81	4.14	0.036		
	4	9.71	1.54	13.74	1.67	3.54	0.84	5.82	0.028		
	8	9.54	1.48	13.77	1.20	3.54	1.18	6.83	0.025		

Table 54. Relative EFA composition of total erythrocyte lipids in B.Ji

Period		Fatty acid									
Oil	Wk	18:2 n-6	20:3 n-6	20:4 n-6	18:3 n-3	20:5 n-3	22:5 n-3	22:6 n-3	20:3 n-9	20:4 n-6	
<----- % of total fatty acids ----->											
BL	0	7.20	1.47	14.37	1.82	4.00	1.93	7.07	0.022		
	1	7.71	1.76	15.59	2.01	3.85	1.68	7.04	0.023		
	2	8.25	1.68	14.37	2.25	4.04	1.40	4.49	0.023		
	4	8.06	1.60	14.46	2.33	4.12	2.07	3.58	0.028		
SB	1	8.43	1.31	13.08	2.36	4.02	1.71	4.47	0		
	2	9.32	1.22	13.08	2.15	4.04	1.42	4.33	0		
	4	-	-	-	-	-	-	-	-		
	8	-	-	-	-	-	-	-	-		
WO	4	9.49	1.30	12.46	1.65	3.45	1.68	6.42	0.022		
PO	2	7.99	1.03	13.67	1.89	3.23	2.19	6.40	0.017		
	3	7.76	1.15	11.15	1.44	3.41	1.35	8.02	0.019		
	4	9.04	1.40	15.00	2.09	3.44	1.96	6.58	0.24		
	8	8.38	1.15	13.38	1.31	3.39	1.35	6.46	0.016		

Table 60. Relative NEFA composition of total erythrocyte lipids in B.Ji

Period		Fatty acid							
Oil	Wk	14:0	16:0	18:0	20:0	16:1	18:1	20:1	20:3 n-9
<----- % of total fatty acids ----->									
BL	0	0.40	23.00	16.57	0.34	0.34	12.25	0.25	0.31
	1	0.24	23.29	14.62	0.76	0	12.43	0.42	0.36
	2	0.30	24.75	17.13	0	0.27	13.27	0	0.33
	4	0.53	26.58	18.80	0	0	13.94	0	0.41
SB	1	0.31	24.36	17.00	0.42	0.23	13.03	0	0
	2	0.30	24.20	17.56	0.44	0	12.89	0	0
	4	-	-	-	-	-	-	-	-
	8	-	-	-	-	-	-	-	-
WO	4	0.39	23.27	17.56	0.37	0.27	12.45	0.13	0.28
PO	2	0.24	22.96	17.02	0.47	0	13.14	0.15	0.23
	3	0.31	24.12	18.20	0.40	0	12.50	0	0.21
	4	0.22	21.37	14.65	0.37	0.19	13.22	0.22	0.36
	8	0.25	23.64	17.51	0.40	0	12.38	0.17	0.21

Table 61. Relative NEFA composition of total erythrocyte lipids in C.Ch

Period		Fatty acid							
Oil	Wk	14:0	16:0	18:0	20:0	16:1	18:1	20:1	20:3 n-9
<----- % of total fatty acids ----->									
BL	0	0.27	22.48	16.87	0.34	0	12.29	0	0.34
	1	0.37	30.01	17.37	0	0	14.48	0	0.36
	2	0.48	24.61	17.55	0	0	11.78	0	0
	4	0.59	25.57	19.24	0	0	12.72	0	0
SB	1	0.35	24.21	17.69	0.38	0	12.29	0	0
	2	0.26	23.79	18.19	0.42	0	12.44	0	0
	4	0.34	25.86	16.33	0	0	12.43	0	0.25
	8	0.36	24.34	18.72	0.44	0	11.56	0.22	0.44
WO	4	0.40	21.56	18.71	0.31	0.23	11.66	0.18	0.21
PO	2	0.28	23.27	19.32	0.39	0.23	11.58	0.19	0.43
	3	0.27	20.67	14.58	0.35	0.24	13.05	0	0.20
	4	0.29	23.81	16.58	0.44	0.19	11.58	0.16	0.32
	8	0.27	24.29	17.30	0.35	0.33	12.34	0.10	0.22

Table 62. Relative NEFA composition of total erythrocyte lipids in N.Su

Period		Fatty acid							
Oil	Wk	14:0	16:0	18:0	20:0	16:1	18:1	20:1	20:3 n-9
<----- % of total fatty acids ----->									
BL	0	0.64	21.74	15.97	0.28	0	11.12	0	0.14
	1	0.42	21.04	15.47	0.39	0	11.48	0.38	0.42
	2	0.45	23.77	17.65	0	0	11.73	0	0.45
	4	0.56	24.21	18.54	0.40	0	11.78	0	0.44
SB	1	0.36	24.09	17.37	0.45	0	11.96	0	0
	2	0.31	23.47	17.24	0.40	0	11.79	0	0
	4	0.47	26.18	16.25	0	0.26	14.00	0	0.28
	8	0.21	21.29	18.53	0.27	0	11.53	0	0.21
WO	4	0.35	22.14	17.76	0.26	0	11.65	0.17	0.20
PO	2	0.20	22.76	14.51	0.37	0.22	13.81	0.21	0.22
	3	0.21	24.82	19.54	0.32	0	11.31	0.23	0.52
	4	0.21	22.87	16.87	0.27	0	11.21	0.14	0.29
	8	0.24	22.51	15.54	0.35	0	11.36	0	0.21

Table 63. Relative NEFA composition of total erythrocyte lipids in P.Jo

Period		Fatty acid							
Oil	Wk	14:0	16:0	18:0	20:0	16:1	18:1	20:1	20:3 n-9
<----- % of total fatty acids ----->									
BL	0	0.26	22.81	15.71	0.32	0.20	13.07	0.21	0.44
	1	0.22	23.43	15.45	0.29	0	12.64	0.16	0.21
	2	0.55	30.26	18.95	0	0	15.73	0	0.56
	4	0.50	29.44	17.76	0.52	0	14.41	0	0.45
SB	1	0.36	24.53	16.45	0	0	13.75	0	0
	2	0.32	24.88	16.60	0.23	0.24	14.17	0	0.20
	4	-	-	-	-	-	-	-	-
	8	0.16	20.54	14.13	0.33	0	13.33	0	0.22
WO	4	0.35	21.98	18.35	0.33	0	14.15	0.11	0.22
PO	2	0.28	23.30	17.78	0.32	0.25	11.10	0.12	0.24
	3	0.20	23.08	16.18	0.31	0.16	13.60	0	0.17
	4	0.27	26.09	16.88	0.38	0.21	14.25	0.13	0.16
	8	0.26	24.31	16.79	0.40	0	13.05	0.15	0.22

Table 65. Relative EFA composition of total erythrocyte lipids in group I

Period		Mean±SEM							
Oil Wk		18:2 n-6	20:3 n-6	20:4 n-6	18:3 n-3	20:5 n-3	22:5 n-3	22:6 n-3	20:3 n-9 20:4 n-6
< % of total fatty acids >									
BL	0	8.01±0.33	1.33±0.07	14.53±0.50	2.06±0.14	4.21±0.10	1.80±0.08	7.16±0.16	0.022±0.003
	1	0.30±0.33	1.29±0.18	14.24±0.61	2.13±0.14	3.95±0.09	1.90±0.06	6.55±0.81	0.018±0.005
	2	8.32±0.43	1.42±0.16	12.90±0.86	2.32±0.11	3.86±0.09	1.23±0.10	3.66±0.42	0.023±0.007
	4	7.95±0.05	1.44±0.10	13.35±0.67	2.30±0.13	3.98±0.07	1.40±0.20	3.47±0.33	0.024±0.005
SB	1	9.38±0.40	1.33±0.07	13.26±0.13	2.18±0.12	4.07±0.07	1.31±0.12	4.34±0.10	f 0.003±0.003
	2	10.08±0.37	1.10±0.10	12.94±0.18	2.34±0.05	4.03±0.07	1.48±0.08	4.31±0.06	0.006±0.004
	4	10.26±0.93	0.98±0.13	12.84±0.33	1.92±0.15	3.82±0.18	1.25±0.40	4.13±0.51	0.024±0.002
	8	11.54±0.55	1.08±0.17	13.29±0.66	2.13±0.08	3.80±0.05	1.47±0.24	5.02±0.71	0.016±0.006
WO	4	10.10±0.38	1.22±0.04	13.68±0.29	1.71±0.08	3.48±0.10	1.20±0.13	5.19±0.16	0.019±0.002
PO	2	8.92±0.33	1.44±0.10	13.65±0.32	1.61±0.13	3.33±0.11	1.76±0.12	6.75±0.15	d 0.021±0.003
	3	8.48±0.29	1.16±0.18	12.42±1.01	1.87±0.14	3.28±0.12	1.35±0.17	5.91±0.59	0.023±0.006
	4	9.20±0.28	1.32±0.12	13.69±0.61	1.58±0.11	3.46±0.08	1.47±0.19	6.34±0.41	f 0.022±0.002
	8	8.76±0.34	1.40±0.09	13.26±0.18	1.38±0.06	3.48±0.14	1.59±0.17	7.04±0.30	f 0.018±0.002

BL4 VS SB1:d,f; BL4 VS SB8:a; WO4 VS PO2:d,f; WO4 VS PO8:d,f; SB8 VS PO8:a,b,f,f*.

a=P<0.001, b=P<0.0025, d=P<0.01, f=P<0.05

Table 66. Relative NEFA composition of total erythrocyte lipids in group I

Period		Mean±SEM							
Oil	Wk	14:0	16:0	18:0	20:0	16:1	18:1	20:1	20:3 n-9
←----- % of total fatty acids ----->									
BL	0	0.45±0.07	22.59±0.18	16.02±0.30	0.32±0.02	0.09±0.06	12.10±0.31	0.08±0.05	0.31±0.04
	1	0.26±0.06	23.87±1.28	16.13±0.50	0.37±0.10	0	12.37±0.47	0.16±0.08	0.25±0.06
	2	0.41±0.04	25.75±1.00	17.99±0.30	0.10±0.06	0.13±0.06	13.16±0.59	0.02±0.02	0.31±0.08
	4	0.53±0.02	26.38±0.71	18.74±0.22	0.15±0.10	0.05±0.05	13.42±0.40	0.07±0.07	0.32±0.04
SB	1	0.36±0.02	24.26±0.08	17.40±0.26	0.24±0.08	0.10±0.06	12.94±0.28	0	0.04±0.04
	2	0.29±0.01	23.74±0.30	17.57±0.25	0.38±0.04	0.04±0.04	12.64±0.34	0	0.08±0.05
	4	0.38±0.03	25.20±0.48	17.92±1.25	0.12±0.12	0.06±0.06	12.40±1.02	0	0.31±0.03
	8	0.26±0.05	22.42±0.78	17.61±0.90	0.39±0.03	0	12.25±0.35	0.04±0.04	0
WO	4	0.36±0.02	22.55±0.37	18.06±0.18	0.31±0.02	0.16±0.05	12.08±0.45	0.15±0.01	0.27±0.03
PO	2	0.27±0.02	22.73±0.23	17.39±0.66	0.39±0.03	0.18±0.04	12.10±0.45	0.17±0.01	0.28±0.04
	3	0.26±0.02	23.86±0.94	17.56±0.76	0.36±0.03	0.09±0.04	12.86±0.38	0.08±0.05	0.26±0.06
	4	0.26±0.01	23.46±0.64	16.57±0.43	0.38±0.03	0.10±0.04	12.48±0.52	0.19±0.02	0.31±0.03
	8	0.28±0.02	23.42±0.32	16.76±0.28	0.39±0.03	0.06±0.06	12.20±0.23	0.14±0.04	0.23±0.02

BL4 VS SB1:b,e,f; BL4 VS SB8:e,f; WO4 VS PO2:e,f; WO4 VS PO8:e; SB8 VS PO8:ns.

b=P<0.0025, e=P<0.025, f=P<0.05

Table 67. Relative EFA composition of total erythrocyte lipids in C.Ki

Period		Fatty acid									
Oil	Wk	18:2 n-6	20:3 n-6	20:4 n-6	18:3 n-3	20:5 n-3	22:5 n-3	22:6 n-3	20:3 n-9	20:4 n-6	
<----- % of total fatty acids ----->											
BL	0	7.16	1.09	15.16	1.62	4.33	1.54	6.22	0.015		
	2	8.94	1.44	13.95	1.63	3.53	1.66	7.20	0.027		
	3	7.95	1.08	15.87	1.38	4.05	1.40	6.33	0.018		
PO	1	7.72	1.03	14.56	1.47	4.24	1.51	8.18	0.017		
	2	7.46	1.20	15.11	1.41	4.35	1.81	7.21	0.022		
	4	7.74	1.11	15.52	1.37	3.98	1.52	7.38	0.014		
	8	7.42	1.19	14.79	1.47	3.88	1.52	6.21	0.018		
WO	4	7.21	1.06	14.76	1.58	3.69	1.35	6.29	0.016		
SB	2	8.18	1.08	16.75	1.54	4.39	1.41	6.28	0.016		
	3	8.41	1.02	15.31	1.55	3.96	1.05	6.04	0.017		
	4	8.53	1.07	15.54	1.54	3.95	1.37	6.06	0.014		
	8	8.74	1.18	14.97	1.37	3.94	1.50	6.06	0.016		

Table 68. Relative EFA composition of total erythrocyte lipids in C.Pe

Period	Fatty acid									
	18:2 n-6	20:3 n-6	20:4 n-6	18:3 n-3	20:5 n-3	22:5 n-3	22:6 n-3	20:3 n-9	20:4 n-6	
Oil	Wk	18:2 n-6	20:3 n-6	20:4 n-6	18:3 n-3	20:5 n-3	22:5 n-3	22:6 n-3	20:3 n-9	20:4 n-6
	0	9.02	1.49	13.80	1.55	3.36	1.66	7.37	0.024	
	2	9.25	1.45	13.21	1.63	3.50	1.39	6.50	0.025	
BL	3	9.38	1.43	13.48	1.40	3.54	1.33	5.83	0.022	
	1	8.52	1.65	13.17	1.48	3.65	1.85	7.40	0.020	
	2	8.47	1.48	14.40	1.45	3.59	1.40	7.82	0.019	
PO	4	8.54	1.74	13.46	1.45	3.33	1.30	7.06	0.022	
	8	8.22	1.83	12.85	1.48	3.12	1.65	6.26	0.014	
WO	4	8.93	1.41	13.13	1.42	2.98	1.79	7.16	0.020	
	2	9.27	1.42	13.70	1.65	3.82	1.70	6.51	0.021	
SB	3	9.32	1.42	13.33	1.57	3.55	1.36	6.18	0.020	
	4	8.99	1.52	13.03	1.63	3.48	1.34	6.25	0.021	
	8	9.25	1.50	13.28	1.64	3.28	1.59	6.02	0.020	

<----- % of total fatty acids ----->



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Table 69. Relative BFA composition of total erythrocyte lipids in P.Lo

Period		Fatty acid									
Oil	Wk	18:2 n-6	20:3 n-6	20:4 n-6	18:3 n-3	20:5 n-3	22:5 n-3	22:6 n-3	20:3 n-9	20:4 n-6	
<----- % of total fatty acids ----->											
BL	0	8.42	1.14	13.27	1.71	3.70	1.68	7.57	0.028		
	2	8.36	1.07	14.45	1.50	3.88	1.32	7.04	0.015		
	3	8.95	1.07	13.67	1.58	3.66	1.21	6.96	0.022		
PO	1	7.93	1.30	13.74	1.33	3.57	1.64	8.35	0.023		
	2	7.79	1.02	13.11	1.48	3.75	1.84	8.23	0.039		
	4	7.85	1.23	12.25	1.35	3.31	1.49	7.19	0.021		
	8	8.03	1.14	13.41	1.49	3.34	1.83	7.24	0.017		
WO	4	8.35	0.99	13.45	1.47	3.14	1.58	7.87	0.020		
SB	2	8.57	1.16	13.67	1.74	3.99	1.57	7.28	0.015		
	3	8.52	1.05	13.22	1.81	3.85	1.15	6.79	0.021		
	4	9.06	1.10	13.38	1.88	3.54	1.40	6.63	0.020		
	8	8.78	1.04	13.53	1.85	3.31	1.49	6.83	0.020		

Table 70. Relative EFA composition of total erythrocyte lipids in S.Na

Period		Fatty acid									
Oil	Wk	18:2 n-6	20:3 n-6	20:4 n-6	18:3 n-3	20:5 n-3	22:5 n-3	22:6 n-3	20:3 n-9	20:4 n-6	
<----- % of total fatty acids ----->											
BL	0	7.57	1.69	12.26	1.70	3.15	1.77	7.43	0.033		
	2	7.92	1.54	12.94	1.80	3.27	1.69	7.34	0.026		
	3	8.02	1.68	13.32	1.68	3.23	1.59	6.40	0.025		
PO	1	7.59	1.53	12.38	1.85	3.27	1.54	6.76	0.027		
	2	7.66	1.48	11.97	1.57	3.48	1.95	8.04	0.012		
	4	7.62	1.61	12.72	1.47	3.02	1.75	7.58	0.026		
	8	7.62	1.57	12.11	1.74	2.98	1.64	6.06	0.024		
WO	4	5.85	1.32	12.51	1.85	3.04	1.64	6.35	0.014		
SB	2	8.61	1.53	12.68	2.08	3.36	1.69	6.31	0.022		
	3	8.18	1.47	12.55	2.10	3.06	1.50	6.01	0.025		
	4	8.57	1.46	12.28	2.18	3.18	1.55	5.88	0.028		
	8	9.15	1.64	12.21	1.97	2.79	1.68	5.86	0.028		

Table 72. Relative EFA composition of total erythrocyte lipids in S.Pu

Period		Fatty acid									
Oil	Wk	18:2 n-6	20:3 n-6	20:4 n-6	18:3 n-3	20:5 n-3	22:5 n-3	22:6 n-3	20:3 n-9	20:4 n-6	
<----- % of total fatty acids ----->											
BL	0	8.04	1.03	14.09	1.72	3.71	1.20	5.98	0.016		
	2	8.89	1.02	14.48	1.52	3.44	1.61	7.53	0.021		
PO	3	9.02	1.12	15.78	1.50	3.41	1.36	5.85	0.020		
	1	8.16	1.05	14.44	1.54	3.36	1.85	7.50	0.020		
	2	7.92	1.59	16.13	1.28	3.93	1.55	6.86	0.033		
	4	8.57	1.36	14.97	1.29	3.16	1.02	6.04	0.023		
	8	8.43	1.26	14.45	1.44	2.97	1.31	6.17	0.017		
WO	4	7.71	1.04	14.74	1.70	3.23	1.20	5.91	0.013		
SB	2	8.68	1.30	15.03	1.74	3.62	1.52	6.26	0.030		
	3	9.21	1.01	14.85	1.51	3.28	1.18	5.80	0.020		
	4	8.90	1.05	14.79	1.78	3.23	1.27	5.82	0.015		
	8	8.74	1.13	15.06	1.52	3.07	1.41	5.88	0.016		

Table 73. Relative NEFA composition of total erythrocyte lipids in C.Ki

Period		Fatty acid							
Oil	Wk	14:0	16:0	18:0	20:0	16:1	18:1	20:1	20:3 n-9
<----- % of total fatty acids ----->									
BL	0	0.40	21.97	16.16	0.35	0.30	11.95	0.14	0.23
	2	0.47	21.79	16.60	0.38	0.28	11.77	0.24	0.38
	3	0.31	21.99	16.72	0.35	0.24	12.20	0.17	0.29
PO	1	0.28	21.25	15.40	0.35	0.26	11.95	0.20	0.25
	2	0.26	21.33	15.49	0.37	0.26	12.22	0.09	0.33
	4	0.31	21.70	15.49	0.35	0.31	12.22	0.16	0.22
	8	0.23	21.99	15.81	0.36	0.22	11.61	0.17	0.27
WO	4	0.30	22.92	16.16	0.28	0.29	12.25	0	0.24
SB	2	0.27	20.58	16.40	0.31	0.22	11.38	0.16	0.27
	3	0.24	21.29	16.14	0.35	0.21	10.96	0.16	0.26
	4	0.27	20.96	15.83	0.37	0.24	10.92	0.16	0.22
	8	0.32	21.85	16.57	0.36	0.13	10.99	0.13	0.24

Table 74. Relative NEFA composition of total erythrocyte lipids in C.Pe

Period		Fatty acid							
Oil	Wk	14:0	16:0	18:0	20:0	16:1	18:1	20:1	20:3 n-9
<----- % of total fatty acids ----->									
BL	0	0.45	22.39	15.71	0.32	0.33	11.66	0.20	0.33
	2	0.47	22.54	16.94	0.34	0.28	12.08	0.20	0.33
	3	0.49	22.74	16.61	0.33	0.30	11.83	0.22	0.30
PO	1	0.33	21.95	15.91	0.32	0.25	11.77	0.18	0.27
	2	0.30	22.21	15.74	0.41	0.25	12.12	0.19	0.27
	4	0.35	22.64	15.74	0.33	0.33	12.89	0.20	0.29
	8	0.29	23.17	16.18	0.36	0.19	12.19	0.13	0.18
WO	4	0.57	22.38	15.23	0.28	0.27	11.86	0.16	0.26
SB	2	0.48	20.84	16.04	0.29	0.25	11.26	0.20	0.29
	3	0.33	22.06	16.02	0.36	0.29	11.53	0.16	0.27
	4	0.37	21.99	15.61	0.31	0.42	11.55	0.18	0.27
	8	0.31	22.53	16.37	0.32	0.24	11.67	0.16	0.26

Table 75. Relative NEFA composition of total erythrocyte lipids in P.Lo

Period		Fatty acid							
Oil	Wk	14:0	16:0	18:0	20:0	16:1	18:1	20:1	20:3 n-9
		<----- % of total fatty acids ----->							
BL	0	0.33	21.48	16.56	0.41	0.17	11.22	0.20	0.37
	2	0.32	22.21	17.72	0.38	0	11.47	0.22	0.22
	3	0.36	22.54	17.40	0.39	0.18	11.68	0.20	0.30
PO	1	0.30	21.23	16.21	0.43	0.21	11.44	0.22	0.32
	2	0.27	21.60	16.14	0.49	0	11.92	0	0.51
	4	0.25	23.12	16.89	0.40	0.18	12.37	0.18	0.26
	8	0.32	22.29	15.96	0.38	0.18	11.64	0.18	0.23
WO	4	0.24	22.08	16.17	0.32	0.19	11.53	0.19	0.27
SB	2	0.37	20.84	16.61	0.34	0.16	11.49	0.14	0.21
	3	0.24	21.82	16.67	0.34	0	11.16	0.23	0.28
	4	0.27	22.06	16.42	0.36	0.19	11.05	0.19	0.27
	8	0.38	22.20	16.68	0.38	0.20	11.18	0.17	0.26

Table 76. Relative NEFA composition of total erythrocyte lipids in S.Na

Period		Fatty acid							
Oil	Wk	14:0	16:0	18:0	20:0	16:1	18:1	20:1	20:3 n-9
< ----- % of total fatty acids ----- >									
BL	0	0.51	23.53	15.99	0.36	0.39	11.77	0.23	0.40
	2	0.53	22.86	16.50	0.47	0.32	12.04	0.23	0.34
	3	0.51	23.54	17.14	0.41	0.34	12.48	0.24	0.33
PO	1	0.40	23.38	16.71	0.40	0.32	12.72	0.22	0.33
	2	0.33	23.11	15.96	0.36	0.29	12.80	0.20	0.14
	4	0.49	22.68	15.74	0.40	0.29	12.62	0.24	0.33
	8	0.37	24.53	16.09	0.36	0.31	12.97	0.24	0.29
WO	4	0.62	24.05	15.95	0.28	0.33	14.20	0.12	0.18
SB	2	0.32	22.56	15.95	0.33	0.30	12.21	0.19	0.28
	3	0.28	23.60	16.22	0.38	0.29	11.88	0.25	0.31
	4	0.39	23.19	16.14	0.37	0.28	11.72	0.20	0.34
	8	0.41	24.32	16.03	0.36	0.28	11.66	0.19	0.34

Table 77. Relative NEFA composition of total erythrocyte lipids in S.Pa

Period		Fatty acid							
Oil	Wk	14:0	16:0	18:0	20:0	16:1	18:1	20:1	20:3 n-9
< % of total fatty acids >									
BL	0	0.36	22.62	16.59	0.33	0.26	11.76	0.18	0.30
	2	0.40	22.91	16.87	0.34	0.30	12.05	0.18	0.34
	3	0.43	22.68	16.66	0.39	0.31	11.84	0.21	0.32
PO	1	0.29	23.26	16.01	0.32	0.29	12.39	0.18	0.27
	2	0.26	23.80	15.92	0.34	0.30	12.71	0.20	0.31
	4	0.36	23.96	15.50	0.32	0.26	12.62	0.19	0.30
	8	0.32	23.59	15.50	0.29	0.40	12.96	0.15	0.29
WO	4	0.33	23.12	15.78	0.31	0.27	12.21	0.16	0.27
SB	2	0.42	22.06	16.47	0.25	0.29	12.01	0	0.14
	3	0.29	22.52	16.13	0.38	0.19	11.53	0.18	0.32
	4	0.33	22.03	15.83	0.32	0.12	11.49	0.20	0.35
	8	0.32	23.15	16.21	0.29	0.31	11.63	0.16	0.29

Table 78. Relative NEFA composition of total erythrocyte lipids in S.Pu

Period		Fatty acid							
Oil	Wk	14:0	16:0	18:0	20:0	16:1	18:1	20:1	20:3 n-9
<----- % of total fatty acids ----->									
BL	0	0.35	22.82	17.39	0.40	0.19	11.61	0	0.22
	2	0.56	22.09	16.52	0.40	0.25	11.34	0.19	0.31
	3	0.34	22.34	16.72	0.54	0.23	11.50	0.18	0.31
PO	1	0.30	22.17	16.12	0.38	0.21	11.39	0.17	0.28
	2	0.42	21.35	15.00	0.37	0.26	11.37	0.43	0.53
	4	0.41	23.40	15.89	0.37	0.23	12.24	0.18	0.34
	8	0.35	22.97	16.13	0.35	0.20	11.78	0.09	0.24
WO	4	0.44	22.64	16.29	0.27	0.22	12.03	0.09	0.19
SB	2	0.32	20.66	15.63	0.32	0.24	10.80	0.22	0.45
	3	0.38	22.15	16.13	0.36	0.12	10.90	0.18	0.30
	4	0.37	22.10	16.22	0.29	0.22	11.12	0.11	0.22
	8	0.39	22.66	16.28	0.28	0.17	10.71	0.09	0.24

Table 79. Relative BFA composition of total erythrocyte lipids in group II

Period		Mean±SEM							
Oil	Wk	18:2 n-6	20:3 n-6	20:4 n-6	18:3 n-3	20:5 n-3	22:5 n-3	22:6 n-3	20:3 n-9 20:4 n-6
← % of total fatty acids →									
BL	0	8.01±0.27	1.30±0.11	13.50±0.45	1.66±0.03	3.61±0.17	1.53±0.09	7.02±0.29	0.023±0.003
	2	8.66±0.19	1.33±0.09	13.55±0.36	1.64±0.05	3.50±0.09	1.54±0.06	7.23±0.18	0.024±0.002
	3	8.60±0.24	1.32±0.11	14.18±0.53	1.52±0.05	3.54±0.12	1.43±0.07	6.56±0.35	0.022±0.001
PO	1	8.10±0.18	1.32±0.10	13.35±0.45 ^e	1.54±0.07	3.58±0.14	1.65±0.07	7.68±0.24 ^e	0.022±0.001
	2	8.06±0.25	1.36±0.09	13.68±0.71	1.47±0.05	3.76±0.14	1.66±0.10	7.53±0.23	0.025±0.004
	4	8.30±0.29	1.40±0.10	13.41±0.64	1.40±0.03	3.28±0.16 ^b	1.44±0.10	7.08±0.22	0.022±0.002
	8	8.03±0.18 ^f	1.44±0.12	13.16±0.54 ^c	1.53±0.04	3.20±0.15	1.60±0.07	6.51±0.21	0.019±0.002
WO	4	7.69±0.44	1.23±0.09	13.32±0.54	1.63±0.07	3.19±0.11	1.54±0.09	6.88±0.33	0.018±0.002
SB	2	8.82±0.21 ^f	1.33±0.07	13.86±0.76	1.76±0.07	3.71±0.19	1.60±0.05	6.64±0.19	0.019±0.003
	3	8.81±0.20	1.26±0.11	13.47±0.58	1.71±0.09	3.47±0.15	1.31±0.09	6.29±0.18	0.022±0.002
	4	8.92±0.14	1.30±0.10	13.37±0.65 ^{e*}	1.86±0.11	3.42±0.13	1.44±0.07	6.26±0.17 ^{c,e}	0.022±0.003
	8	9.10±0.19 ^{c,f}	1.36±0.11 ^e	13.47±0.56	1.73±0.11	3.23±0.16	1.55±0.04	6.21±0.17	0.021±0.002

BL3 VS P01:e; BL3 VS P08:b,c,f; W04 VS SB2:e,f; W04 VS SB8:e,f; P08 VS SB8:c,e*.

b=P<0.0025, c=P<0.005, e=P<0.025, f=P<0.05

Table 80. Relative NEFA composition of total erythrocyte lipids in group II

Period		Mean±SEM							
Oil	Wk	14:0	16:0	18:0	20:0	16:1	18:1	20:1	20:3 n-9
----- % of total fatty acids ----->									
BL	0	0.40±0.03	22.47±0.29	16.40±0.24	0.36±0.02	0.29±0.03	11.66±0.10	0.19±0.02	0.31±0.03
	2	0.46±0.04	22.40±0.18	16.86±0.19	0.38±0.02	0.29±0.01	11.79±0.13	0.21±0.01	0.32±0.02
	3	0.41±0.03	22.64±0.21	16.88±0.13	0.40±0.03	0.27±0.02	11.92±0.15	0.21±0.01	0.31±0.01
PO	1	0.31±0.02 ^c	22.21±0.38	16.06±0.17 ^c	0.37±0.02	0.26±0.02	11.94±0.22	0.20±0.01	0.29±0.01
	2	0.31±0.02	22.23±0.42	15.71±0.17	0.39±0.02	0.27±0.01	12.17±0.22	0.17±0.03	0.35±0.06
	4	0.36±0.03	22.92±0.32	15.88±0.21	0.36±0.01	0.27±0.02	12.48±0.12	0.19±0.01	0.29±0.02
	8	0.31±0.02 ^f	23.09±0.37	15.94±0.10 ^c	0.35±0.01	0.25±0.04	12.19±0.26	0.17±0.02	0.25±0.02 ^e
WO	4	0.42±0.06	22.87±0.28	15.93±0.16	0.29±0.01	0.26±0.02	12.35±0.39	0.16±0.01	0.23±0.02
SB	2	0.36±0.03 ^a	21.26±0.34	16.18±0.15	0.31±0.01	0.24±0.02	11.53±0.21 ^f	0.17±0.01	0.27±0.04
	3	0.29±0.02	22.24±0.32	16.22±0.09	0.36±0.01	0.22±0.03	11.53±0.16	0.20±0.02	0.29±0.01
	4	0.33±0.02	22.06±0.29	16.01±0.12	0.34±0.01	0.24±0.04	11.31±0.13	0.19±0.01	0.28±0.02
	8	0.36±0.02 ^e	22.78±0.36 ^e	16.36±0.10 ^{f,f*}	0.33±0.02	0.22±0.03	11.31±0.17 ^{c,f*}	0.16±0.01	0.27±0.02

BL3 VS PO1:c; BL3 VS PO8:c,e,f; WO4 VS SB2:a,f; WO4 VS SB8:f*; PO8 VS SB8:c,e,f.
a=P<0.001, c=P<0.005, e=P<0.025, f=P<0.05

levels at SB8 were significantly higher than those at P08 but opposite results were observed for erythrocyte 16:0 and 18:1.

Platelet function

The means($\pm$ SEM) percentages of maximal platelet aggregation induced by ADP, epinephrine or collagen in groups I and II are shown in Tables 81 and 82. No significant differences in these parameters were found in group I. In group II, maximal platelet aggregation value induced by ADP and collagen at P01 were significantly higher than that at BL3 whereas the percentage of maximal platelet aggregation or induced by ADP at SB8 was significantly higher than that at P08.

Table 81. Means $\pm$ SEM of percentage of maximal platelet aggregation induced by ADP, epinephrine, or collagen in group I

Period		Percentage of maximal platelet aggregation		
Oil	Wk	ADP, 3 μ M	Epinephrine, 5 μ M	Collagen, 0.2 mg/ml
BL	0	19.3 $\pm$ 3.6	61.1 $\pm$ 10.2	83.0 $\pm$ 1.2
	1	32.2 $\pm$ 9.4	55.2 $\pm$ 11.4	85.6 $\pm$ 3.3
	2	12.6 $\pm$ 3.4	50.4 $\pm$ 13.6	91.7 $\pm$ 2.3
	4	32.4 $\pm$ 10.2	62.2 $\pm$ 13.7	86.5 $\pm$ 0.8
SB	1	26.1 $\pm$ 6.2	48.7 $\pm$ 11.5	85.4 $\pm$ 2.3
	2	21.0 $\pm$ 6.5	45.6 $\pm$ 16.6	83.4 $\pm$ 1.2
	4	31.1 $\pm$ 8.5	51.9 $\pm$ 14.4	86.6 $\pm$ 3.3
	8	36.2 $\pm$ 11.4	65.2 $\pm$ 15.5	89.3 $\pm$ 2.5
WO	4	21.4 $\pm$ 4.0	34.5 $\pm$ 9.3	89.0 $\pm$ 2.5
PO	2	25.1 $\pm$ 5.1	41.1 $\pm$ 11.5	91.7 $\pm$ 2.3
	3	26.4 $\pm$ 5.5	30.1 $\pm$ 10.9	87.9 $\pm$ 2.2
	4	20.6 $\pm$ 5.4	43.0 $\pm$ 12.4	87.0 $\pm$ 1.9
	8	25.1 $\pm$ 5.5	61.7 $\pm$ 10.9	90.7 $\pm$ 1.4

BL4 VS SB1:ns; BL4 VS SB8:ns; WO4 VS PO2:ns; WO4 VS PO8:ns;
SB8 VS PO8:ns.

Table 82. Means $\pm$ SEM of percentage of maximal platelet aggregation induced by ADP, epinephrine, or collagen in group II

Period		Percentage of maximal platelet aggregation		
Oil	Wk	ADP, 3 μ M	Epinephrine, 5 μ M	Collagen, 0.2 mg/ml
BL	0	36.9 $\pm$ 6.5	68.4 $\pm$ 9.3	85.0 $\pm$ 2.4
	2	25.0 $\pm$ 5.8	45.4 $\pm$ 11.4	86.6 $\pm$ 1.4
	3	20.8 $\pm$ 3.4	30.8 $\pm$ 11.5	85.1 $\pm$ 2.0
PO	1	33.4 $\pm$ 5.4 ^f	71.9 $\pm$ 7.4	93.7 $\pm$ 2.0 ^e
	2	33.8 $\pm$ 6.7	57.2 $\pm$ 10.9	86.0 $\pm$ 3.0
	4	25.2 $\pm$ 3.6	40.0 $\pm$ 11.6	89.5 $\pm$ 1.4
	8	18.7 $\pm$ 4.1	45.7 $\pm$ 12.9	87.8 $\pm$ 2.7
WO	4	33.1 $\pm$ 7.8	57.3 $\pm$ 14.5	82.2 $\pm$ 3.0
SB	2	22.4 $\pm$ 4.4	57.7 $\pm$ 9.6	83.4 $\pm$ 5.9
	3	32.2 $\pm$ 3.6	53.5 $\pm$ 21.3	85.3 $\pm$ 4.6
	4	31.1 $\pm$ 2.5	69.1 $\pm$ 10.6	96.2 $\pm$ 1.8
	8	34.6 $\pm$ 6.2 ^e	66.2 $\pm$ 12.1	90.1 $\pm$ 4.4

BL3 VS P01:e,f; BL3 VS P08:ns; WO4 VS SB2:ns; WO4 VS SB8:ns;
 P08 VS SB8:e.
 e=P<0.025, f=P<0.05

CHAPTER IV

DISCUSSION

General nutritional status

General nutritional status of all the subjects was assessed by dietary intake, anthropometric and hematological parameters.

Anthropometric parameters were assessed by body weight, BMI and body fat. Before entering the study, all of the subjects had BMI in the range of 19.10-25.20 kg/m². There were no significant changes of BMI, body weight and body fat throughout the study (Table 9). This confirmed that the subjects had adequate energy intake during the vegetable oil periods (Table 6).

Throughout the study there were no striking changes in hematological parameters including Hb, Hct, RBC, MCV, MCH, MCHC, WBC, platelet and total lymphocyte counts and the values were within the normal limits (62).

Cholesterol-lowering diet

Present evidence indicates that elevated serum total cholesterol levels due to high levels of LDL-C play a casual role in atherosclerotic heart disease (63,64). Appropriate dietary intake is the primary mode to lower serum total cholesterol level for the general population

and high risk individuals. The current dietary recommendation consists of controlling obesity by decreasing energy intake and by exercise, reducing total fat intake to 30% or less of total dietary energy with equal distribution of saturated, monounsaturated, and polyunsaturated fatty acids (SFA, MUFA, PUFA), and lowering daily cholesterol intake to less than 300 mg (65,66). Based on this recommendation, the subjects were assigned to consume the same amount of energy and cholesterol intakes during the vegetable oil periods (Tables 6-8), with a daily dietary energy distribution of 15, 30 and 55% derived from protein, fat and carbohydrate, respectively. The two vegetable oils, i.e., soybean and palm oils employed in this study made the difference of individual fatty acid intake.

PUFA

The precursors of PUFA of n-3, n-6, n-7 and n-9 families are alpha-linolenic (18:3 n-3) acid, linoleic (18:2 n-6) acid, palmitolic (16:1 n-7) acid and oleic (18:1 n-9) acid. Each family can be transformed by a series of desaturation and elongation reactions leading to metabolites that are not interconvertible. The important metabolites of alpha-linolenic acid are eicosapentaenoic (20:5 n-3) and docosahexaenoic (22:6 n-3) acids. Major dietary source of 18:3 n-3 is plant oil, linseed oil or

soybean oil and of 20:5 n-3, and 22:6 n-3 are marine origins. However, linoleic (18:2 n-6) acid is more prevalent in the diets than n-3. It is the principle PUFA in vegetable seed oil. The important metabolic derivatives of 18:2 n-6 are dihomogamma-linolenic (20:3 n-6) and arachidonic (20:4 n-6) acids. PUFA of n-3 and n-6 families serves as the structure and function of biological membranes, precursors of the eicosanoids which include prostaglandins, prostacyclins, thromboxanes and leukotrienes and regulators of lipoprotein metabolism (67-69). MUFA, i.e., palmitoleic (16:1 n-7) and oleic (18:1 n-9) acids can be provided exogenously from foods or endogenously from desaturation of SFA, palmitic (16:0) or stearic (18:0) acids. These MUFA are important fuel molecules and have structural and functional roles in case of EFA deficiency (70).

Fatty acid composition of soybean and palm oils

Table 1 shows that soybean and palm oils have markedly differences in fatty acid composition. SFA content in soybean oil is 12.9% whereas that in palm oil is 43.7%. The main SFA in both oils is palmitic acid. MUFA constitutes 26.8% of total fatty acids in soybean oil and 43.2% in palm oil. The main MUFA in both oils is oleic acid. PUFA contents in soybean and palm oils are 60 and 12.4%, respectively. The main PUFA in both oils is

linoleic acid. It should be noted that the palmitate, oleate, and linoleate contents in soybean oil are 9.2, 26.5 and 53.0% respectively, whereas those in palm oil are 38.2, 42.5 and 12.0%. Besides, alpha-linolenate content in soybean oil is 7.0% whereas that in palm oil is 0.4%. Thus the P/S ratio of SB is 4.6 whereas that of PO is 0.3. However, palm oil is low in sterols and rich in carotenoids and vitamin E (71). Nutritional properties of soybean oil is widely studied and its high PUFA content can lower serum LDL-C level (64,72). In contrast to soybean oil, effects of palm oil on blood lipids appeared to be contradictory findings.

Analysis of fatty acid composition

The determination of fatty acid composition of the appropriate tissues provides the information on the adequacy of EFA status. Human specimens serve for this purpose include serum, erythrocyte and adipose tissue. In these constituents, turn over of fatty acids is at different rates; differences arise in time required for a change in dietary fat type to be totally reflected in the fatty acid pattern. The fatty acid composition of human serum triglyceride reflects the composition of the last few meals, that of erythrocyte membrane reflects the dietary intake of the preceding weeks or months (73,74) whereas that of human subcutaneous adipose tissue is a

valid index of the fatty acid composition of the habitual diet over the past 2-3 years (75-77).

Membrane of RBC and its protein composition determine the fluidity in blood circulation and also the rate of transfer of many plasma constituents. RBC membrane like plasma membrane of the other cells that it is made up mainly of phospholipid and free cholesterol. Total fatty acid composition of normal red cell are concluded as phospholipid fatty acid in which saturated and unsaturated fatty acids are about equally distributed (78).

Four major steps, i.e., extraction of total lipids, saponification, methylation of fatty acids, and determination of fatty acid pattern by gas-liquid chromatography are required for fatty acid analysis. The levels of individual fatty acid are expressed as relative composition in total lipids (79-81). In our study, fatty acid pattern in each subject was determined in their total serum and erythrocyte lipids.

N-6 PUFA status

Human inadequate linoleate status can be sequentially categorized into 3 stages: biochemical linoleate depletion, biochemical linoleate deficiency, and clinical linoleate deficiency. Biochemical linoleate depletion is diagnosed by the decrease in serum 18:2 n-6

level with concomitant increase in serum 18:1 n-9 level whereas 20:4 n-6 level may be normal or decreased. Biochemical linoleate deficiency is characterized by serum 20:3 n-9/20:4 n-6 ratio of greater than 0.2 in addition to the decreases in serum 18:2 n-6 and 20:4 n-6 levels. Clinical linoleate deficiency consists of clinical manifestations of scaly dermatitis and biochemical findings of linoleate deficiency (69,81-87).

The mean serum linoleate levels at the baseline period in groups I and II ranged from 20.97 to 23.64% of total fatty acids (Tables 37 and 51). During the baseline period, both groups did not show significant changes in mean serum 18:2 n-6, 20:3 n-6, and 20:4 n-6 levels (Tables 37 and 51). The same findings were observed when these n-6 PUFA levels were considered as individual subject (Tables 25-30 and 39-45). It should be noted that the mean($\pm$ SD) serum 18:2 n-6, 20:3 n-6 and 20:4 n-6 levels in 3 control subjects studied by Bjerve et al (87) were 29.1 ± 1.64 , 2.5 ± 0.63 , and $7.0\pm1.97\%$, respectively. Thus our data indicate that both groups of our subjects during the baseline period had adequate n-6 PUFA status. This is also supported by the serum 20:3 n-9/20:4 n-6 ratio of less than 0.2 (Tables 25-30, 37, 39-44, and 51) (69,81-87). For comparisons between the vegetable oil and baseline periods, the fatty compositions in group I at wk

4 of the baseline period (BL4) and that in group II at wk 3 (BL3) were used as the reference values.

Pakpeankitvatana and Tanphaichitr (72) have shown the effects of soybean oil (SB), cottonseed oil (CS), rice bran oil (RB) and palm oil (PO) intake on lipid status in 8 normolipidemic healthy men with the age of 30-36 yr and BMI of 20 kg/m² and above at Clinical Research Ward, Ramathibodi Hospital. They consumed 4 isocaloric diets each for 3 weeks. The energy distribution of each diet was 15% protein, 30% fat and 55% carbohydrate. One-third of the fat intake came from structural fat which remained constant throughout the study. Two-thirds of the fat intake were derived from either, SB, CS, RB, or PO. The only difference of these 4 diets were the amounts of individual fatty acid intake, especially linoleic, alpha-linolenic, oleic and palmitic acids. The linoleate intake during the SB, CS, RB, and PO were 11.2, 11.0, 7.6 and 3.3% of total calories while the oleate and palmitate intakes were 8.8 and 3.9% during the SB period, 7.0 and 7.0% during the CS period, 11.8 and 5.4% during the RB period, and 11.9 and 9.5% during the PO period. These fatty acid intakes together with the ratio of linoleate:oleate intake correlated with its levels in the serum. These indicate the adherence of their subjects to the diets employed in their study. Linoleate status in their subjects were adequate throughout the study. However,

during the SB and CS periods they had the highest serum linoleate levels. During consuming the 4 diets, the subjects had a daily cholesterol intakes of 925 mg. Serum total cholesterol and LDL-C levels decreased by an average of 10.1 and 15.5% for SB, 7.4 and 12.0% for CS, 14.4 and 20.8% for RB, and 1.3 and 0% for PO. Regarding to alpha-linolenic acid, the subjects had the highest serum alpha-linolenic acid during consuming SB. Thus it seems that SB is the most appropriate vegetable oil to maintain the adequacy of linoleate and alpha-linolenate status with concomitant decrease in serum total cholesterol and LDL-C levels among the 4 tested vegetable oils. The fatty acid composition of serum lipids in each subject was determined not only in serum total lipids but also in its subclasses including cholesterol esters, phospholipids, triglycerides, and free fatty acids. During the SB and CS periods, linoleate intakes in these subjects were nearly equal, i.e., 11.2 and 11.0% of total calories. Their linoleate intakes during the RB and PO periods were lower than those during the SB and CS periods, i.e., 7.6 and 3.3% of total calories, respectively. Since the mean ($\pm$ SEM) fat absorption during consuming SB, CS, PO, and RB were 96.54 ± 0.55 , 96.09 ± 0.58 , 96.54 ± 0.31 , and $92.72 \pm 0.80\%$, respectively, it was anticipated that the fatty acid composition of these vegetable oils should influence the fatty acid composition of their serum lipids. This was

evident by the significant increases in serum 18:2 n-6 levels in total serum lipids, cholesterol esters, phospholipids, and triglycerides during the SB, CS, and RB periods. There were also significant increases in serum 18:2 n-6 levels in free fatty acids during the SB and CS periods. Besides, there were significant positive correlations between linoleate intake and its levels in total serum lipids and lipid subclasses.

Regarding to dihomogamma-linolenic and arachidonic acids which are the metabolic derivatives of linoleic acid, these two serum EFA levels during the SB, CS, PO and RB periods tended to be lower than those during the BL period. However, the significant differences were observed in serum cholesterol esters for arachidonic acid and in serum cholesterol esters, phospholipids, and triglycerides for dihomogamma-linolenic acid. The decrease in serum arachidonate levels during the SB, CS PO, and RB periods were most likely due to the limited intake of this EFA derived from food structural fat. Since their subjects had identical amount of arachidonate intake during these 4 dietary periods, the varying serum arachidonate levels in total lipids and lipid subclasses should represent the difference in biosynthesized arachidonic acid. The low serum dihomogamma-linolenate and arachidonate levels suggested there was no increase in biosynthesized arachidonic acid from linoleic acid. The

suppression of biotransformation of linoleic acid to arachidonic acid in the presence of a significant amount of alpha-linolenate intake was unlikely to take place in their subjects because low serum arachidonate levels were observed even at low alpha-linolenate intake.

Pakpeankitvatana and Tanphaichitr (72) have also shown the influence of the amount of oleate intake on serum oleate level. The oleate intake in these subjects during the SB, CS, PO and RB periods were 8.8, 7.0, 11.9, and 11.8% of total calories, respectively. Serum oleate levels in total lipids and lipid subclasses during the PO and RB periods were nearly equal and higher than those during the SB and CS periods. Besides, there were significant positive correlations between oleate intake and serum oleate levels in total lipids, lipid subclasses except free fatty acids.

Palmitic acid was the main saturated fatty acid intake during the SB, CS, PO, and RB periods and constituted 3.9, 7.0, 9.5, and 5.4% of total calories, respectively. There were significant positive correlations between palmitate intake and serum palmitate levels in total lipids, triglycerides, and free fatty acids.

The ratios of linoleate: oleate intake during the SB, CS, PO, and RB periods were 1.27, 1.57, 0.28, and 0.64, respectively. The influence of these two fatty acid intake on serum linoleate/oleate ratio in the subjects was not

only observed in cholesterol esters but also in total lipids, phospholipids, triglycerides and free fatty acid. These indicate the adherence of the subjects to the 4 diets employed in the study of Pakpeankitvatana and Tanphaichitr (72).

There are 3 main points of differences between our study and Pakpeankitvatana and Tanphaichitr's study (72). First, only soybean and palm oils were employed in our study but the duration of the consumption of each vegetable oil was longer, i.e., 8 wks instead of 3 wks. Secondly, there was a 4-wk washout period between the two vegetable oil periods in our study. Thirdly, the protein sources in Pakpeankitvatana and Tanphaichitr's study (72) were pork, egg, and rice which supplied 7.6, 2.8, and 4.6% of total calories whereas the protein sources in our study were pork, chicken, and rice which supplied 5.67, 5.58, and 3.75% of total calories. This, in turn, caused the difference in the amount of cholesterol intake between the two studies. The mean daily cholesterol intakes in our subjects and Pakpeankitvatana and Tanphaichitr's subjects (72) were 177 and 925 mg, respectively.

In our study, during the soybean oil period linoleate and oleate intakes in group I were 13.67 and 8.08% of total calories, respectively, whereas during the palm oil period their linoleate and oleate intakes were 3.44 and 12.42% (Tables 6-8). Thus the ratios of their

linoleate: oleate intakes during the soybean oil and palm oil periods were 1.69 and 0.28, respectively. Their linoleate: oleate ratios of total serum lipids during the soybean oil period at wks 1, 2, 4 and 8 were 2.70, 2.59 and 2.82 and 2.45, respectively, which were higher than those during the baseline period (1.62, 1.88, 2.07, and 1.91 at wks 0, 1, 2, and 4, respectively), during the washout period (2.03), and during the palm oil period (1.77, 1.66, 1.72 and 1.96 at wks 2, 3, 4, and 8, respectively (Tables 37 and 38). These data indicate that our subjects complied to the assigned menus served during the soybean oil and palm oil periods. The findings are consistent with the highest linoleate percentages of total serum lipids during the soybean oil period (Table 37) and there were no striking changes in serum 18:2 n-6 and 18:1 n-9 levels within each study period (Tables 37 and 38). The influence of high linoleate intake during the soybean oil period was detected within one week. The influence of high oleate intake on serum oleate levels was also evident by higher serum oleate levels during the palm oil period than other dietary periods (Table 38). The result agrees with the previous study (72)

The influence of dietary arachidonate intake on serum arachidonate percentage of total serum lipids (69,81-86) is also observed in our study. Despite of the increases in serum linoleate percentages during the

soybean oil period in group I, their serum arachidonate percentages declined. The arachidonate intakes in these subjects during the soybean oil and palm oil periods were identical, i.e., 0.07% of total calories. The suppression of biotransformation of linoleic acid to arachidonic acid in the presence of a significant amount of alpha-linolenate intake (72,83,86) was unlikely to take place in our subjects because low serum arachidonate level was also observed during the palm oil period (Table 37).

All of the aforementioned findings were also observed in group II (Tables 79 and 80). This is due to the fact that group II had similar fatty acid intakes as in group I during the vegetable oil periods. Their linoleate, oleate, and arachidonate intakes during the soybean oil period were 13.80, 8.15, and 0.07% of total calories whereas the corresponding figures during the palm oil period were 3.48, 12.55, and 0.07% of total calories.

The mean erythrocyte 18:2 n-6 levels in groups I and II during the baseline period ranged from 7.95-8.32% of total fatty acids (Tables 65 and 79), which were similar to the reports from China = $\text{mean} \pm \text{SD} = 8.47 \pm 1.09\%$ (88), from England ($\text{mean} \pm \text{SEM} = 8.85 \pm 0.32\%$) (89), and from Canada ($\text{mean} \pm \text{SEM} = 9.78 \pm 0.24\%$) (90). The findings indicate the long-term adequacy of linoleate status in our subjects before entering the vegetable oil periods. The influence of high linoleate intake on linoleate

percentages of total erythrocyte lipids was evident by higher erythrocyte linoleate levels during the soybean oil period than during the palm oil periods (Tables 65 and 79).

In contrast to the findings in serum total lipids, there was no decrease in erythrocyte 20:4 n-6 levels in group I during the soybean oil period (Table 65) whereas it increased in group II (Table 79). These findings strengthen the view that there is no suppression of arachidonate biosynthesis from alpha-linolenate intake under our dietary condition.

N-3 PUFA status

There are increasing evidences indicating that alpha-linolenic acid is required for humans (69,88,92,93). The estimated daily alpha-linolenate requirement in children is 0.54% of total caloric intake or 44 mg/kg/day (91) whereas the estimated minimal daily requirement of alpha-linolenic acid and other n-3 PUFA in adults is 0.2-0.3% and 0.1-0.2%, respectively, of total energy intake (87,92). In our study, the alpha-linolenate intakes in groups I and II during the soybean oil period were 1.77 and 1.79% of total calories whereas those in both groups during the palm oil period were 0.07% of total calories (Tables 7 and 8). The influence of the amount of alpha-linolenate intake on serum and erythrocyte alpha-

linolenate levels was observed in both groups evidenced by higher serum and erythrocyte 18:3 n-3 levels during the soybean oil period than during the palm oil period (Tables 37, 51, 65 and 79). These data indicate that our subjects adhere to the assigned diets.

Since 20:5 n-3 and 22:6 n-3, the metabolic derivatives of 18:3 n-3, play several biological functions including those of retina and central nervous system (91,93,94), the n-3 PUFA were measured in serum and total erythrocyte lipids in our study. Despite of the high serum 18:3 n-3 levels during the soybean oil period, there were no striking changes in the concentrations of its metabolic derivatives (Tables 37 and 51). The influence of dietary 20:5 n-3 and 22:6 n-3 intakes on their serum levels were supported by the following findings: (a) serum 20:5 n-3 and 22:6 n-3 levels in group I during the baseline and washout periods were higher than those during the soybean oil and palm oil periods (Table 37), whereas such findings were not observed in group II (Table 51), and (b) serum 20:5 n-3 and 22:6 n-3 levels in both groups during the soybean oil and palm oil periods were rather constant (Tables 37 and 51) due to the consumption of the assigned menus. Our results are consistent with the previous study (72).

The influence of dietary alpha-linolenate intake on erythrocyte 18:3 n-3 levels was also observed in our

study. Erythrocyte 18:3 n-3 levels during the soybean oil period were higher than those during the palm oil period but the values reached statistical significance in group I at wk 8 only (Tables 65 and 79). One striking finding is that erythrocyte 22:6 n-3 levels in both groups during the palm oil period at wk 8 were higher than those during the soybean oil period at wk 8 (Tables 65 and 79). Whether this is related to the suppression of biosynthesized 22:6 n-3 from 18:3 n-3 due to high 18:2 n-6 intake or not (69,95) needs further investigation.

Effect of fatty acid intakes on serum lipoprotein, and fibrinogen levels and platelet aggregation

The relationship between PUFA, monounsaturated and saturated fatty acid intakes on serum lipoprotein have been studied by many investigators. Keys et al (96) reported the predictive equation to detect changes in serum cholesterol related to saturated fatty acids, oleic acid, and PUFA. They concluded that saturated fatty acids raised the serum total cholesterol about twice as much as linoleic acid lowered the serum total cholesterol level whereas the effect of oleic acid is uncertain. Kinsell et al (97) reported that linoleic acid lowered plasma lipid levels whereas oleic acid did not. Ahrens et al (98) have demonstrated a cholesterol-lowering effect of the fish oils. Grande et al (99) found that highly unsaturated

fish oils do not appear to be more hypocholesterolemic than oil containing primarily linoleic acid.

A hypocholesterolemic action of linoleic acid is well established but the mechanisms by which linoleic acid lowers serum LDL-C levels have not been elucidated with certainty. Current evidence suggests that the decrease in the serum LDL-C levels upon exchanging linoleic acid for saturated fatty acids may be due to an increased activity of hepatocytic LDL receptors secondary to the removal of dietary saturated fatty acids (100). Besides, saturated fatty acid including lauric (12:0), myristic (14:0), and palmitic (16:0) acids that have the greatest effect in raising serum TC levels down-regulates hepatocytic LDL receptors, which, in turn, leads to the increased serum LDL levels (100,101). In addition, saturated fatty acids including stearic acid may predispose platelets to aggregation and facilitate thrombosis. These undesirable effects of saturated fatty acids on serum LDL concentrations and thrombogenesis are accentuated at high fat and cholesterol intakes (102).

The effect of increasing dietary cholesterol intake on raising serum TC levels varies from one subject to another and even within a given subject from one time to another. On the average, increasing dietary cholesterol by 100 mg/1,000 kcal will increase serum TC by approximately 10 mg/dL (102-104). However, the response

may not be constant at all levels of cholesterol intake. Most of the increase in serum TC level occurs in the LDL, but several reports suggest that increases also occur in VLDL and HDL. The mechanism by which dietary cholesterol increases serum TC level is due to its effect in suppressing the synthesis of hepatic LDL receptors (100).

At the baseline period 2 out of 6 subjects in each group (Tables 21 and 22) were hypercholesterolemic based on at least one value showing serum TC ≥ 5.2 mmol/L whereas 1 subject (C.Ki) in group II was type IV hyperlipoproteinemia based on serum TG ≥ 1.8 mmol/L and LDL-C < 3.4 mmol/L. However, the mean serum TC levels in both groups were within normal limit (Tables 20 and 24).

In our study the saturated fatty acids, oleate, and linoleate intakes in both groups during the soybean oil period were 4.82-4.86, 8.08-8.15, and 13.67-13.80% of total calories, respectively, whereas those during the palm oil period were 12.50-12.62, 12.42-12.55, and 3.44-3.48% of total calories (Tables 7 and 8). The daily mean($\pm$ SEM) cholesterol intakes in groups I during the 2 vegetable oil periods were identical, i.e., 179 ± 12 mg (Table 7). This is also true in group II (174 ± 11 mg) (Table 8).

In group I, cholesterol-lowering effect of soybean oil was detected within one week and lasted throughout the soybean oil period (Table 20). The net decreases in serum

TC and LDL-C levels at SB8 from those at BL4 were 30 and 40%, respectively. On the contrary, there were no significant changes in serum TC and LDL-C levels between the palm oil and washout periods. Such findings indicate the beneficial effect of soybean oil in lowering serum TC and LDL-C levels. This is supported by the significantly lower serum TC and LDL-C levels at SB8 than those at P08 (Table 20). It should be noted that one hypercholesterolemic subject (P.Jo) became normocholesterolemic at SB4 and the other (S.Pr) became normocholesterolemic at SB1 (Table 19). P.Jo became hypercholesterolemic throughout the washout and palm oil periods while S.Pr was hypercholesterolemic at P02, 3, and 8.

Since the statistical analysis (ANOVA) revealed the effect of sequence of dietary feedings on serum TC and LDL-C levels the data in group II were treated separately from those in group I. Unlike in group I, there was no significant difference in serum TC and LDL-C levels between P01 and BL3. However, only serum TC level at P08 was significantly lower than that at BL3 (Table 24). The net decreases in serum TC and LDL-C levels at P08 from those at BL3 were 9 and 8%, respectively. When comparisons were made between the soybean oil and washout periods, only serum TG level at SB2 was significantly lower than that at W04 whereas both serum TC and TG levels at SB8 were significantly lower than those at W04. The

net changes of serum TC, LDL-C, and TG levels at SB8 from W04 were -3, 16, and -39%, respectively. However, serum TC, LDL-C, and TG levels at SB8 were still lower than those at the P08 but only serum TC levels reached statistical significance.

It should be noted that C.Ki who was type IV hyperlipoproteinemia at the baseline period became normolipidemic during the soybean oil period only (Table 21). C.Pe who was hypercholesterolemic at the baseline period became normocholesterolemic at P04, P08, W04, SB4, and SB8 (Table 21). P.Lo who was hypercholesterolemic at the baseline period became normocholesterolemic at P01, P02, and throughout the soybean oil period (Table 21).

The decreases in serum TC and LDL-C levels during the study lead to the decline in serum TC/HDL-C and LDL-C/HDL-C ratios (Tables 20 and 24). The changes in serum M- and S- particle levels in both groups were consistent with those in their serum TC and TG levels (Tables 15 and 16).

Our study has shown that there was no striking changes in serum HDL-C levels in both groups during the soybean oil period and the mean levels were above the lowest limit (0.9 mmol/L) (Tables 20 and 24). Though serum HDL-C level in group I at P08 was significantly higher than that at SB8 (Table 20) this finding was not observed in group II (Table 24). Our results are

consistent with the current view that the lowering effect of linoleate-rich diets on serum HDL-C level appears to be a short term phenomenon, and occurs only with very large increase in linoleate intake (105).

The apoproteins are the major proteins found in HDL (106). Approximately 50% of HDL mass is protein, and Apo A-I and A-II constitute nearly 90% of it. Although the exact site of synthesis is still unclear, experimental evidence suggests that Apo A-I and A-II originate in the intestine or liver or both. After they enter the circulation as a component of chylomicrons, Apo A-I and A-II transfer to and accumulate in HDL. Apo B is the major protein moiety of all lipoproteins other than HDL. Two forms of Apo B are found in humans. The most abundant form is known as large B or B-100 and constitutes the Apo B found in lipoproteins synthesized in the liver. The other form of Apo B, small B or B-48, is believed to be synthesized in the intestinal wall. In normal subjects, very little if any B-48 is found in fasting plasma; however, in subjects with defects in clearance of chylomicron remnants (e.g., with chronic renal failure), levels of B-48 are increased.

The significant changes of serum apo A-I and apo B levels in our subjects during the study (Tables 13 and 14) were related to those of their serum HDL-C and LDL-C levels evidenced by significant positive correlations

between serum LDL-C and apo B levels ($y=17.1811+27.8120x$, $r=0.77$, $df=148$, $P<0.001$) as well as between serum HDL-C and apo A-I levels ($y=62.3268+52.6386x$, $r=0.51$, $df=148$, $p<0.001$).

Regarding to the plasma fibrinogen levels, both groups exhibited normal levels throughout the study (62). Though plasma fibrinogen levels in group II at P08 was significant lower than that at SB8 (Table 16) this finding was not observed in group I (Table 15).

It has been shown that substituting saturated fatty acid intake by linoleic acid decreases platelet aggregation (107-110). However, this was not observed in our study when ADP, epinephrine, and collagen were used as the platelet aggregating agent (Tables 81 and 82). Though group II showed lower platelet aggregation induced by 3 μ M of ADP at P08 than that at SB8 (Table 82) this finding was not observed in group I (Table 81).

CHAPTER V

SUMMARY

The objectives of this study are to compare the effect of soybean and palm oils intakes on serum lipoprotein levels, essential fatty acid status and, platelet function in man. Twelve healthy men, with the age of 28-39 yr and BMI of 19.10-25.2 kg/m² were recruited in the study. They were divided equally into two groups, group I and II according to the types of vegetable oil intake. The total study period was 24 wks constituting of 4 wks of baseline period, 8 wks of the first vegetable oil period, 4 wks of washout period, and 8 wks of the second vegetable oil period. Either soybean oil or palm oil was consumed during the vegetable oil period. Daily energy intake in each subject during the vegetable oil periods was adjusted according to his caloric intake during the baseline period and was held constant throughout the study. Daily dietary energy distribution served during the vegetable oil periods were 15, 30 and 55% derived from protein, fat and carbohydrate respectively. The protein sources were pork, chicken and rice, providing 5.67, 5.58, and 3.75% of total calories. The fat sources consisted of food structural fat and soybean oil or palm oil supplying 10 and 20% of total calories. The first and second vegetable oils consumed by

group I were soybean oil and palm oil, respectively, whereas the reverse sequence was carried out in group II. since all of the subjects consumed the assigned menus during the vegetable oil periods the only fluctuation of nutrient intake between the soybean and palm oil periods was fatty acids derived from these two vegetable oils.

Venous blood was obtained from each subject after a 12-14 hr fast at day 1 of each week of the study periods. In group I, venous blood was obtained at wks 0, 1, 2, and 4 of the BL period; wks 1, 2, 4, and 8 of the SB period; wk 4 of the W0 period; and wks 2, 3, 4, and 8 of PO period. In group II, venous blood collection was obtained at wks 0, 2, and 3 of the BL period; wks 1, 2, 4, and 8 of the PO period; wk 4 of the W0 period; and wks 2, 3, 4 and 8 of the SB period. Whole blood, plasma, serum, and red blood cells were properly prepared for further analysis. The determinations included hematological parameters, plasma fibrinogen, serum lipoproteins, serum lipids, serum apoprotein, and fatty acid.

General nutritional status

There were no significant changes of BMI, body weight and body fat throughout the study. This confirmed that the subjects had adequate energy intake during the vegetable oil periods, throughout the study there were no striking changes in hematological parameters including Hb,

Hct, RBC, MCV, MCH, MCHC, WBC, platelet and total lymphocyte counts and the values were within the normal limits.

N-6 PUFA

During the soybean oil period respectively linoleate and oleate intakes in group I were 13.67 and 8.08% of total calories, whereas during the palm oil period their linoleate and oleate intakes were 3.44 and 12.42% . Thus the ratios of their linoleate: oleate intakes during the soybean oil and palm oil periods were 1.69 and 0.28, respectively. Their linoleate: oleate ratios of total serum lipids during the soybean oil period at wks 1, 2, 4 and 8 were 2.70, 2.59 and 2.82 and 2.45, respectively which were higher than those during the baseline period (1.62, 1.88, 2.07, and 1.91 at wks 0, 1, 2, and 4, respectively), during the washout period (2.03), and during the palm oil period (1.77, 1.66, 1.72 and 1.96 at wks 2, 3, 4, and 8, respectively. These data indicate that our subjects complied to the assigned menus served during the soybean oil and palm oil periods. The findings are consistent with the highest linoleate percentages of total serum lipids during the soybean oil period and there were no striking changes in serum 18:2 n-6 and 18:1 n-9 levels within each study period. The influence of high linoleate intake during the soybean oil period was

detected within one week. The influence of high oleate intake on serum oleate levels was also evident by higher serum oleate levels during the palm oil period than other dietary periods.

The influence of dietary arachidonate intake on serum arachidonate percentage of total serum lipids is also observed in our study despite of the increases in serum linoleate percentages during the soybean oil period in group I, their serum arachidonate percentages declined the arachidonate intakes in these subjects during the soybean oil and palm oil periods were identical, i.e., 0.07% of total subjects calories. The suppression of biotransformation of linoleic to arachidonic acid in the presence of a significant amount of alpha-linolenate intake was unlikely to take place in our subjects because low serum arachidonate level were also observed during the palm oil period.

All of the aforementioned findings were also observed in group II. This due to the fact that group II had similar fatty acid intakes as in group I during the vegetable oil periods. Their linoleate, oleate, and arachidonate intakes during the soybean oil period were 13.80, 8.15, and 0.07% of total calories whereas the corresponding figures during the palm oil period were 3.48, 12.55, and 0.07% of total calories.

The mean erythrocyte 18:2 n-6 levels in groups I and II during the baseline period ranged from 7.95-8.32% of total fatty acids which are comparable to other reports. The findings indicate the long-term adequacy of linoleate status in our subjects before entering the vegetable oil periods. The influence of high linoleate intake on linoleate percentages of total erythrocyte lipids was evident by higher erythrocyte linoleate levels during the soybean oil period than during the palm oil period.

In contrast to the findings in serum total lipids, there was no decrease in erythrocyte 20:4 n-6 levels in group I during the soybean oil period whereas it increased in group II. These findings strengthen the view that there is no suppression of arachidonate biosynthesis from alpha-linolenate intake under our dietary condition.

N-3 PUFA status

The alpha-linolenate intakes in groups I and II during the soybean oil period were 1.77 and 1.79% of total calories whereas those in both groups during the palm oil period were 0.07% of total calories. The influence of the amount of alpha-linolenate intake on serum and erythrocyte alpha-linolenate levels was observed in both groups evidenced by higher serum and erythrocyte 18:3 n-3 levels during the soybean oil period than during the palm oil

period. These data indicate that our subjects adhere to the assigned diets.

Despite of the high serum 18:3 n-3 levels during the soybean oil period, there were no striking changes in serum 20:5 n-3 and 22:6 n-3 levels. The influence of dietary 20:5 n-3 and 22:6 n-3 intakes on their serum levels were supported by the following findings: (a) serum 20:5 n-3 and 22:6 n-3 levels in group I during the baseline and washout periods were higher than those during the soybean oil and palm oil periods, whereas such findings were not observed in group II, and (b) serum 20:5 n-3 and 22:6 n-3 levels in both groups during the soybean oil and palm oil periods were rather constant due to the consumption of the assigned menus.

The influence of dietary alpha-linolenate intake on erythrocyte 18:3 n-3 levels was also observed in our study. Erythrocyte 18:3 n-3 levels during the soybean oil period were higher than those during the palm oil period but the values reached statistical significance in group I at wk 8 only. One striking finding is that erythrocyte 22:6 n-3 levels in both groups during the palm oil period at wk 8 were higher than those during the soybean oil period at wk 8. Whether this is related to the suppression of biosynthesized 22:6 n-3 from 18:3 n-3 due to high 18:2 n-6 intake or not needs further investigation.

Effect of fatty acid intakes on serum lipoprotein, and fibrinogen levels and platelet aggregation

At the baseline period 2 out of 6 subjects in each group were hypercholesterolemic based on at least one value showing serum TC ≥ 5.2 mmol/L whereas 1 subject (C.Ki) in group II was type IV hyperlipoproteinemia based on serum TG ≥ 1.8 mmol/L and LDL-C < 3.4 mmol/L. However, the mean serum TC levels in both groups were within normal limit.

The saturated fatty acids, oleate, and linoleate intakes in both groups during the soybean oil period were 4.82-4.86, 8.08-8.15, and 13.67-13.80% of total calories, respectively, whereas those during the palm oil period were 12.50-12.62, 12.42-12.55, and 3.44-3.48% of total calories. The daily mean($\pm$ SEM) cholesterol intakes in groups I during the 2 vegetable oil periods were identical, i.e., 179 ± 12 mg. This is also true in group II (174 ± 11 mg).

In group I, cholesterol-lowering effect of soybean oil was detected within one week and lasted throughout the soybean oil period. The net decreases in serum TC and LDL-C levels at SB8 from those at BL4 were 30 and 40%, respectively. On the contrary, there were no significant changes in serum TC and LDL-C levels between the palm oil and washout periods. Such findings indicate the

beneficial effect of soybean oil in lowering serum TC and LDL-C levels. This is supported by the significantly lower serum TC and LDL-C levels at SB8 than those at P08. It should be noted that one hypercholesterolemic subject (P.Jo) became normocholesterolemic at SB4 and the other (S.Pr) became normocholesterolemic at SB1. P.Jo became hypercholesterolemic throughout the washout and palm oil periods while S.Pr was hypercholesterolemic at P02, 3, and 8.

Unlike in group I, there was no significant difference in serum TC and LDL-C levels between P01 and BL3 group II. However, only serum TC level at P08 was significantly lower than that at BL3. The net decreases in serum TC and LDL-C levels at P08 from those at BL3 were 9 and 8%, respectively. When comparisons were made between the soybean oil and washout periods, only serum TG level at SB2 was significantly lower than that at W04 whereas both serum TC and TG levels at SB8 were significantly lower than those at W04. The net changes of serum TC, LDL-C, and TG levels at SB8 from W04 were -3, 16, and -39%, respectively. However, serum TC, LDL-C, and TG levels at SB8 were still lower than those at the P08 but only serum TC levels reached statistical significance.

It should be noted that C.Ki who was type IV hyperlipoproteinemia at the baseline period became normolipidemic during the soybean oil period only. C.Pe

who was hypercholesterolemic at the baseline period became normocholesterolemic at P04, P08, W04, SB4, and SB8. P.Lo who was hypercholesterolemic at the baseline period became normocholesterolemic at P01, P02, and throughout the soybean oil period.

The decreases in serum TC and LDL-C levels during the study lead to the decline in serum TC/HDL-C and LDL-C/HDL-C ratios. The changes in serum M- and S- particle levels in both groups were consistent with those in their serum TC and TG levels.

There was no striking changes in serum HDL-C levels in both groups during the soybean oil period and the mean levels were above the lowest limit (0.9 mmol/L). Though serum HDL-C level in group I at P08 was significantly higher than that at SB8 this finding was not observed in group II.

The significant changes of serum apo A-I and apo B levels in our subjects during the study were related to those of their serum HDL-C and LDL-C levels evidenced by significant positive correlations between serum LDL-C and apo B levels as well as between serum HDL-C and apo A-I levels.

Regarding to the plasma fibrinogen levels, both groups exhibited normal levels throughout the study. Though plasma fibrinogen levels in group II at P08 was

significantly lower than that at SB8, this finding was not observed in group I.

It has been shown that substituting saturated fatty acid intake by linoleic acid decreases platelet aggregation. However, this was not observed in our study when ADP, epinephrine, and collagen were used as the platelet aggregating agent.

Conclusion

The results presented herein are concluded as follows: First, dietary fatty acid intakes can influence fatty acid composition both in total serum and erythrocyte lipids. Serum and erythrocyte 18:2 n-6, 18:1 n-9, and 18:3 n-3 levels reflect these fatty acid intakes. Secondly, energy distribution derived from total fat, saturated fatty acids, monounsaturated fatty acids, and polyunsaturated fatty acids, especially linoleic acid, as well as the amount of cholesterol intake determine the lowering effect of serum TC and LDL-C levels. The results indicate that soybean oil lowers serum TC, LDL-C, and TG levels better than palm oil when they are consumed at isocaloric level. Thirdly, there were no striking changes in plasma fibrinogen levels and platelet function assessed by platelet count and platelet aggregation due to different fatty acid intake.

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