CHAPTER III

RESULTS

Platelet Concentrates

One hundred and twenty two units of hepatitic viral-free and HIV-free platelet concentrates with various blood groups (A, AB, B and O) were prepared from blood specimen donated to Thai Red Cross by healthy volunteers. All freshly prepared samples were kindly provided to the present study by the National Blood Center, Thai Red Cross Society.

Since the blood donors were not limited within the scope of either gender or blood group, the effects of both parameters to the product of platelet concentrates, if occurred, would have to be considered. Parameters which could differentiate the characteristics of platelet concentrates prepared from Thai Red Cross would have to be ruled out from the study. **Tables 2-3** show the characteristics of PC when gender and blood groups were identified and separated.

A. Effect of Gender

Blood cells, specific gravity and volumes of 122 platelet concentrates (PC) prepared as described previously in the text were grouped according to gender:

100 for male (M) and 22 for female (F). The data are shown in **Table 2**. The results showed that PC bags prepared from bloods of either genders contained not different amounts of various blood cells, either platelets, white blood cells and red blood cells. Their specific gravity and volumes were also similar. The gender provided no effect to the preparation of PC thus the present study did not take the gender into account when the specimen of PC's were randomized for subjecting in the experiment.

B. Effect of Blood Groups

When the contents of blood cells in PC bags as well as specific gravity and volume of PC were grouped according to blood groups (A, AB, B and O) as shown in **Table 3**. The results also verified that PC of donors with various groups prepared by the similar procedure were similar in those characteristics.

As one can see from both **Tables 2** and **3**, platelets were vast majority of blood cells in PC bags. The contamination of white blood cells in PC was not exceed 0.03% whereas that of RBC was trace and ignorable.

Lecithin's Lipids and Fatty Acids

Two kinds of fish meal were preliminary selected for the present study. The first sample was grade 1 Thai fish meal which had been employed in our previous experiment (Chanilbandhu, 1996). We had proved that grade 1 fish meal was superior in its lecithin and DHA contents to other 3 grades of Thai fish meal. Actually,

Table 2 The presentation of blood cells, specific gravity and volumes of platelet concentrates separating by gender (male and female) from 122 donors.

Sex	n	Vol (ml)	Sp.gr.	RBC ($10^6/mm^3$)	WBC ($10^3/mm^3$)	PLT ($10^3/mm^3$)
M	100	49.69 ± 3.57	1.03 ± 0.00	0.01 ± 0.03	0.42 ± 0.29	1822.00 ± 610.25
F	22	49.71 ± 3.23	1.03 ± 0.00	0.01 ± 0.01	0.49 ± 0.35	1890.50 ± 741.54

The results of male and female donors are expressed as Mean ± S.D.

Table 3 The presentation of blood cells, specific gravity and volumes of platelet concentrates separating by blood groups (A, AB, B, and O) from 122 donors.

Blood group	n	Vol (ml)	Sp.gr.	RBC (10^6/mm^3)	WBC (10^3/mm^3)	PLT (10^3/mm^3)
A	6	50.01 ± 1.87	1.03 ± 0.00	0.01 ± 0.01	0.57 ± 0.33	1831.17 ± 290.23
AB	8	48.96 ± 2.02	1.03 ± 0.00	0.00 ± 0.01	0.49 ± 0.24	1880.12 ± 602.36
B	97	49.81 ± 3.82	1.03 ± 0.00	0.01 ± 0.03	0.40 ± 0.25	1850.54 ± 620.41
O	11	49.07 ± 1.56	1.03 ± 0.00	0.00 ± 0.01	0.59 ± 0.45	1851.63 ± 472.29

The results of four groups (A, AB, B and O) are expressed as Mean ± S.D.

Thai fish meal was prepared from marine fish harvested from the gulf of Thailand. The second sample was Danish fish meal sourced by marine fish cought from the North Atlantic Ocean. Between both premium grades of fish meal, only one would be selected for employed throughout the present study. Thus the characteristics of lipids of both fish meal samples were determined and compared as shown in the following results.

A. Source of Lecithin

At the earliest step of the experiment two raw materials: grade 1 (G-1) Thai fish meals and Danish fish meals, were selected and sampled for proximate fat analysis as well as for lecithin determination according to the procedures described earlier. The results showed that lecithin extracted from Danish fish meals had DHA content of 27-29% whereas Thai fish meals had 20-23%. Danish fish meal was chosen for the present study according to its prominent in lipid characteristics in comparison to grade 1 Thai fish meal used in our previous experiment (Chatnilbandhu, 1996). The lipid characteristics in phospholipid of Danish fish meal in comparison to G-1 Thai fish meal are shown in **Table 4**. The contents of polyenes, EPA, DHA, total n-3 PUFA's and the ratio of n-3/n-6 of Danish fish meal were significantly higher than those of Thai fish meal. The superiority of Danish fish meal convinced us to choose it as the sole source of fish meal lecithins in our present experiment.

Table 4 Saturated, Monoenes and Polyenes fatty acids in phospholipids of Danish fish meal comparing G-1 Thai fish meal (g/100 g total fatty acids)

Phospholipid	Fish meal	
Fatty Acid	Danish	Thai (G-1)
Saturated	32.73 ± 0.75^{b}	43.56 ± 0.32^{a}
Monoenes	16.37 ± 0.64	16.27 ± 0.10
Polyenes	44.18 ± 0.93^{a}	33.97 ± 0.50^{b}
EPA	7.85 ± 0.24^{a}	4.44 ± 0.07^{b}
DHA	28.32 ± 0.73^{a}	22.16 ± 0.43^{b}
n-3	38.49 ± 0.87^{a}	28.10 ± 0.41^{b}
n-6	5.69 ± 0.19	5.87 ± 0.10
n-3 / n-6	6.76 ± 0.09^{a}	4.79 ± 0.03^{b}

The results are expressed as Mean ± S.D. of three determination. The different letters in the same row shown as a, b are significant differences ($p<0.05$).

Data of G-1 Thai fish meal obtained from Chatnilbandhu's experiment (1996).

B. Lecithins of Fish Meal

Danish fish meal utilized in this experiment had proximate contents of moisture 7.52, protein 64.55, fat 8.08 and ash 15.60 g/100 g sample (**Table 1**) as provided by manufacturer. Noticeably, the value of fat content was obtained by means of proximate analysis employing petroleum ether as solvent for fat extraction. However, in the present experiment recovered fat content in fish meal with different procedure by employing 3 different organic solvents as described earlier and resulted in fat content of 17.4 g/ 100 g sample with lecithin content of 10.2 g/ 100 g sample, respectively. This much higher fat content is probably explained by the higher recovery of fats by our procedure, the partial contamination of polar proteins following methanol extraction and/or the remaining of water droplets derived from moisture.

All the contaminants, majorily in hydrophobic molecular structure, if present were possibly eliminated from fat particles and splitted out into aqueous media during the preparation of fat emulsion which employed hugh volume of water. Lecithin prepared by three consecutive organic solvent extraction according to our procedure was fractionated into phospholipids (PL) and triglycerides or triacylglycerols (TG) by chromatographic technique of one-dimensional TLC and the contents of both lipid subclasses were assessed. Our lecithin extracted from Danish fish meal comprised 24.5% PL and 75.5% TG (w/w) and finally provided PL:TG ratio of approximately 1:3.

C. Lecithin's Fatty Acids

1. Total Fatty Acids

After the fractionation of lipid subclasses by TLC, both PL and TG were subjected into fatty acid methylation and FAME's were quantitated. **Table 5** shows the composition of fatty acids in Danish fish lecithin and in their fractions of TG and PL. When the quantity of fatty acids in lecithin was considered, Danish fish meal showed its high EPA (eicosapentaenoic acid, C 20:5) and DHA (docosahexaenoic acid, C 22:6) contents of 7.51 and 21.68 g/100 g total fatty acids. Despite TG-FA had high DHA content of 17.56, PL-FA demonstrated much higher DHA content of 28.32 g/100 g total fatty acids. It was thus confirmed that Danish fish meal was a good source of n-3 PUFA's especially DHA and the latter present majorily in PL subfractions. Therefore, this is an advantage for the preparation of liposomes by Danish fish meal since it's high PL-DHA would make its orientation of DHA on liposome's surface and dominated the PUFA exchanges between liposome particles and blood cells during the incubation in our experiments.

When all fatty acids were grouped into saturated, monoenes and polyenes, **Table 6** clearly expressed that PL fraction of lecithin contained significantly higher content of polyenes mainly n-3 PUFA's than that of TG fraction. One can notice that all polyenoic fatty acids present majorily in PL fractions (44.18 vs 32.84 for polyenes, 38.49 vs 27.88 for n-3 and 5.69 vs 4.96 for n-6 PUFA's for PL-FA vs TG-FA, respectively).

Table 5 Fatty acid composition of total lecithin derived from Danish fish meal and in their fractions: triglyceride and phospholipid. The data is expressed as g/100 g total fatty acids.

Fatty acid	Fish meal	Lecithin	
	lecithin	Triglyceride	Phospholipid
C 14:0	4.94 ± 0.21	6.18 ± 0.50[a]	1.93 ± 0.18[b]
C 16:0	24.40 ± 0.52	25.17 ± 0.83[a]	21.55 ± 0.67[b]
C 16:1 n-7	4.36 ± 0.17	5.33 ± 0.21[a]	1.85 ± 0.12[b]
C 18:0	8.18 ± 0.16	6.82 ± 0.23[b]	9.25 ± 0.19[a]
C 18:1 n-9	11.49 ± 0.47	12.78 ± 0.74[a]	9.80 ± 0.57[b]
C 18:1 n-7	2.96 ± 0.15	2.56 ± 0.14[b]	2.99 ± 0.21[a]
C 18:2 n-6	2.12 ± 0.04	2.55 ± 0.09[a]	1.97 ± 0.06[b]
C 18:3 n-3	1.03 ± 0.05	1.48 ± 0.06[a]	0.47 ± 0.07[b]
C 20:4 n-6	2.93 ± 0.25	2.41 ± 0.30[b]	3.72 ± 0.29[a]
C 20:5 n-3	7.51 ± 0.36	7.32 ± 0.13[b]	7.85 ± 0.24[a]
C 22:5 n-3	1.66 ± 0.11	1.52 ± 0.13[b]	1.85 ± 0.22[a]
C 22:6 n-3	21.68 ± 0.65	17.56 ± 0.96[b]	28.32 ± 0.73[a]
C 24:1	1.57 ± 0.09	1.34 ± 0.14[b]	1.73 ± 0.11[a]
Others	5.17 ± 0.36	6.98 ± 0.76[a]	6.72 ± 0.44[b]

The results of individual fatty acids are Mean ± S.D. of three determinations. The different letters in the same row shown as a, b are significant differences ($p<0.05$).

Table 6 Saturated, Monoenes and Polyenes fatty acids in lecithin, TG fraction and PL fraction of Danish fish meal (g/100 g total fatty acids)

Fatty acid	Fish Meal		
	Lecithin	TG fraction	PL fraction
Saturated	37.52 ± 0.63	38.17 ± 0.97	32.73 ± 0.75
Monoenes	20.38 ± 0.48	22.01 ± 0.83	16.37 ± 0.64
Polyenes	36.93 ± 0.77	32.84 ± 1.15	44.18 ± 0.93
n-3	31.88 ± 0.75	27.88 ± 1.07	38.49 ± 0.87
n-6	5.05 ± 0.31	4.96 ± 0.25	5.69 ± 0.19
n-3/n-6	6.31 ± 0.08	5.62 ± 0.15	6.76 ± 0.09

The results of fatty acids are expressed as Mean ± S.D. of three determinations.

2. Polyenes

As mentioned earlier, PL fraction of lecithin was rich source of polyene especially n-3 PUFA. **Figure 12** compares the proportion of unsaturated fatty acids found in PL and TG fractions in histograms so as to the significant different would be vividly demonstrated. The figure shows that PL had markedly lower content of MUFA ($p < 0.05$) but significant higher content of PUFA's in both groups of n-3 and n-6 polyenoic fatty acids ($p < 0.05$). The result also confirms that n-3 PUFA were major polyenes in fat of marine animals. The differences between the contents of n-3 and n-6 PUFA's obtained from fish meal used in the study ranged for 5-6 times. In comparison to other n-3 PUFA's, DHA dominated in moieties of both TG and PL. Obviously, DHA of PL was found in much higher amount than that of TG. This confirms the fact that DHA of marine fish distributed favorably in PL.

Lecithin-Rich Fat Emulsions

A. Composition of Lipids

Four fat emulsions with high content of lecithins, FM-LRFE, SY-LRFE and SL-FOFE were prepared in the present study whereas 20% Lipofundin (EY-LRFE) was commercially available. Lecithin extracted from Danish fish meal had PL content of 24-25 g/100g. Actually, as high as nearly three-fourth of weight content of fish meal lecithin was TG. Low PL/TG ratio of fish meal lecithin thus limited the

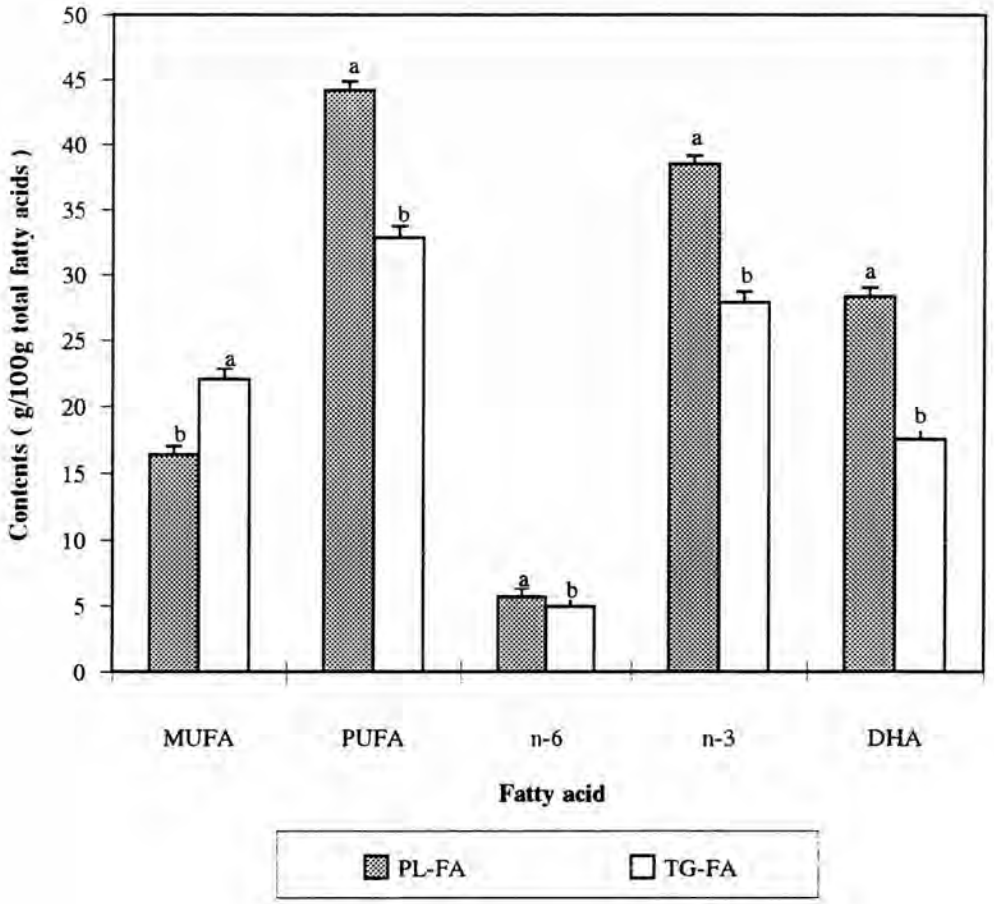

Figure 12 Comparison of fatty acid content in percentage between unsaturated fatty acids : MUFA , PUFA ,n-6 PUFA ,n-3 PUFA and DHA ,expressed as Mean ± S.D., in phospholipids (PL-FA) and those in triglycerides (TG-FA) of fish meal.

The different letters shown as a, b are significant differences ($p<0.05$).

Table 7 Fatty acid composition in whole mixture, TG fraction and LE fraction of FM-LRFE (g/100 g total fatty acids) with PL:TG ratio of 1:3

Fatty acid	FM-LRFE		
	Whole mixture	TG fraction	LE fraction
C 14:0	4.94 ± 0.21	6.18 ± 0.50	1.93 ± 0.18
C 16:0	24.40 ± 0.52	25.17 ± 0.83	21.55 ± 0.67
C 16:1 n-7	4.36 ± 0.17	5.33 ± 0.21	1.85 ± 0.12
C 18:0	8.18 ± 0.16	6.82 ± 0.23	9.25 ± 0.19
C 18:1 n-9	11.49 ± 0.47	12.78 ± 0.74	9.80 ± 0.57
C 18:1 n-7	2.96 ± 0.15	2.56 ± 0.14	2.99 ± 0.21
C 18:2 n-6	2.12 ± 0.04	2.55 ± 0.09	1.97 ± 0.06
C 18:3 n-3	1.03 ± 0.05	1.48 ± 0.06	0.47 ± 0.07
C 20:4 n-6	2.93 ± 0.25	2.41 ± 0.30	3.72 ± 0.29
C 20:5 n-3	7.51 ± 0.36	7.32 ± 0.13	7.85 ± 0.24
C 22:6 n-3	21.68 ± 0.65	17.56 ± 0.96	28.32 ± 0.73
C 24:0	1.66 ± 0.11	1.52 ± 0.13	1.85 ± 0.22
C 24:1	1.57 ± 0.09	1.34 ± 0.14	1.73 ± 0.11
Others	5.17 ± 0.36	6.98 ± 0.76	6.72 ± 0.44

The results are expressed as Mean ± S.D. of three determinations.

Table 8 Fatty acids composition in whole mixture, TG fraction and LE fraction of SY-LRFE (g/100 g total fatty acids) with PL:TG ratio of 1:3

Fatty acid	SY-LRFE		
	Whole mixture	TG fraction	LE fraction
C 14:0	0.06 ± 0.01	0.07 ± 0.02	0.07 ± 0.01
C 16:0	16.25 ± 0.24	13.79 ± 0.34	20.85 ± 0.56
C 18:0	4.10 ± 0.17	4.12 ± 0.21	3.94 ± 0.15
C 18:1 n-9	16.83 ± 0.61	22.19 ± 0.38	8.58 ± 0.27
C 18:1 n-7	1.16 ± 0.02	1.36 ± 0.08	1.10 ± 0.06
C 18:2 n-6	54.89 ± 0.38	52.63 ± 0.45	57.77 ± 0.62
C 18:3 n-3	6.71 ± 0.23	5.84 ± 0.19	7.69 ± 0.24

The results are expressed as Mean ± S.D. of three determinations.

Table 9 Fatty acid composition in whole mixture, TG fraction and PL fraction of SL-FOFE (g/100 g total fatty acids) with PL:TG ratio of 1:3

Fatty acid	SL-FOFE		
	Whole mixture	TG fraction	PL fraction
C 14:0	4.26 ± 0.09	4.65 ± 0.10	0.08 ± 0.01
C 16:0	21.98 ± 0.36	23.98 ± 0.36	21.14 ± 0.32
C 16:1 n-7	4.35 ± 0.14	4.87 ± 0.21	-
C 18:0	4.41 ± 0.08	5.49 ± 0.11	4.10 ± 0.08
C 18:1 n-9	11.67 ± 0.24	12.74 ± 0.19	8.46 ± 0.20
C 18:1 n-7	1.48 ± 0.11	1.82 ± 0.12	1.10 ± 0.07
C 18:2 n-6	28.55 ± 0.43	19.30 ± 0.27	57.61 ± 0.38
C 18:3 n-3	4.68 ± 0.06	3.44 ± 0.07	7.51 ± 0.10
C 20:0	0.46 ± 0.00	0.60 ± 0.01	-
C 20:4 n-6	0.54 ± 0.01	0.80 ± 0.01	-
C 20:5 n-3	7.61 ± 0.14	9.85 ± 0.22	-
C 22:5 n-3	1.46 ± 0.06	1.84 ± 0.08	-
C 22:6 n-3	5.86 ± 0.13	7.23 ± 0.19	-
C 24:1	0.53 ± 0.01	0.8 ± 0.01	-
Others	2.16 ± 0.14	2.59 ± 0.18	-

The results are expressed as Mean ± S.D. of three determinations.

Table 10 Fatty acid composition in whole mixture, TG fraction and PL fraction of 20% Lipofundin (commercial EY-LRFE) (g/100 g total fatty acids)with PL:TG ratio of 1.2:20

Fatty acids	20% Lipofundin		
	Whole mixture	TG fraction	PL fraction
C 6:0	0.14 ± 0.01	0.22 ± 0.02	-
C 8:0	30.73 ± 0.86	30.98 ± 1.03	-
C 10:0	16.14 ± 0.45	16.73 ± 0.64	-
C 12:0	0.11 ± 0.01	0.20 ± 0.01	-
C 14:0	0.12 ± 0.01	0.06 ± 0.01	0.34 ± 0.06
C 16:0	7.99 ± 0.32	7.59 ± 0.05	31.13 ± 0.89
C 16:1 n-7	0.23 ± 0.02	0.05 ± 0.01	1.20 ± 0.12
C 18:0	2.37 ± 0.14	2.38 ± 0.18	14.88 ± 0.52
C 18:1 n-9	12.24 ± 0.35	11.95 ± 0.64	26.28 ± 0.81
C 18:1 n-7	1.15 ± 0.20	1.11 ± 0.18	3.23 ± 0.26
C 18:2 n-6	24.43 ± 0.47	24.81 ± 0.83	15.24 ± 0.17
C 18:3 n-3	3.50 ± 0.09	3.92 ± 0.14	2.97 ± 0.19
C 20:4 n-6	0.49 ± 0.02	-	2.87 ± 0.24
C 22:6 n-3	0.36 ± 0.01	-	1.86 ± 0.13

The results are expressed as Mean ± S.D. of three determinations.

composition of PL and TG in all other 3 fat emulsions used in the experiment to be 1:3 (w/w) except for EY-LRFE so as to the results of incubation in the following sections would be comparable.

As mentioned earlier, those 3 fat emulsions have ratio of PL and TG physically similar, however, they were different in the chemical property of their fatty acid composition in moieties of both surface (PL) and core lipids (TG) as shown in **Tables 7-9** whereas EY-LRFE's fatty acid composition with PL-TG ratio of 1.2:20 (w/w) is shown in **Table 10**. As shown in **Table 7**, the content of DHA in the LE fraction (surface) of FM-LRFE was approximately 61% higher than that found in TG fraction (core) (28.32 vs 17.56 for PL-DHA vs TG-DHA).

When the values was considered as total saturated fatty acids (SAFA), monounsaturated fatty acids (MUFA) PUFA, n-3 PUFA and n-6 PUFA as shown in **Table 11**, total n-3 FA of the surface was also nearly 38% higher than that of the core (38.49 vs 27.88). By contrast, SY-LRFE and SL-FOFE show their rich of n-6 FA's expecially LA (C 18:2 n-6) in the surface (57.77 vs 57.61 as shown in **Tables 8** and **9**) where as 20% Lipofundin (commercial EY-LRFE) exhibits high content of LA and AA (C 20:4 n-6) in the surface as 15.24 and 2.87%, respectively (**Table 10**).

Tables 11-14 show degree of unsaturation of fatty acids in whole mixture, TG fraction and LE fraction of 4 fat emulsions. The ratio of n-3/ n-6 of FM-LRFE's surface lipids shown in **Table 11** is much greater than those of SY-LRFE in **Table 12**, of SL-FOFE in **Table 13** and of 20% Lipofundin in **Table 14** (6.76 vs 0.13, 0.13 and 0.27, respectively).

Table 11 Saturated, Monoenes and Polyenes fatty acids in whole mixture, TG fraction and PL fraction of FM-LRFE (g/100 g total fatty acids)

Fatty acid	FM-LRFE		
	Whole mixture	TG fraction	PL fraction
SAFA	37.52 ± 0.63	38.17 ± 0.97	32.73 ± 0.75
MUFA	20.38 ± 0.48	22.01 ± 0.83	16.37 ± 0.64
PUFA	36.93 ± 0.77	32.84 ± 1.15	44.18 ± 0.93
PUFA/MUFA	1.81 ± 0.01	1.49 ± 0.01	2.70 ± 0.01
n-3	31.88 ± 0.75	27.88 ± 1.07	38.49 ± 0.87
n-6	5.05 ± 0.31	4.96 ± 0.25	5.69 ± 0.19
n-3/n-6	6.31 ± 0.08	5.62 ± 0.15	6.76 ± 0.09

The results are expressed as Mean ± S.D. of three determinations.

Table 12 Saturated, Monoenes and Polyenes fatty acids in whole mixture, TG fraction and PL fraction of SY-LRFE (g/100 g total fatty acids)

Fatty acid	SY-LRFE		
	Whole mixture	TG fraction	PL fraction
SAFA	20.41 ± 0.36	17.98 ± 0.41	24.86 ± 0.58
MUFA	17.99 ± 0.70	23.55 ± 0.46	9.68 ± 0.38
PUFA	61.60 ± 0.47	58.47 ± 0.53	65.46 ± 0.74
PUFA/MUFA	3.42 ± 0.01	2.48 ± 0.02	6.76 ± 0.03
n-3	6.71 ± 0.23	5.84 ± 0.19	7.69 ± 0.24
n-6	54.89 ± 0.38	52.63 ± 0.45	57.77 ± 0.62
n-3/n-6	0.12 ± 0.00	0.11 ± 0.00	0.13 ± 0.01

The results are expressed as Mean ± S.D. of three determinations.

Table 13 Saturated, Monoenes and Polyenes fatty acids in whole mixture, TG fraction and PL fraction of SL-FOFE (g/100 g total fatty acids)

Fatty acid	SL-FOFE		
	Whole mixture	TG fraction	PL fraction
SAFA	31.11 ± 0.39	34.63 ± 0.46	25.32 ± 0.38
MUFA	18.03 ± 0.36	20.32 ± 0.29	9.56 ± 0.24
PUFA	48.70 ± 0.54	42.46 ± 0.42	65.12 ± 0.45
PUFA/MUFA	2.70 ± 0.03	2.09 ± 0.02	6.81 ± 0.04
n-3	19.61 ± 0.19	22.36 ± 0.25	7.51 ± 0.10
n-6	29.09 ± 0.45	20.10 ± 0.29	57.61 ± 0.38
n-3/n-6	0.67 ± 0.01	1.11 ± 0.01	0.13 ± 0.00

The results are expressed as Mean ± S.D. of three determinations.

Table 14 Saturated, Monoenes and Polyenes fatty acids in whole mixture, TG fraction and PL fraction of 20% Lipofundin (g/100 g total fatty acids)

Fatty acid	20% Lipofundin		
	Whole mixture	TG fraction	PL fraction
SAFA	57.60 ± 0.97	58.16 ± 1.13	46.35 ± 0.64
MUFA	13.62 ± 0.39	13.11 ± 0.84	30.71 ± 0.95
PUFA	28.78 ± 0.56	28.73 ± 0.87	22.94 ± 0.41
PUFA/MUFA	2.11 ± 0.02	2.19 ± 0.03	0.75 ± 0.01
n-3	3.86 ± 0.12	3.92 ± 0.14	4.83 ± 0.21
n-6	24.92 ± 0.53	24.81 ± 0.83	18.11 ± 0.39
n-3/n-6	0.15 ± 0.01	0.16 ± 0.02	0.27 ± 0.01

The results are expressed as Mean ± S.D. of three determinations.

B. Polyenes in Emulsions' Surface

Figure 13 compares some PUFA's present in the lecithin surfaces of 4 fat emulsions : DHA, total n-3 FA's and total n-6 FA's. The solid column represents fatty acids in the surface of FM-LRFE whereas the striped, the vertical striped and the horizontal striped columns represent those of 20% Lipofundin, SY-LRFE and SL-FOFE, respectively. One can see the highest content of DHA found in FM-LRFE's surface whereas small amount is found in 20% Lipofundin's surface but none in SY-LRFE's and SL-FOFE's surfaces.

Again, the result confirms that fish meal is the rich source of DHA-containing lecithins which exhibits predominantly at the surface of the prepaed emulsion as previously described in **Table** 7. Markedly higher contents of n-3 PUFA and DHA present in the surface of FM-LRFE in comparison to other 3 emulsions: SY-LRFE, SL-FOFE and 20% Lipofundin, are obviously impressive and statistically significant ($p< 0.05$). By contrast, when n-6 PUFA contents in the emulsions' surface are considered, FM-LRFE possesses the lowest value whereas SY-LRFE and SL-FOFE surfaces contain majorily of n-6 PUFA exclusively LA to the value of approximately 58 g/100g total PL-FA.

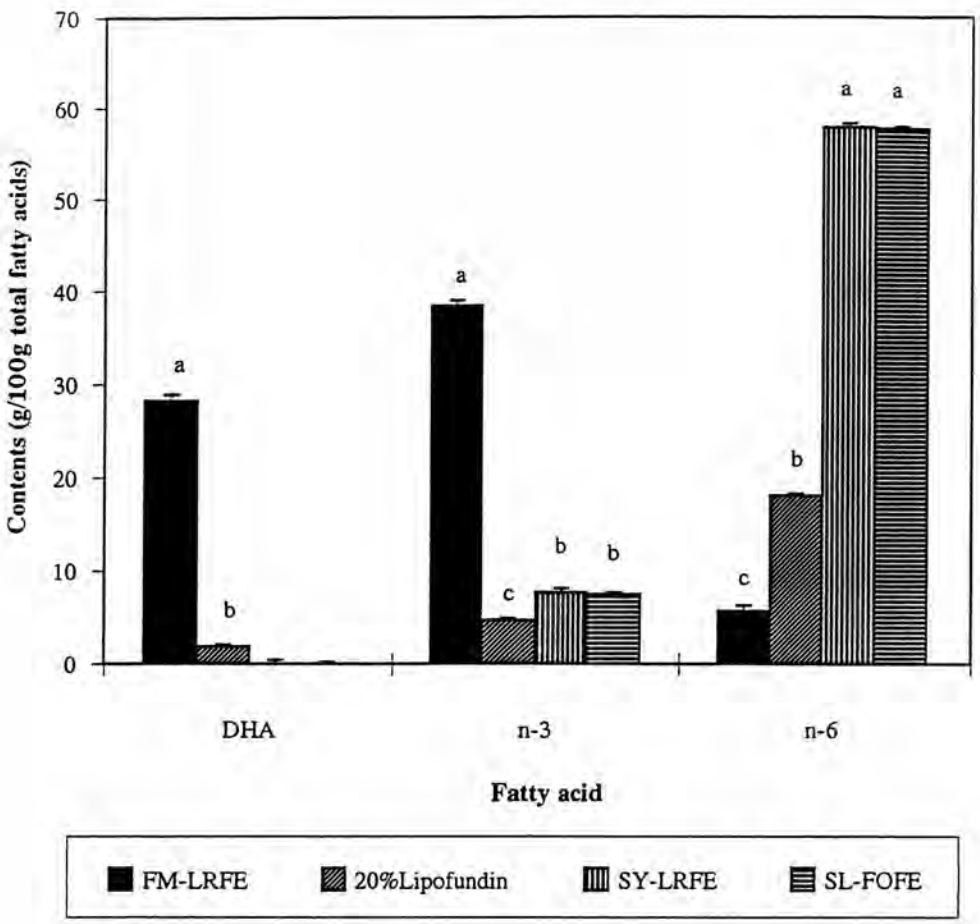

Figure 18 Comparison of fatty acid content in percentage between DHA, n-3 PUFA and n-6 PUFA found in PL surface of FM-LRFE, 20%Lipofundin, SY-LRFE and SL-FOFE. The different letters shown as a, b and c are significant differences ($p<0.05$).

Conditioning the Incubation of Platelets

A. Effect of Plasma on PUFA Transfer

In the presence of plasma, blood cells exhibit their membrane fatty acid exchanges with plasma lipoprotein and exogenous liposomes and/or fat emulsion. In the present experiment, we investigated the fatty acid exchanges among those particles in the presence and absence of whole plasma. After the incubation of platelets with and without plasma, fatty acid profiles of platelets were assessed and evaluated.

1. Total Fatty Acids

Tables 15-16 show the profiles of fatty acids on platelets before and after incubating with various concentrations of FM-LRFE. **Table 15** demonstrates the alteration of individual fatty acids of platelets incubating with autologous plasma whereas **Table 16** shows the result of incubation with similar condition except that the plasma was absent. Obviously, the alteration of individual fatty acids of platelets incubating without plasma are found to be higher than that incubating with autologous plasma. At lecithin concentration of 600 mg/dl, DHA increased 31% in the presence of plasma (from 2.44 rose upto 3.2) but soared dramatically as high as 236% in the absence of plasma (from 2.47 rose upto 5.82).

Table 15 Fatty acid profiles in g/100 g total PLT-FA of platelets after the incubation with FM-LRFE for 1 h at 22°C in the presence of lecithin at the concentrations of 0, 100,300 and 600 mg/dl (PLT incubation with autologous plasma)

PLT-FA	FM-LRFE				
	0 mg/dl	100 mg/dl	300 mg/dl	600 mg/dl	P-value
C 14:0	0.27 ± 0.05^{b}	0.29 ± 0.07^{b}	0.32 ± 0.06^{b}	0.43 ± 0.09^{a}	0.02
C 15:1	3.20 ± 0.25^{a}	2.99 ± 0.22^{a}	2.93 ± 0.27^{a}	2.62 ± 0.21^{b}	0.03
C 16:0	16.23 ± 0.73^{b}	16.93 ± 0.86^{b}	$17.61 \pm 0.93^{a,b}$	18.24 ± 0.81^{a}	0.04
C 16:1 n-7	0.21 ± 0.06^{b}	0.23 ± 0.05^{b}	0.30 ± 0.04^{a}	0.34 ± 0.06^{a}	0.00
C 18:0	17.20 ± 0.24^{a}	16.97 ± 0.31^{b}	16.85 ± 0.27^{b}	17.01 ± 0.38^{b}	0.02
C 18:1 n-9	13.18 ± 0.53	13.11 ± 0.47	12.96 ± 0.65	12.88 ± 0.62	0.31
C 18:1 n-7	0.81 ± 0.08^{b}	$0.86 \pm 0.09^{a,b}$	$0.89 \pm 0.10^{a,b}$	0.93 ± 0.08^{a}	0.04
C 18:2 n-6	5.71 ± 0.36	5.66 ± 0.45	5.56 ± 0.38	5.44 ± 0.48	0.57
C 18:3 n-3	0.05 ± 0.01^{b}	0.05 ± 0.01^{b}	$0.06 \pm 0.02^{a,b}$	0.07 ± 0.01^{a}	0.05
C 20:0	1.59 ± 0.25	1.48 ± 0.43	1.45 ± 0.22	1.50 ± 0.31	0.71
C 20:4 n-6	22.01 ± 0.29^{a}	$21.73 \pm 0.33^{a,b}$	21.38 ± 0.40^{b}	20.89 ± 0.36^{c}	0.01
C 20:5 n-3	0.41 ± 0.14^{b}	$0.54 \pm 0.10^{a,b}$	0.62 ± 0.09^{a}	0.65 ± 0.14^{a}	0.01
C 21:0	1.11 ± 0.12	1.09 ± 0.08	1.08 ± 0.11	1.08 ± 0.13	0.83
C 22:0	2.67 ± 0.26^{a}	$2.54 \pm 0.27^{a,b}$	$2.49 \pm 0.19^{a,b}$	2.36 ± 0.21^{b}	0.04
C 22:5 n-3	0.88 ± 0.06^{b}	$0.92 \pm 0.08^{a,b}$	0.95 ± 0.07^{a}	0.98 ± 0.06^{a}	0.01
C 22:6 n-3	2.44 ± 0.28^{c}	2.81 ± 0.30^{b}	$2.89 \pm 0.36^{a,b}$	3.20 ± 0.32^{a}	0.00
C 24:0	1.84 ± 0.07^{a}	1.72 ± 0.09^{b}	1.68 ± 0.06^{b}	1.53 ± 0.10^{c}	0.00
C 24:1	1.90 ± 0.20	1.87 ± 0.19	1.84 ± 0.16	1.76 ± 0.26	0.64
Others	8.29 ± 0.34	8.21 ± 0.65	8.14 ± 0.26	8.03 ± 0.51	0.72

The results are expressed as Mean ± S.D. of three determinations.

The different letters in the same row shown as a, b, c, d are significant differences ($p<0.05$).

Table 16 Fatty acid profiles in g/100 g total PLT-FA of platelets after the incubation with FM-LRFE for 1 h at 22°C in the presence of lecithin at the concentrations of 0, 100, 300 and 600 mg/dl (PLT incubation wihtout plasma)

PLT-FA	FM-LRFE				
	0 mg/dl	100 mg/dl	300 mg/dl	600 mg/dl	P-value
C 14:0	0.29 ± 0.06^{c}	0.40 ± 0.08^{b}	0.59 ± 0.09^{a}	0.63 ± 0.07^{a}	0.00
C 15:0	3.19 ± 0.25^{a}	2.96 ± 0.24^{a}	2.63 ± 0.23^{b}	2.57 ± 0.21^{b}	0.00
C 16:0	16.30 ± 0.85^{b}	$17.61 \pm 1.33^{a,b}$	18.48 ± 1.25^{a}	18.74 ± 0.82^{a}	0.01
C 16:1 n-7	0.23 ± 0.05^{b}	0.29 ± 0.05^{b}	0.42 ± 0.06^{a}	0.49 ± 0.06^{a}	0.00
C 18:0	17.11 ± 0.35^{a}	17.25 ± 0.21^{a}	16.63 ± 0.39^{b}	$16.92 \pm 0.21^{a,b}$	0.02
C 18:1 n-9	13.12 ± 0.74	12.98 ± 0.73	12.58 ± 0.65	12.50 ± 0.73	0.28
C 18:1 n-7	0.81 ± 0.16^{b}	$0.92 \pm 0.13^{a,b}$	1.06 ± 0.11^{a}	1.09 ± 0.12^{a}	0.01
C 18:2 n-6	5.63 ± 0.41	5.41 ± 0.42	5.33 ± 0.38	5.33 ± 0.45	0.48
C 18:3 n-3	0.06 ± 0.01^{b}	0.06 ± 0.02^{b}	0.08 ± 0.01^{a}	0.10 ± 0.01^{a}	0.00
C 20:0	1.64 ± 0.32	1.46 ± 0.29	1.46 ± 0.41	1.37 ± 0.25	0.60
C 20:4 n-6	21.90 ± 0.44^{a}	20.72 ± 0.68^{b}	19.65 ± 0.29^{c}	19.20 ± 0.32^{c}	0.00
C 20:5 n-3	0.44 ± 0.11^{d}	0.71 ± 0.12^{c}	0.99 ± 0.15^{b}	1.33 ± 0.13^{a}	0.00
C 21:0	1.13 ± 0.18	1.06 ± 0.16	1.04 ± 0.12	1.04 ± 0.15	0.72
C 22:0	2.75 ± 0.28^{a}	$2.49 \pm 0.31^{a,b}$	2.26 ± 0.35^{b}	2.16 ± 0.33^{b}	0.05
C 22:5 n-3	0.89 ± 0.09^{c}	$0.95 \pm 0.07^{b,c}$	0.99 ± 0.04^{b}	1.06 ± 0.06^{a}	0.01
C 22:6 n-3	2.47 ± 0.23^{d}	3.59 ± 0.37^{c}	4.98 ± 0.39^{b}	5.82 ± 0.30^{a}	0.00
C 24:0	1.85 ± 0.05^{a}	1.65 ± 0.06^{b}	1.49 ± 0.10^{c}	1.46 ± 0.10^{c}	0.00
C 24:1	1.92 ± 0.25^{a}	$1.80 \pm 0.15^{a,b}$	$1.68 \pm 0.20^{a,b}$	1.55 ± 0.12^{b}	0.04
Others	8.28 ± 0.40^{a}	7.73 ± 0.89^{b}	7.67 ± 0.33^{b}	6.64 ± 0.76^{c}	0.01

The results are expressed as Mean ± S.D. of five determinations.

The different letters in the same row shown as a, b, c, d are significant differences ($p<0.05$).

2. Polyenes

Table 17 shows fatty acids of platelets in the presence and absence of plasma after incubating with FM-LRFE for 1 h at 22°C in lecithin concentration at 600 mg/dl. Incubation without plasma yielded platelets with higher content of DHA and n-3 PUFA than that incubated with plasma (5.82 vs 3.2 and 8.31 vs 4.9 for DHA and n-3 PUFA's, respectively). Meanwhile, the lower content of n-6 PUFA's was observed. **Figures 14** and **15** compare n-3, n-6 and the ratios of two major precursors of eicosanoids in n-3 and n-6 series: EPA/AA, as well as n-3/n-6. Incubation without plasma, n-3 content of platelet increased markedly and higher than that with plasma which was contrast to the results of n-6 PUFA's (**Figure 14**). Both ratios of EPA/AA and n-3/n-6 PUFA's of platelets incubating without plasma increased to the levels significantly higher than those of platelets incubating with plasma (**Figure 15**).

The alterations of platelet FA (in g/100 g total FA's) after incubation platelets with FM-LRFE with and without plasma is summarized in **Table 18.** Incubating without plasma induced the marked increment of n-3 PUFA upto 4.45 g/100 g total FA's whereas incubating with plasma affected much less (1.12 g/100 g total FA's). Focussing in n-3 PUFA, incubating without plasma induced the marked increase of DHA upto 3.35 g/100 g total FA's whereas incubating with plasma affected much less. Since incubation without plasma induces much higher alteration in platelet FA's, the incubation of platelets with all LRFE's were conditioned without plasma in all experiments of the present study so as to gain high alteration.

Table 17 Polyenes fatty acids in g/100 g total PLT-FA of platelets with and without plasma after the incubation with FM-LRFE for 1 h at 22 °C in the presence of lecithin at the concentration of 600 mg / dl. See FA content after incubating at lecithin content of 0 mg/dl in **Table 15,16** for with and without plasma, respectively.

PLT-FA	FM-LRFE	
	with plasma	without plasma
EPA	0.65 ± 0.14	1.33 ± 0.13
DHA	3.20 ± 0.32	5.82 ± 0.30
LA	5.44 ± 0.48	5.33 ± 0.45
AA	20.89 ± 0.36	19.20 ± 0.32
n-3	4.90 ± 0.29	8.31 ± 0.37
n-6	26.33 ± 0.69	24.53 ± 0.42
n-3/n-6	0.19 ± 0.02	0.34 ± 0.01

The results of PLT-FA incubating with plasma are expressed as Mean ± S.D. of three determinations whereas PLT-FA incubating without plasma are Mean ± S.D. of five determinations.

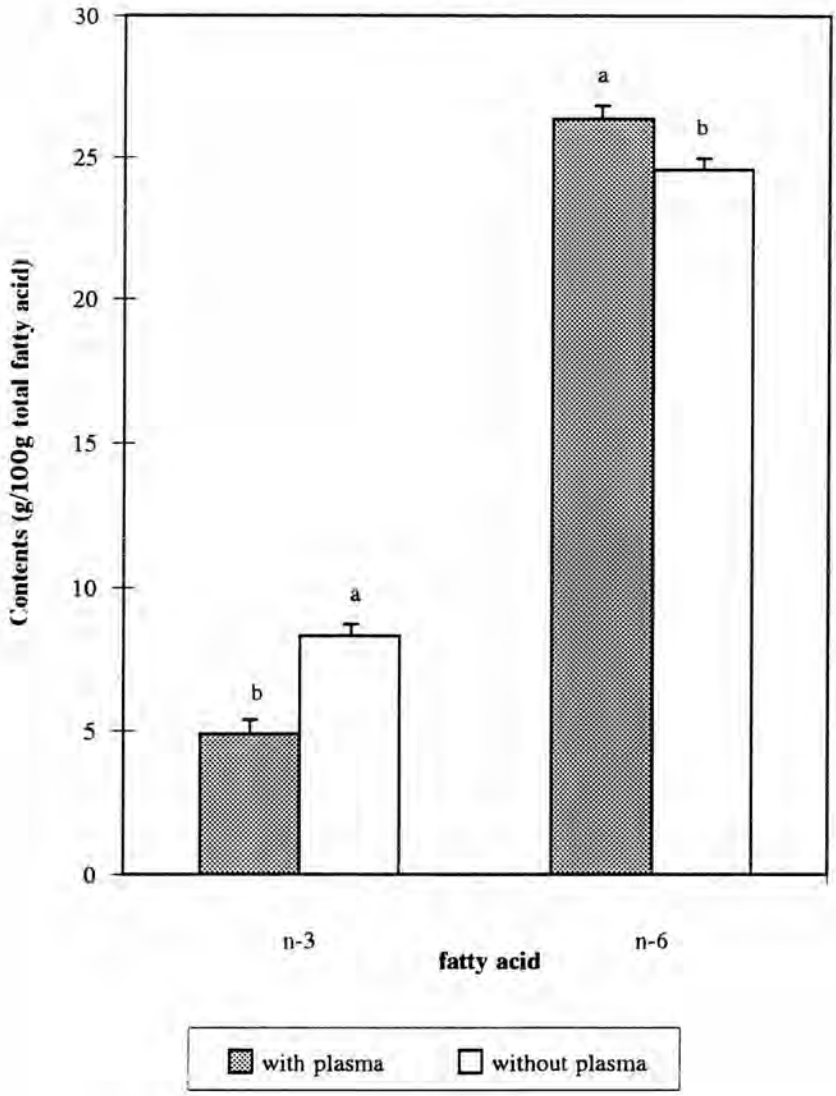

Figure 14 Comparison of fatty acid content in percentage between unsaturated fatty acids : n-3 PUFA and n-6 PUFA , expressed as Mean ± S.D., with plasma and those without plasma of platelets after the incubation with FM-LRFE for 1 h at 22°C in the presence of lecithin at theconcentration of 600 mg/dl. The different letters shown as a , b are significant differences ($p<0.05$).

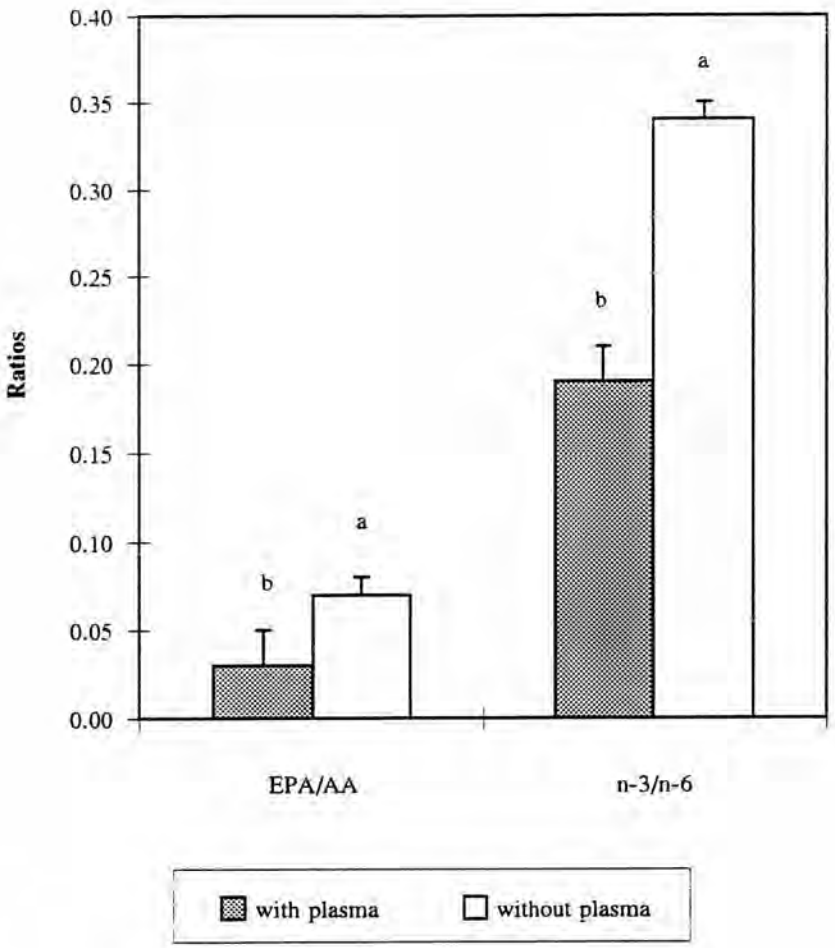

Figure 15 Ratios of EPA/AA and n-3/n-6 in PL surface,expressed as Mean ±S.D. with plasma and those without plasma of platelets after the incubation with FM-LRFE for 1h at 22°C in the presence of lecithin at the concentration of 600 mg/dl. The different letters shown as a,b are significant differences ($p<0.05$).

Table 18 Changes of platelet fatty acids (PLT-FA) comparing between PLT with and without plasma after the incubation with FM-LRFE for 1 h at 22°C in the presence of lecithin at the concentration of 600 mg/dl

PLT-FA	FM-LRFE	
	with plasma	without plasma
Saturated	1.24 ± 0.29	1.25 ± 0.30
Monoenes	-0.77 ± 0.42	-1.07 ± 0.49
Polyenes	-0.27 ± 0.38	1.46 ± 0.36
LA	-0.27 ± 0.10	-0.30 ± 0.13
AA	-1.12 ± 0.26	-2.70 ± 0.28
EPA	0.24 ± 0.08	0.89 ± 0.09
DHA	0.76 ± 0.31	3.35 ± 0.34
n-3	1.12 ± 0.38	4.45 ± 0.42
n-6	-1.39 ± 0.30	-3.00 ± 0.27
n-3/n-6	0.05 ± 0.01	0.20 ± 0.02

The figures obtained by substracing the percentage values of PLT-FA at 600 mgPL/dl from those at 0 mgPL/dl.

The results of PLT-FA incubating with plasma are expressed as Mean ± S.D. of three determinations whereas PLT-FA incubating without plasma are Mean ± S.D. of five determinations.

B. Stability of Transferred Fatty Acids

It was questioned whether fatty acids transferred from fat emulsions and raised on platelet membranes would remain unchange for how much time, temporarily or permanently. In order to answer the question, an experiment was designed. Platelets were incubated with lecithin at highest concentration and after halting the incubation, platelets were washed out and soaked in NSS for certain periods of time before subjecting for fatty acid analysis.

After soaking in NSS for 0, 1, 3 and 5 h, platelets previously incubated with FM-LRFE for 1 h at 22 °C in the presence of lecithin at the concentration of 600 mg/dl were pretreated and methylated for platelets Fatty acid analysis. The data are in **Table 19** which one can see that all altered fatty acids remained unchange after prolonging the time before subjecting platelets for fatty acid analysis. **Figure 16** shows fatty acid content in percentage of PUFA found in platelets with various times delayed after the incubation. The figure shows no significant alteration of platelet FA at the various times prolong. The results demonstrate that fatty acids changes on platelet membranes remain stable for a period of time at least for 5 h.

Table 19 Fatty acid profiles of platelets in g/100g total PLT-FA after leaving in NSS 0, 1, 3,and 5 h. The cells were preincubated with FM-LRFE for 1h at 22°C in the presence of lecithin at the concentration of 600mg /dl.

PLT-FA	FM-LRFE				
	Control	0 h	1 h	3 h	5 h
C 14:0	0.28 ± 0.07	0.69 ± 0.08	0.64 ± 0.07	0.66 ± 0.07	0.64 ± 0.07
C 15:1	3.20 ± 0.22	2.73 ± 0.23	2.70 ± 0.25	2.63 ± 0.24	2.69 ± 0.22
C 16:0	16.65 ± 0.82	18.84 ± 0.91	18.94 ± 0.89	18.81 ± 0.82	18.84 ± 0.97
C 16:1n-7	0.24 ± 0.04	0.50 ± 0.05	0.51 ± 0.06	0.50 ± 0.06	0.52 ± 0.05
C 18:0	17.01 ± 0.23	16.87 ± 0.27	16.92 ± 0.31	16.86 ± 0.35	16.84 ± 0.27
C 18:1n-9	13.21 ± 0.71	12.51 ± 0.65	12.59 ± 0.74	12.65 ± 0.72	12.60 ± 0.68
C 18:1n-7	0.81 ± 0.11	1.17 ± 0.13	1.21 ± 0.13	1.25 ± 0.12	1.15 ± 0.11
C 18:2n-6	5.63 ± 0.38	5.35 ± 0.41	5.32 ± 0.44	5.28 ± 0.42	5.34 ± 0.36
C 18:3n-3	0.06 ± 0.01	0.11 ± 0.02	0.11 ± 0.01	0.12 ± 0.01	0.10 ± 0.01
C 20:0	1.60 ± 0.21	1.31 ± 0.25	1.26 ± 0.24	1.30 ± 0.26	1.33 ± 0.31
C 20:4n-6	21.96 ± 0.51	19.45 ± 0.47	19.46 ± 0.36	19.48 ± 0.44	19.46 ± 0.56
C 20:5n-3	0.41 ± 0.11	1 .35 ± 0.12	1.34 ± 0.13	1.36 ± 0.12	1.33 ± 0.13
C 21:0	1.11 ± 0.11	1.04 ± 0.14	1.05 ± 0.10	1.03 ± 0.12	1.04 ± 0.14
C 22:0	2.56 ± 0.31	1.97 ± 0.36	1.97 ± 0.33	1.98 ± 0.27	2.00 ± 0.25
C 22:5n-3	0.90 ± 0.07	1.06 ± 0.04	1.05 ± 0.08	1.06 ± 0.05	1.06 ± 0.07
C 22:6n-3	2.46 ± 0.28	5.94 ± 0.32	5.93 ± 0.30	5.90 ± 0.24	5.89 ± 0.35
C 24:0	1.93 ± 0.05	1.47 ± 0.08	1.52 ± 0.06	1.53 ± 0.09	1.50 ± 0.08
C 24:1	1.90 ± 0.12	1.55 ± 0.14	1.59 ± 0.15	1.56 ± 0.13	1.54 ± 0.11
Others	8.08 ± 0.46	6.09 ± 0.62	5.89 ± 0.70	6.04 ± 0.53	6.13 ± 0.77
n-3	3.83 ± 0.33	8.46 ± 0.37	8.43 ± 0.33	8.44 ± 0.30	8.38 ± 0.43
n-6	27.59 ± 0.62	24.80 ± 0.57	24.78 ± 0.71	24.76 ± 0.83	24.80 ± 0.76
n-3/n-6	0.14 ± 0.01	0.34 ± 0.01	0.34 ± 0.01	0.34 ± 0.02	0.34 ± 0.01

The results are expressed as Mean ± S.D. of three determinations.

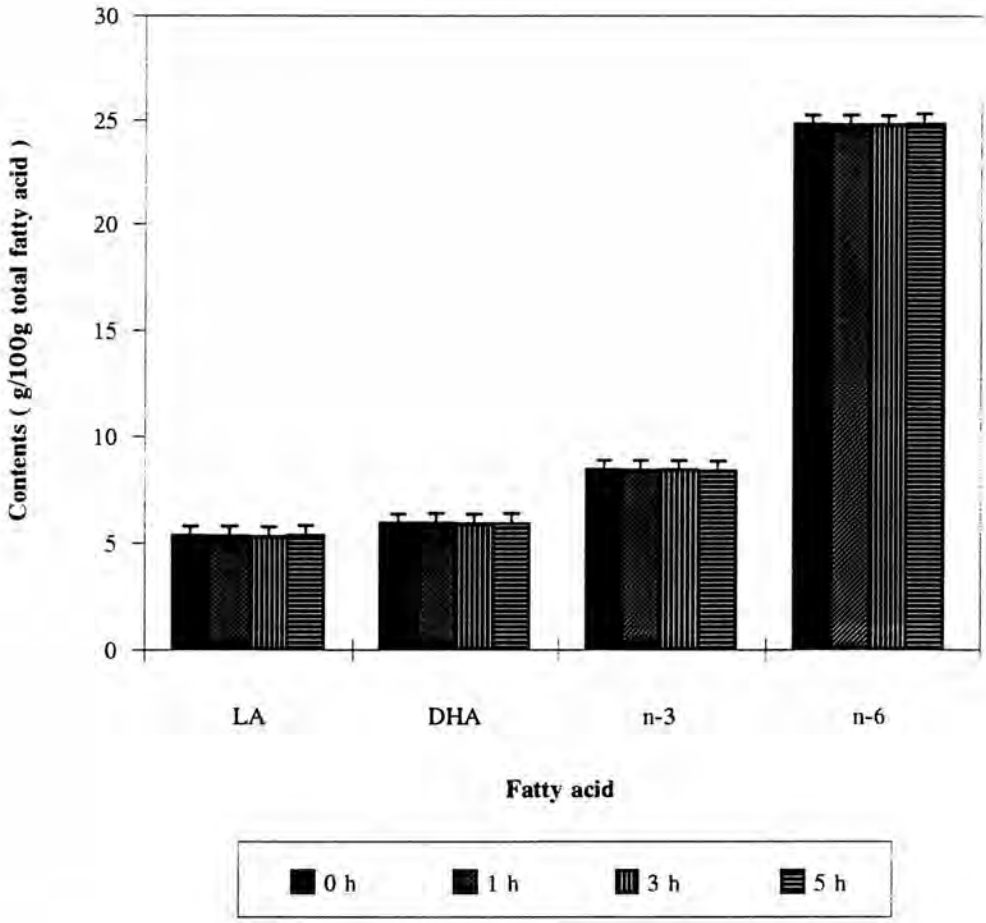

Figure 16 Comparison of fatty acid content in percentage between LA, DHA, n-3 PUFA and n-6 PUFA found in platelets with various times (0, 1, 3 and 5 h) after the incubation with FM-LRFE for 1 h at 22°C in the presence of lecithin concentration of 600 mg/dl.

No significant alteration of PLT-FA at the various times was observed.

Fatty Acid Transfer from Fat Emulsions to Platelets

A. Platelet's Fatty Acid Changed after Incubation

1. Total Fatty Acids

The profiles of PLT fatty acids before and after incubating with various concentrations of either FM-LRFE, SY-LRFE, SL-FOFE and 20% Lipofundin are shown in **Tables 20-27**. **Table 20** demonstrates the alteration of individual fatty acids of platelets after incubating with FM-LRFE. There are at least three individual platelet fatty acids obviously affected by fatty acids of FM-LRFE , ie. AA, EPA and DHA. The significant differences are expressed in **Table 21** which one can observe the marked rise of n-3 PUFA ($p<0.001$). Polyenes of n-3 fatty acids show their expansion in composition from 3.86 upto 8.31 at FM-LRFE concentration of 600 mg/dl incubation mexture. Contrarily, n-6 polyenes dropped from the baseline value of 27.53 to 24.53 after incubating with the highest concentration of FM-LRFE ($p<0.001$). Omega-3 polyene increment is higher than the proportion of n-6 polyene drop. The consequent rise of n-3/n-6 ratio is then clearly expressed ($p<0.001$).

Table 22 shows individual fatty acid profiles of platelets before and after incubation with SY-LRFE. the significant changes are clearly observed in **Table 23**. The results show that saturated and monoenoic fatty acids were not much affected by SY-LRFE. The obvious alterations are observed in polyenoic fatty acids in both groups of n-3 and n-6. As shown in **Table 23** one can see the marked increment of

Table 20 Fatty acid profiles in g/100 g total PLT-FA of platelets after the incubation with FM-LRFE for 1 h at 22°C in the presence of lecithin at the concentrations of 0, 100, 300 and 600 mg/dl

PLT-FA	FM-LRFE				
	0 mg/dl	100 mg/dl	300 mg/dl	600 mg/dl	P-value
C 14:0	0.29 ± 0.06^{c}	0.40 ± 0.08^{b}	0.59 ± 0.09^{a}	0.63 ± 0.07^{a}	0.00
C 15:0	3.19 ± 0.25^{a}	2.96 ± 0.24^{a}	2.63 ± 0.23^{b}	2.57 ± 0.21^{b}	0.00
C 16:0	16.30 ± 0.85^{b}	$17.61 \pm 1.33^{a,b}$	18.48 ± 1.25^{a}	18.74 ± 0.82^{a}	0.01
C 16:1 n-7	0.23 ± 0.05^{b}	0.29 ± 0.05^{b}	0.42 ± 0.06^{a}	0.49 ± 0.06^{a}	0.00
C 18:0	17.11 ± 0.35^{a}	17.25 ± 0.21^{a}	16.63 ± 0.39^{b}	$16.92 \pm 0.21^{a,b}$	0.02
C 18:1 n-9	13.12 ± 0.74	12.98 ± 0.73	12.58 ± 0.65	12.50 ± 0.73	0.28
C 18:1 n-7	0.81 ± 0.16^{b}	$0.92 \pm 0.13^{a,b}$	1.06 ± 0.11^{a}	1.09 ± 0.12^{a}	0.01
C 18:2 n-6	5.63 ± 0.41	5.41 ± 0.42	5.33 ± 0.38	5.33 ± 0.45	0.48
C 18:3 n-3	0.06 ± 0.01^{b}	0.06 ± 0.02^{b}	0.08 ± 0.01^{a}	0.10 ± 0.01^{a}	0.00
C 20:0	1.64 ± 0.32	1.46 ± 0.29	1.46 ± 0.41	1.37 ± 0.25	0.60
C 20:4 n-6	21.90 ± 0.44^{a}	20.72 ± 0.68^{b}	19.65 ± 0.29^{c}	19.20 ± 0.32^{c}	0.00
C 20:5 n-3	0.44 ± 0.11^{d}	0.71 ± 0.12^{c}	0.99 ± 0.15^{b}	1.33 ± 0.13^{a}	0.00
C 21:0	1.13 ± 0.18	1.06 ± 0.16	1.04 ± 0.12	1.04 ± 0.15	0.72
C 22:0	2.75 ± 0.28^{a}	$2.49 \pm 0.31^{a,b}$	2.26 ± 0.35^{b}	2.16 ± 0.33^{b}	0.05
C 22:5 n-3	0.89 ± 0.09^{c}	$0.95 \pm 0.07^{b,c}$	0.99 ± 0.04^{b}	1.06 ± 0.06^{a}	0.01
C 22:6 n-3	2.47 ± 0.23^{d}	3.59 ± 0.37^{c}	4.98 ± 0.39^{b}	5.82 ± 0.30^{a}	0.00
C 24:0	1.85 ± 0.05^{a}	1.65 ± 0.06^{b}	1.49 ± 0.10^{c}	1.46 ± 0.10^{c}	0.00
C 24:1	1.92 ± 0.25^{a}	$1.80 \pm 0.15^{a,b}$	$1.68 \pm 0.20^{a,b}$	1.55 ± 0.12^{b}	0.04
Others	8.28 ± 0.40^{a}	7.73 ± 0.89^{b}	7.67 ± 0.33^{b}	6.64 ± 0.76^{c}	0.01

The results are expressed as Mean $\pm$ S.D. of five determinations.

The different letters in the same row shown as a, b, c, d are significant differences ($p<0.05$).

Table 21 Composition of Saturated, and Unsaturated fatty acid in g/100g total PLT-FA of platelets after the incubation with FM-LR FE for 1h at 22°C in the presence of lecithin at the concentrations of 0, 100, 300 and 600 mg/dl.

PLT-FA	FM-LRFE				
	0mg/dl	100mg/dl	300mg/dl	600mg/dl	P-value
SAFA	41.07 ± 0.80	41.91 ± 1.04	41.93 ± 1.11	42.32 ± 0.58	0.21
MUFA	19.27 ± 1.26	18.94 ± 1.11	18.38 ± 1.09	18.20 ± 1.12	0.45
PUFA	31.38 ± 0.86	31.43 ± 1.08	32.02 ± 0.86	32.84 ± 0.83	0.07
LA	5.63 ± 0.40	5.41 ± 0.42	5.33 ± 0.38	5.33 ± 0.45	0.48
AA	21.90 ± 0.44^{a}	20.72 ± 0.68^{b}	19.65 ± 0.29^{c}	19.20 ± 0.32^{c}	0.00
EPA	0.44 ± 0.11^{d}	0.71 ± 0.12^{c}	0.99 ± 0.15^{b}	1.33 ± 0.13^{a}	0.00
DHA	2.47 ± 0.23^{d}	3.59 ± 0.37^{c}	4.98 ± 0.39^{b}	5.82 ± 0.30^{a}	0.00
n-3	3.86 ± 0.29^{d}	5.30 ± 0.45^{c}	7.04 ± 0.48^{b}	8.31 ± 0.37^{a}	0.00
n-6	27.53 ± 0.64^{a}	26.13 ± 0.83^{b}	24.98 ± 0.64^{c}	24.53 ± 0.42^{c}	0.00
n-3/n-6	0.14 ± 0.01^{d}	0.20 ± 0.02^{c}	0.28 ± 0.02^{b}	0.34 ± 0.01^{a}	0.00

The results are expressed as Mean ± S.D. of five determinations.

The different letters in the same row shown as a, b, c, d are significant differences ($p<0.05$).

Table 22 Fatty acid profiles in g/100 g total PLT-FA of platelets after the incubation with SY-LRFE for 1 h at 22°C in the presence of lecithin at the concentrations of 0, 100, 300 and 600 mg/dl

PLT-FA	SY-LRFE				
	0 mg/dl	100 mg/dl	300 mg/dl	600 mg/dl	P-value
C 14:0	0.25 ± 0.05	0.29 ± 0.11	0.28 ± 0.06	0.28 ± 0.09	0.89
C 15:1	3.41 ± 0.27^{a}	2.88 ± 0.67^{a,b}	2.83 ± 0.33^{a,b}	2.55 ± 0.22^{b}	0.03
C 16:0	16.87 ± 0.47^{b}	17.48 ± 0.45^{a,b}	17.85 ± 0.35^{a}	17.78 ± 0.52^{a}	0.01
C 16:1	0.25 ± 0.10	0.22 ± 0.08	0.23 ± 0.07	0.22 ± 0.09	0.92
C 18:0	17.47 ± 0.56^{a}	16.47 ± 0.50^{b}	15.80 ± 0.98^{b,c}	14.94 ± 0.46^{c}	0.00
C 18:1 n-9	13.24 ± 0.38^{b}	13.81 ± 0.40^{a,b}	13.92 ± 0.65^{a}	14.16 ± 0.23^{a}	0.03
C 18:1 n-7	0.78 ± 0.15	0.78 ± 0.17	0.81 ± 0.16	0.86 ± 0.13	0.82
C 18:2 n-6	5.60 ± 0.88^{d}	9.22 ± 0.94^{c}	11.49 ± 0.84^{b}	14.26 ± 0.47^{a}	0.00
C 18:3 n-3	0.04 ± 0.01^{d}	0.44 ± 0.07^{c}	0.78 ± 0.07^{b}	1.05 ± 0.11^{a}	0.00
C 20:0	1.56 ± 0.08	1.61 ± 0.35	1.38 ± 0.16	1.27 ± 0.16	0.07
C 20:4 n-6	20.73 ± 0.54^{a}	18.65 ± 0.40^{b}	16.81 ± 1.18^{c}	15.59 ± 0.96^{d}	0.00
C 20:5 n-3	0.42 ± 0.04	0.39 ± 0.05	0.38 ± 0.02	0.37 ± 0.04	0.21
C 21:0	1.08 ± 0.19^{a}	0.85 ± 0.12^{b}	0.87 ± 0.07^{b}	0.82 ± 0.08^{b}	0.02
C 22:0	3.09 ± 0.13	3.19 ± 0.36	2.87 ± 0.41	2.60 ± 0.39	0.07
C 22:5 n-3	0.88 ± 0.18	0.82 ± 0.19	0.82 ± 0.21	0.83 ± 0.18	0.28
C 22:6 n-3	2.39 ± 0.21	2.29 ± 0.14	2.19 ± 0.07	2.28 ± 0.22	0.36
C 24:0	2.13 ± 0.08	2.15 ± 0.46	2.04 ± 0.37	1.95 ± 0.35	0.80
C 24:1	2.03 ± 0.15^{a}	1.74 ± 0.17^{b}	1.55 ± 0.20^{b}	1.59 ± 0.19^{b}	0.00
Others	7.63 ± 0.54	6.72 ± 1.01	7.10 ± 0.64	6.48 ± 0.52	0.09

The results are expressed as Mean ± S.D. of five determinations.

The different letters in the same row shown as a, b, c, d are significant differences ($p<0.05$).

Table 23 Composition of Saturated and Unsaturated fatty acid in g/100g total PLT-FA of platelets after the incubation with SY-LRFE for 1h at 22°C in the presence of lecithin at the concentrations of 0, 100, 300 and 600 mg/dl.

PLT-FA	SY-LRFE				
	0 mg/dl	100 mg/dl	300 mg/dl	600 mg/dl	P-value
SAFA	42.45 ± 1.72^{a}	42.04 ± 1.71^{a}	41.08 ± 1.72^{a,b}	39.64 ± 1.34^{b}	0.03
MUFA	19.71 ± 0.84	19.43 ± 0.86	19.34 ± 0.69	19.38 ± 0.51	0.92
PUFA	30.06 ± 1.86^{c}	31.81 ± 1.43^{b}	32.48 ± 1.34^{b}	34.38 ± 1.20^{a}	0.00
LA	5.60 ± 0.88^{d}	9.22 ± 0.94^{c}	11.49 ± 0.84^{b}	14.26 ± 0.47^{a}	0.00
AA	20.73 ± 0.54^{a}	18.65 ± 0.40^{b}	16.81 ± 1.18^{c}	15.59 ± 0.96^{d}	0.00
EPA	0.42 ± 0.04	0.39 ± 0.05	0.38 ± 0.02	0.37 ± 0.04	0.21
DHA	2.39 ± 0.21	2.29 ± 0.14	2.19 ± 0.07	2.28 ± 0.22	0.36
n-3	3.73 ± 0.19^{c}	3.93 ± 0.18^{b,c}	4.17 ± 0.15^{b}	4.53 ± 0.28^{a}	0.00
n-6	26.33 ± 1.56^{c}	27.87 ± 1.22^{b}	28.30 ± 1.21^{b}	29.85 ± 1.25^{a}	0.00
n-3/n-6	0.14 ± 0.02	0.14 ± 0.02	0.15 ± 0.01	0.15 ± 0.01	0.38

The results are expressed as Mean ± S.D. of five determinations.

The different letters in the same row shown as a, b, c, d are significant differences ($p<0.05$).

total n-3 FA, from 3.73 the baseline value before the incubation upto 4.53. Omega-6 fatty acid shows its significant increment in relation to the contents of PL in incubation mixture. This is due to the fact that SY-LRFE contain n-6 FA especially LA in their PL surface in much higher proportion comparing to platelets (57.77 vs 5.60 , for SY-LRFE's surface shown in **Table 8** and PLT shown in **Table 22**, respectively).

Individual fatty acid profiles of platelets before and after incubation with SL-FOFE are shown in **Table 24**. The significant differences are expressed in **Table 25**. The explanation for **Tables 24-25** is similar to that described for the results of the incubation with SY-LRFE above.

Table 26 demonstrates the alteration of platelet FA composition after the incubation with 20% Lipofundin (commercial EY-LRFE) at various concentrations. The results are likely to demonstrate the maintenance of membrane fatty acid composition as shown in **Table 27**.

2. Individual Fatty Acids Changed

The effect of fat emulsion particles and liposomes on platelet membranes was elucidated when the alterations of each individual fatty acid during the incubation of platelets with LRFE's were calculated as percentage of relative membrane FA changed as shown in **Figures 17-20**. Incubating platelets with FM-LRFE, the six major membrane fatty acids were markedly affected and changed in their contribution in platelets as shown in **Figure 17**. Two fatty acids demonstrated their

Table 24 Fatty acid profiles in g/100 g total PLT-FA of platelets after the incubation with SL-FOFE for 1 h at 22°C in the presence of lecithin at the concentrations of 0, 100, 300 and 600 mg/dl

PLT-FA	SL-FOFE				
	0 mg/dl	100 mg/dl	300 mg/dl	600 mg/dl	P-value
C 14:0	0.29 ± 0.07^{b}	$0.43 \pm 0.13^{a,b}$	0.49 ± 0.11^{a}	0.52 ± 0.11^{a}	0.02
C 15:1	3.62 ± 0.20^{a}	3.14 ± 0.14^{b}	$2.90 \pm 0.22^{b,c}$	2.64 ± 0.21^{c}	0.00
C 16:0	16.91 ± 0.34^{b}	17.89 ± 0.65^{b}	18.46 ± 0.74^{a}	18.89 ± 0.79^{a}	0.00
C 16:1 n-7	0.26 ± 0.07^{b}	0.29 ± 0.10^{b}	$0.35 \pm 0.09^{a,b}$	0.47 ± 0.10^{a}	0.01
C 18:0	17.58 ± 0.06^{a}	16.60 ± 0.55^{b}	15.58 ± 0.24^{c}	15.07 ± 0.37^{d}	0.00
C 18:1 n-9	13.36 ± 0.92	13.15 ± 0.53	12.82 ± 0.41	12.92 ± 0.32	0.53
C 18:1 n-7	0.72 ± 0.06^{b}	$0.85 \pm 0.06^{a,b}$	0.87 ± 0.05^{a}	0.89 ± 0.07^{a}	0.00
C 18:2 n-6	5.95 ± 0.32^{d}	8.91 ± 0.57^{c}	12.09 ± 0.99^{b}	14.59 ± 1.40^{a}	0.00
C 18:3 n-3	0.04 ± 0.01^{d}	0.39 ± 0.04^{c}	0.78 ± 0.12^{b}	1.08 ± 0.15^{a}	0.00
C 20:0	1.50 ± 0.10^{a}	1.31 ± 0.21^{b}	1.26 ± 0.09^{b}	1.22 ± 0.08^{b}	0.01
C 20:4 n-6	20.57 ± 0.37^{a}	18.86 ± 0.83^{b}	17.50 ± 0.82^{c}	15.80 ± 1.15^{d}	0.00
C 20:5 n-3	0.45 ± 0.17	0.49 ± 0.08	0.50 ± 0.09	0.49 ± 0.14	0.90
C 21:0	1.22 ± 0.24	1.13 ± 0.23	1.06 ± 0.19	0.93 ± 0.20	0.24
C 22:0	2.95 ± 0.24^{a}	$2.77 \pm 0.33^{a,b}$	$2.54 \pm 0.21^{b,c}$	2.33 ± 0.17^{c}	0.01
C 22:5 n-3	2.01 ± 0.30	1.93 ± 0.29	1.66 ± 0.29	1.62 ± 0.36	0.17
C 22:6 n-3	2.35 ± 0.39	2.37 ± 0.21	2.33 ± 0.35	2.21 ± 0.42	0.89
C 24:1	1.92 ± 0.28^{a}	$1.78 \pm 0.05^{a,b}$	$1.61 \pm 0.10^{b,c}$	1.41 ± 0.14^{c}	0.00
Others	8.32 ± 0.58^{a}	$7.69 \pm 0.64^{a,b}$	$7.22 \pm 0.27^{b,c}$	6.88 ± 0.33^{c}	0.00

The results are expressed as Mean ± S.D. of five determinations.

The different letters in the same row shown as a, b, c, d are significant differences ($P<0.05$).

Table 25 Composition of Saturated and Unsaturated fatty acid in g/100g total PLT-FA of platelets after the incubation with SL-FOFE for 1h at 22°C in the presence of lecithin at the concentrations of 0, 100, 300 and 600 mg/dl.

PLT-FA	SL-FOFE				
	0 mg/dl	100 mg/dl	300 mg/dl	600 mg/dl	P-value
SAFA	42.46 ± 1.63^{a}	42.05 ± 1.23^{a}	$41.06 \pm 0.78^{a,b}$	40.56 ± 0.91^{b}	0.02
MUFA	19.88 ± 0.77^{a}	$19.31 \pm 0.82^{a,b}$	18.65 ± 0.57^{b}	18.43 ± 0.28^{b}	0.01
PUFA	30.26 ± 0.78^{c}	31.86 ± 0.75^{b}	34.00 ± 0.65^{a}	34.98 ± 1.01^{a}	0.00
LA	5.95 ± 0.32^{d}	8.91 ± 0.57^{c}	12.09 ± 0.99^{b}	14.59 ± 1.40^{a}	0.00
AA	20.57 ± 0.37^{a}	18.86 ± 0.83^{b}	17.50 ± 0.82^{c}	15.80 ± 1.15^{d}	0.00
EPA	0.45 ± 0.17	0.49 ± 0.08	0.50 ± 0.08	0.49 ± 0.14	0.90
DHA	2.35 ± 0.39	2.36 ± 0.21	2.32 ± 0.35	2.21 ± 0.42	0.89
n-3	3.74 ± 0.56^{b}	$4.08 \pm 0.29^{a,b}$	4.42 ± 0.42^{a}	4.60 ± 0.55^{a}	0.02
n-6	26.52 ± 0.29^{d}	27.78 ± 0.71^{c}	29.59 ± 0.41^{b}	30.38 ± 0.58^{a}	0.00
n-3/n-6	0.14 ± 0.02	0.15 ± 0.01	0.15 ± 0.01	0.15 ± 0.02	0.42

The results are expressed as Mean ± S.D. of five determinations.

The different letters in the same row shown as a, b, c, d are significant differences ($p<0.05$).

Table 26 Fatty acid profiles in g/100 g total PLT-FA of platelets after the incubation with 20% Lipofundin for 1 h at 22°C in the presence of lecithin at the concentrations of 0, 100, 300 and 600 mg/dl

PLT-FA	20%Lipofundin				
	0 mg/dl	100 mg/dl	300 mg/dl	600 mg/dl	P-value
C 14:0	0.28 ± 0.12	0.28 ± 0.76	0.28 ± 0.04	0.25 ± 0.05	0.87
C 15:1	3.29 ± 0.47	3.02 ± 0.42	2.97 ± 0.33	2.93 ± 0.40	0.52
C 16:0	16.20 ± 1.19	16.96 ± 1.12	17.28 ± 0.87	17.10 ± 0.59	0.34
C 16:1 n-7	0.26 ± 0.08	0.27 ± 0.34	0.28 ± 0.06	0.27 ± 0.04	0.97
C 18:0	17.32 ± 0.55	17.34 ± 0.85	17.10 ± 0.66	17.52 ± 0.80	0.83
C 18:1 n-9	13.50 ± 0.29	13.86 ± 0.26	14.06 ± 0.48	14.03 ± 0.36	0.16
C 18:1 n-7	0.74 ± 0.10	0.83 ± 0.11	0.81 ± 0.09	0.81 ± 0.07	0.48
C 18:2 n-6	5.44 ± 0.91	6.51 ± 0.71	6.65 ± 0.76	6.81 ± 0.48	0.07
C 18:3 n-3	0.04 ± 0.02^{b}	0.24 ± 0.08^{a}	0.25 ± 0.07^{a}	0.27 ± 0.07^{a}	0.00
C 20:0	1.41 ± 0.25	1.39 ± 0.31	1.37 ± 0.19	1.45 ± 0.32	0.97
C 20:4 n-6	21.83 ± 0.16	21.06 ± 1.22	20.94 ± 0.51	20.74 ± 1.01	0.17
C 20:5 n-3	0.42 ± 0.06	0.33 ± 0.05	0.32 ± 0.02	0.32 ± 0.06	0.02
C 21:0	1.18 ± 0.20	1.05 ± 0.12	1.06 ± 0.15	1.07 ± 0.17	0.58
C 22:0	2.95 ± 0.41	2.83 ± 0.34	2.76 ± 0.13	2.79 ± 0.49	0.84
C 22:5 n-3	0.88 ± 0.18	0.81 ± 0.19	0.82 ± 0.12	0.80 ± 0.10	0.77
C 22:6 n-3	2.45 ± 0.30	2.47 ± 0.27	0.24 ± 0.34	2.33 ± 0.24	0.87
C 24:0	2.35 ± 0.12^{a}	1.97 ± 0.24^{b}	1.90 ± 0.18^{b}	1.91 ± 0.14^{b}	0.00
C 24:1	2.06 ± 0.30	1.83 ± 0.27	1.79 ± 0.29	1.62 ± 0.28	0.16
Others	7.42 ± 0.63	6.98 ± 0.87	6.97 ± 0.67	7.03 ± 0.37	0.60

The results are expressed as Mean ± S.D. of five determinations.

The different letters in the same row shown as a, b, c, d are significant differences ($p<0.05$).

Table 27 Composition of Saturated and Unsaturated fatty acid in g/100g total PLT-FA of platelets after the incubation with 20%Lipofundin for 1h at 22°C in the presence of lecithin at the concentrations of 0, 100, 300 and 600 mg/dl.

PLT-FA	20%Lipofundin				
	0 mg/dl	100 mg/dl	300 mg/dl	600 mg/dl	P-value
SAFA	41.68 ± 0.81	41.80 ± 1.82	41.76 ± 1.08	42.05 ± 0.76	0.96
MUFA	19.86 ± 0.62	19.81 ± 0.82	19.90 ± 0.41	19.66 ± 0.79	0.95
PUFA	31.07 ± 0.81	31.41 ± 1.07	31.36 ± 0.82	31.26 ± 0.56	0.86
LA	5.44 ± 0.81	6.51 ± 0.71	6.65 ± 0.76	6.81 ± 0.48	0.07
AA	21.83 ± 0.16	21.06 ± 1.22	20.94 ± 0.51	20.74 ± 1.02	0.17
EPA	0.42 ± 0.06^{a}	0.33 ± 0.05^{b}	0.32 ± 0.02^{b}	0.32 ± 0.06^{b}	0.02
DHA	2.45 ± 0.30	2.46 ± 0.27	2.38 ± 0.34	2.33 ± 0.24	0.87
n-3	3.79 ± 0.34	3.84 ± 0.30	3.77 ± 0.38	3.72 ± 0.33	0.93
n-6	27.28 ± 0.95	27.57 ± 0.99	27.59 ± 0.95	27.54 ± 0.72	0.94
n-3/n-6	0.14 ± 0.01	0.14 ± 0.01	0.14 ± 0.02	0.14 ± 0.01	0.97

The results are expressed as Mean ± S.D. of five determinations.

The different letters in the same row shown as a, b, c, d are significant differences ($p<0.05$).

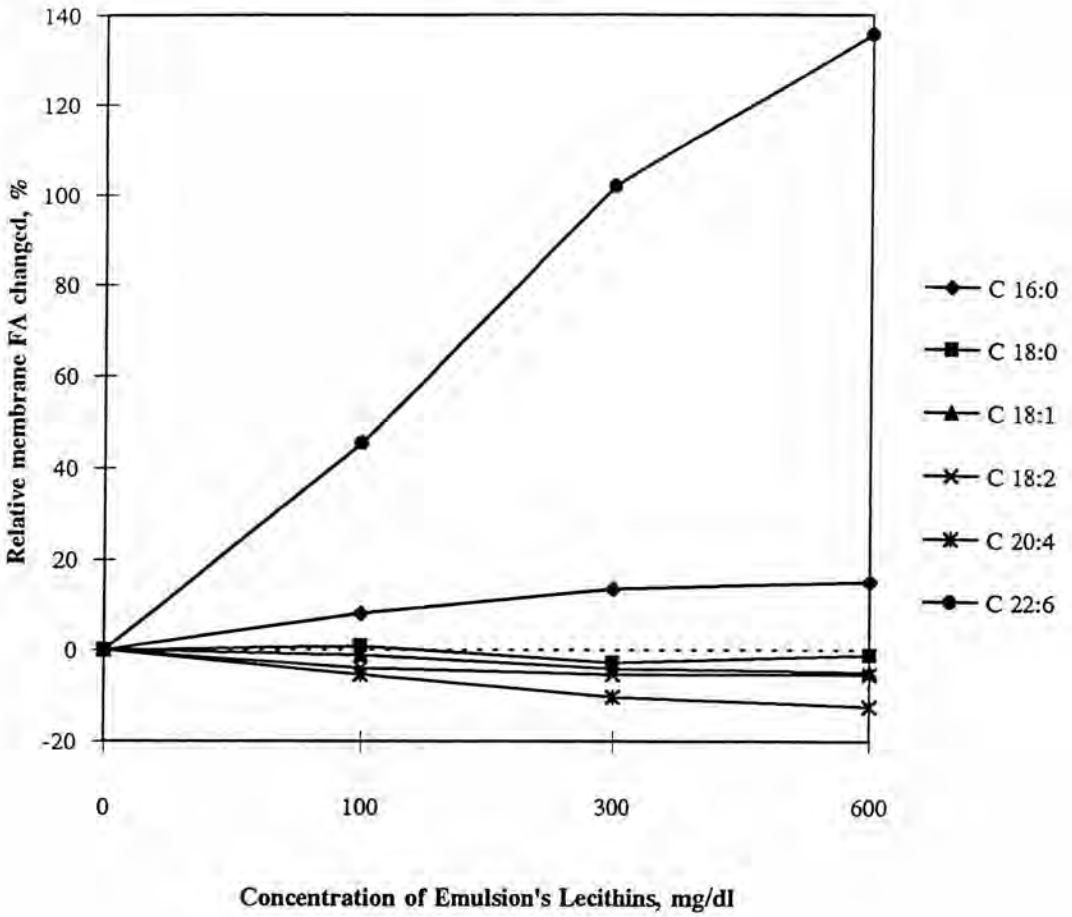

Figure 17 The mean values of relative individual membrane fatty acid changed in percentage after the incubation of platelets with FM-LRFE at the concentrations of 0, 100, 300, 600 mg lecithins/dl. The individual values was calculated as described in the method.

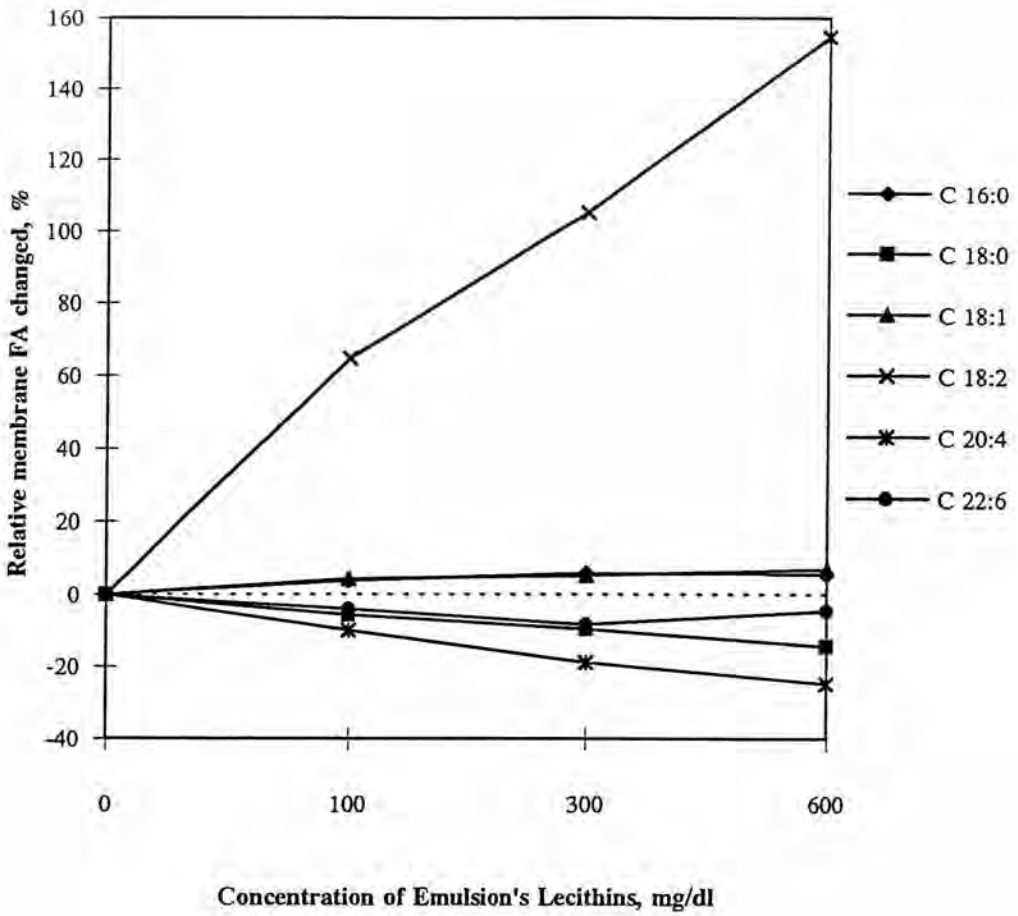

Figure 18 The mean values of relative individual membrane fatty acid changed in in percentage after the incubation of platelets with SY-LRFE at the concentrations of 0, 100, 300, 600 mg lecithins/dl. The individual values was calculated as described in the method.

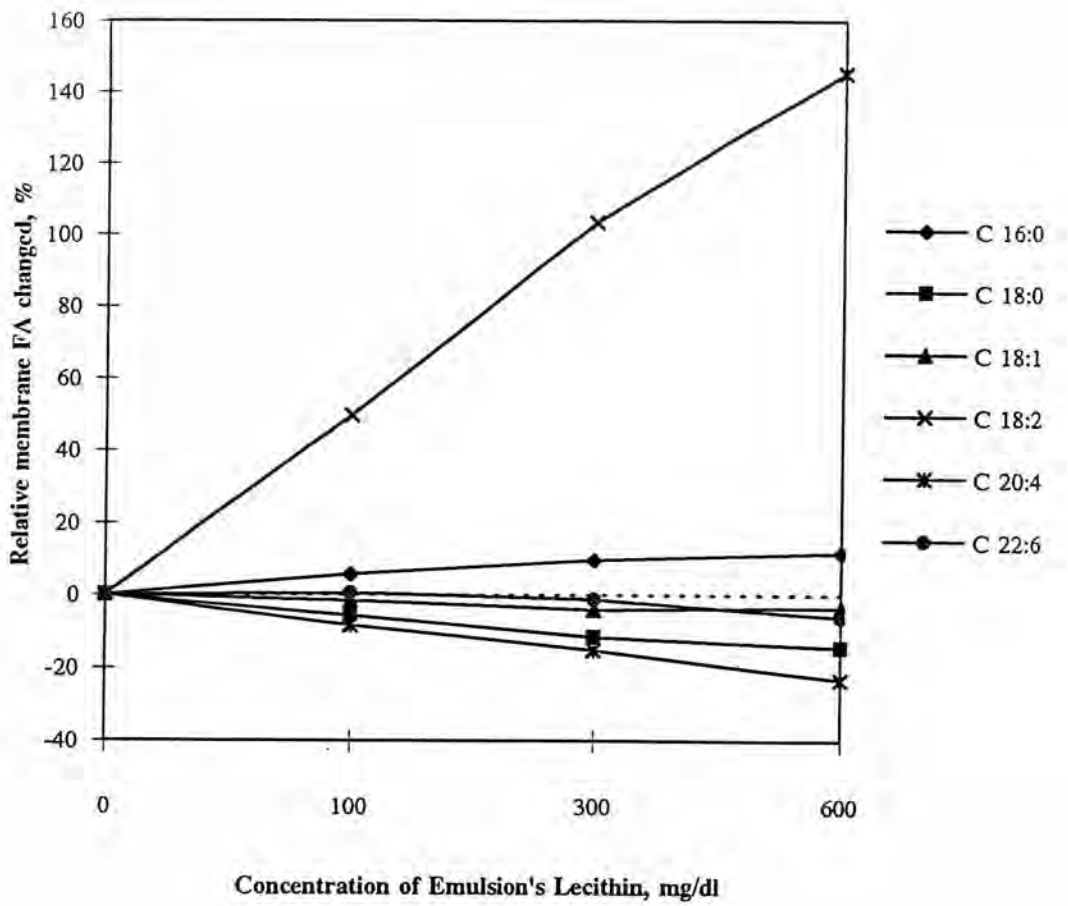

Figure 19 The mean values of relative individual membrane fatty acid changed in in percentage after the incubation of platelets with SL-FOFE at the concentrations of 0, 100, 300, 600 mg lecithins/dl. The individual values was calculated as described in the method.

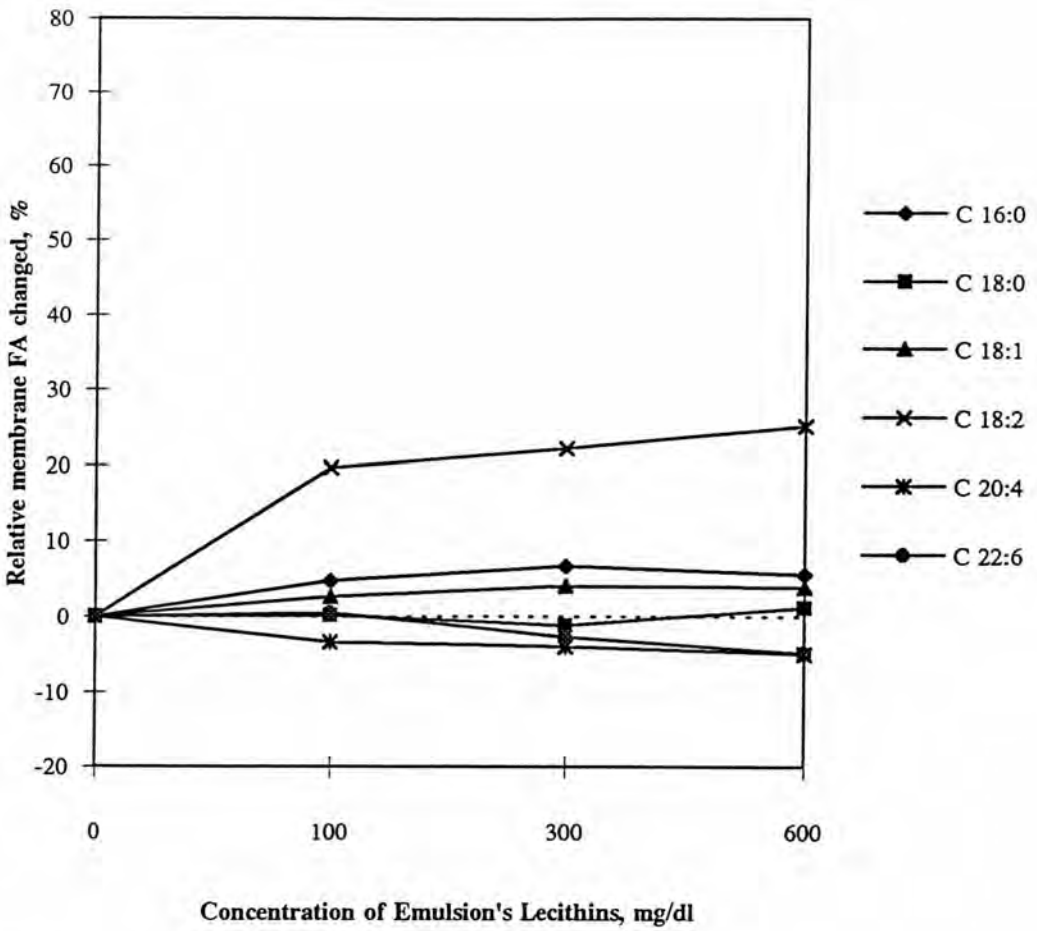

Figure 20 The mean values of relative individual membrane fatty acid changed in percentage after the incubation of platelets with 20% Lipofundin at the concentrations of 0, 100, 300, 600 mg lecithins/dl. The individual values was calculated as described in the method.

mark increments: DHA and palmitic acid (C 16:0). Among all fatty acids, DHA exhibited its tramendous increment whereas C 16:0 rose with much less extent.

In the mean time, 4 fatty acids decreased, 2 in 4 were saturated: C 18:0 and monoene : C 18:1 n-9, other two were polyenes: LA and AA. Among them, C 18:0, C 18:1 n-9 and LA showed their gradual drop whereas AA reached the plateau at the lowest concentration of PL at 100 mg/dl incubation mixture.

Figure 18 shows the results of 6 major platelet fatty acids affected by the incubation with SY-LRFE. Membrane LA rose markedly reaching the relative value of approximately 155%. Rationally, the huge amount of LA present in SY-LRFE 's surface was responsible for the rise in membrane. The losses of membrane fatty acids were found in three major fatty acids especially C 18:0, AA and DHA. The replacemant of LA for C 18:0, AA and DHA at sn-2 position of membrane PL was probably the answer of this exchanges.

The effect of SL-FOFE on platelet membrane is shown in **Figure 19** . The results of 5 major platelet fatty acids affected by SL-FOFE changed resemblingly with SY-LRFE except for C 18:1n-9 which showed its gradual increment with SY-LRFE but maintained with SL-FOFE.

After the incubation of platelets with 20% Lipofundin, 6 major platelet fatty acids were slightly affected as one can see in **Figure 20**. The steady decrement of C 20:4 n-6 and DHA were probably responsible by the rise of LA. Noticeably, slight drop of DHA (C 22:6 n-3) shows that it was probably affected by the incubation with 20% Lipofundin.

The alterations of membrane fatty acids after incubation with 4 fat emulsions are summarized in **Table 28**. One can see the increment of saturated fatty acids upto 1.25 and 0.37 of platelet incubated with respective FM-LRFE and 20% Lipofundin whereas SAFA of those incubated with SY-LRFE and SL-FOFE decreased. The decrement of monoenoic fatty acids were found in platelets incubated with 4 fat emulsions.

Incubating with SY-LRFE and SL-FOFE induced the marked increment of polyenes in platelets upto 4.32% and 4.72%, respectively whereas FM-LRFE and 20%Lipofundin affected much less (1.46 and 0.19, respectively, $p<0.05$). Focussing in polyenes, FM-LRFE induced the marked increase of n-3 FA upto 4.45% with DHA contributed for 75% (3.35 in 4.45) whereas no alteration was observed with SY-LRFE, SL-FOFE and 20%Lipofundin. Meanwhile, marked decrease of n-6 FA was found in FM-LRFE group in contrary to the result observed in SY-LRFE and SL-FOFE which show their rise upto respective 3.52% and 3.87% exclusively LA ($p<0.05$). Differently from two former groups, 20%Lipofundin shows consistency of n-6 FA. All results of n-3 FA and n-6 FA as described earlier lead to much higher ratio of n-3/n-6 of FM-LRFE in comparison to those of SY-LRFE, SL-FOFE and 20% Lipofundin.

B. Relationship between PL Concentration and Fatty Acids

The questions of whether the concentration of PL in incubation mixture affect the alteration of individual membrane fatty acids and how they affect are

Table 28 Change of platelet fatty acids (PLT-FA) after the incubation with FM-LRFE, SY-LRFE, SL-FOFE and 20%Lipofundin for 1h at 22°C in the presence of lecithin at the concentration of 600 mg/dl

PLT-FA	FM-LRFE	SY-LRFE	SL-FOFE	20%LIPOFUNDIN
SAFA	1.25 ± 0.30^{a}	-2.81 ± 0.86^{b}	-1.90 ± 0.57^{b}	0.37 ± 0.89^{a}
MUFA	-1.07 ± 0.49^{b}	-0.32 ± 0.46^{a}	-1.46 ± 0.72^{b}	-0.20 ± 0.25^{a}
PUFA	1.46 ± 0.36^{b}	4.32 ± 1.73^{a}	4.72 ± 0.51^{a}	0.19 ± 0.63^{c}
n-3	4.45 ± 0.42^{a}	0.80 ± 0.33^{b}	0.86 ± 0.27^{b}	-0.07 ± 0.18^{c}
n-6	-3.00 ± 0.27^{c}	3.52 ± 1.75^{a}	3.87 ± 0.41^{a}	0.27 ± 0.58^{b}
n-3/n-6	0.20 ± 0.02^{a}	0.01 ± 0.02^{b}	0.01 ± 0.01^{b}	0.00 ± 0.01^{c}
LA	-0.30 ± 0.13^{c}	8.66 ± 1.08^{a}	8.64 ± 1.13^{a}	1.36 ± 1.07^{b}
AA	-2.70 ± 0.28^{b}	-5.14 ± 0.85^{c}	-4.77 ± 0.87^{c}	-1.09 ± 0.96^{a}
EPA	0.89 ± 0.09^{a}	-0.05 ± 0.05^{c}	0.04 ± 0.18^{b}	-0.10 ± 0.09^{c}
DHA	3.35 ± 0.34^{a}	-0.11 ± 0.34^{b}	-0.14 ± 0.34^{b}	-0.32 ± 0.64^{b}

The figures obtained by substracting the percentage values of PLT-FA at 600 mg/dl from those at 0 mg/dl.

The results are expressed as Mean ± S.D. of five determinations.

The different letters in the same row shown as a, b, c, d are significant differences ($p<0.05$).

answered by considering the values of slope and coefficient of correlation (r) as shown in **Tables 29-32**. Both values were obtained from linear regression of equation. As shown in **Table 29**, all platelet PUFA's except for LA were affected in relation to the concentrations of PL in FM-LRFE: n-3 PUFA's increased whereas n-6 PUFA's (except for LA) decreased. The correlation between the ratio of n-3/n-6 PUFA's and the concentration of FM-LRFE's PL is impressive at the value as high as 0.95 ($p<0.001$). High correlation to nearly 1 between n-3 PUFA's: EPA and DHA, and FM-LRFE's PL concentrations (0.93, 0.94 and 0.95 for r values of EPA, DHA and n-3 PUFA, respectively) imply that FM-LRFE is effective donor of n-3 PUFA's to platelets.

The concentrations of SY-LRFE's PL yielded high correlation with PUFA's of platelets especially ALA and two major n-6 PUFA's: LA and AA (0.93 and 0.88 for r of LA and AA, respectively, shown in **Table 30**). The correlation was low and non-significant with n-3 PUFA's. The results imply that SY-LRFE behaves like a good carrier of n-6 PUFA's as well as of ALA for platelets (r between PL concentration and ALA equal to 0.94). The alteration of n-3/n-6 PUFA ratio is, however, not dramatically affected with SY-LRFE as found with FM-LRFE (r equal to 0.65 vs 0.95 for n-3/n-6 ratio of SY-LRFE vs FM-LRFE). As shown in **Table 31**, one can see that the effectiveness of SL-FOFE as the carrier of PUFA to platelets is alike SY-LRFE except that there was no correlation in n-3/n-6 ratio with SL-FOFE (r equal to 0.38 vs 0.65 for SL-FOFE vs SY-LRFE). SL-FOFE is a good carrier of n-6 PUFA 's as well as of ALA for platelets but not for EPA and DHA.

Table 29 Equations, the correlation (r), t and p values obtained from the regression equations of percentages of fatty acids (Y) before and after the incubation at various concentrations (X) of FM-LRFE.

FA	FM-LRFE				
	Equation	r	df	t	p-value
SAFA	Y=41.3848+0.0017X	0.4170	18	1.9468	NS
MUFA	Y=19.1363-0.0018X	0.3626	18	1.6504	NS
PUFA	Y=31.2642+0.0028X	0.5794	18	3.0161	<0.010
ALA	Y=0.0553+7.6E-05X	0.8094	18	5.8483	<0.001
EPA	Y=0.5080+0.0014X	0.9319	18	10.8994	<0.001
DHA	Y=2.8702+0.0054X	0.9360	18	11.2771	<0.001
n-3	Y=4.1335+0.0075X	0.9455	18	12.3112	<0.001
LA	Y=5.5264-0.0004X	0.2406	18	1.0516	NS
AA	Y=21.4172-0.0042X	0.8578	18	7.0776	<0.001
n-6	Y=26.9436-0.0046X	0.8135	18	5.9336	<0.001
n-3/n-6	Y=0.1593+0.0003X	0.9522	18	13.2250	<0.001

Data obtained from the calculation as described in the text.

Table 30 Equations, the correlation (r), t and p values obtained from the regression equations of percentages of fatty acids (Y) before and after the incubation at various concentrations (X) of SY-LRFE.

FA	SY-LRFE				
	Equation	r	df	t	p-value
SAFA	Y=42.4801-0.0047X	0.6437	18	3.5682	<0.005
MUFA	Y=19.5728-0.0004X	0.1196	18	0.5111	NS
PUFA	Y=30.5773+0.0053X	0.8402	18	6.5743	<0.001
ALA	Y=0.1842+0.0016X	0.9381	18	11.4963	<0.001
EPA	Y=0.4051-0.0001X	0.3981	18	1.8414	NS
DHA	Y=2.3296-0.0002X	0.2135	18	0.9271	NS
n-3	Y=3.7949+0.0011X	0.8586	18	7.1076	<0.001
LA	Y=6.8316+0.0133X	0.9334	18	11.0331	<0.001
AA	Y=19.9469-0.0080X	0.8832	18	7.9855	<0.001
n-6	Y=26.7785+0.0052X	0.7891	18	5.4496	<0.001
n-3/n-6	Y=0.1437+3.0E-05X	0.6501	18	3.6298	<0.005

Data obtained from the calculation as described in the text.

Table 31 Equations, the correlation (r), t and p values obtained from the regression equations of percentages of fatty acids (Y) before and after the incubation at various concentrations (X) of SL-FOFE.

FA	SL-FOFE				
	Equation	r	df	t	p-value
SAFA	Y=42.3341-0.0032X	0.6590	18	3.7169	<0.005
MUFA	Y=19.1363-0.0023X	0.6520	18	3.6486	<0.005
PUFA	Y=30.9058+0.0075X	0.8851	18	8.0684	<0.001
ALA	Y= 0.1711+0.0015X	0.9257	18	10.3767	<0.001
EPA	Y=0.4702+0.0001X	0.1044	18	0.4454	NS
DHA	Y=2.3761-0.0003X	0.1806	18	0.7791	NS
n-3	Y=3.9056+0.0011X	0.6231	18	3.3809	<0.005
LA	Y=5.9489+0.0137X	0.9378	18	11.4505	<0.001
AA	Y=20.0473-0.0075X	0.8964	18	8.5780	<0.001
n-6	Y=26.9962+0.0063X	0.9074	18	9.1564	<0.001
n-3/n-6	Y=0.1503+3.0E-05X	0.3846	18	1.7675	NS

Data obtained from the calculation as described in the text.

Table 32 Equations, the correlation (r), t and p values obtained from the regression equations of percentages of fatty acids (Y) before and after the incubation at various concentrations (X) of 20% Lipofundin.

FA	20% Lipofundin				
	Equation	r	df	t	p-value
SAFA	Y=41.6860+0.0005X	0.1170	18	0.4998	NS
MUFA	Y=19.8824-0.0003X	0.1077	18	0.4597	NS
PUFA	Y=31.2772+0.0002X	0.0728	18	0.3097	NS
ALA	Y=0.1238+0.0003X	0.6072	18	3.2419	<0.005
EPA	Y=0.3793-0.0001X	0.4770	18	2.3021	<0.050
DHA	Y=2.4656-0.0001X	0.1995	18	0.8636	NS
n-3	Y=3.8587-0.0001X	0.0490	18	0.2082	NS
LA	Y=5.9041+0.0018X	0.4549	18	2.1672	<0.050
AA	Y=21.5143-0.0015X	0.4205	18	1.9659	NS
n-6	Y=27.4185+0.003X	0.0854	18	0.3637	NS
n-3/n-6	Y=0.1415-3.4E-06X	0.0648	18	0.2755	NS

Data obtained from the calculation as described in the text.

Among 4 fat emulsions, 20% Lipofundin affected to the alteration of platelet FA the least (**Table 32**). The statistically significant p values were found at rather low values of r not exceed to 0.65 for ALA (r, 0.61), EPA (r, 0.48) and LA (0.45). The results of correlation imply that commercial fat emulsion with egg yolk PL do not provide fatty acids to blood cells. It is thus considered as highest stable emulsion in comparison to other emulsions prepared in our experiment.