

FOOD SCIENCES

Comparison of Fatty Acid Composition of Infant Formulas with Breast Milk

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(Received 13/6/1418; accepted for publication 30/6/1419)

Abstract. The objective of the present study was to compare fatty acid composition of fourteen powdered infant formulas with breast milk. The powdered formulas were purchased from local markets. Breast milk was collected from ten healthy lactating mothers who had been breast-feeding for 3-4 months. Seven formulas were starting formulas, six formulas were follow-up formulas and one formula was special formula (low lactose). Fatty acid composition of breast milk and formulas was determined by gas-liquid chromatography. The level of palmitic acid ranged from 9.75-38.23% in infant formulas as compared to 21.10% in breast milk. The concentration of linoleic acid (C18:2, n-6) in eight formulas and in breast milk was comparable with that stated by the American Academy of Pediatrics, Committee on Nutrition. Three formulas and breast milk comply with the European Society for Pediatric Gastroenterology and Nutrition (ESPGAN) recommendations regarding linoleic/α-linolenic ratio. Breast milk lipid contains long-chain polyunsaturated fatty acids (LCPUFA), whereas LCPUFA was not found in infant formulas. However, more efforts should be made to produce infant formulas balanced in their fatty acids and resembling breast milk in its LCPUFA.

Introduction

Lipids are the major energy source in breast milk, usually representing 45-50% of energy [1, p.157]. Essential fatty acids, especially their long chain polyunsaturated fatty acids (LCPUFA) function to maintain membrane integrity, maintain optimal levels of unsaturation in tissue lipids, play a role in growth, and developments of brain and retina [2 -4].

Fat from cow's milk was the only fat source in the first generation of infant formulas but its fatty acid composition differs considerably from breast milk [5-6]. Today infant formulas on the market obtain their fat content from vegetable oils and thus do not contain polyunsaturated fatty acid (PUFA) with more than 18-C atoms [7]. It was suggested that conversion to 20-C and 22-C PUFA from dietary 18-C precursors may occur with difficulty in the human neonate [8-10].

Soy oil based formulas provide a more balance supply of both linoleic and linolenic acids. However, many infant formulas have contained corn rather than soy oil because of susceptibility of the large amounts of linolenic acid (C18:3 n-3) in soy oil to oxidative degradation [11, p.223]. The optimal ratio of linoleic acid (C18:2 n-6) to C18:3, n-3 for a balanced synthesis of their long derivatives has been indicated as 10:1 [12]. Several studies have shown that there are large differences between the fatty acid composition of different formulas, and many differ considerably from the fatty acid composition of breast milk [7, 13, 14]. Jorgensen *et al.* [15] reported that 4 of 13 Danish infant formulas had a linoleic: ∞ linolenic ratios between 5 and 15 which is approximately the ratio found in breast milk. They also found some deviation in the other fatty acid classes from the composition of breast milk.

The objective of the present study was to analyze the fatty acid composition of commercial formulas available on the Saudi market in 1997 and to compare them with the fatty acid composition of breast milk. The study was extended to focus on the 18:2 (n-6) to 18:3 (n-3) ratio.

Materials and Methods

Infant formulas and breast milk samples collection

Fourteen different infant formulas (three cans from each formula) were collected for fatty acid analysis. All formulas were purchased from local markets. Seven of the formulas were starting for first age formulas, six were follow-up formulas and one was special formula (low lactose formula). The sources of fat in the studied formulas are shown in Table 1. The formulas were dissolved in water according to manufacturers' instructions.

Breast milk samples were freshly obtained from ten healthy lactating mothers at 3 to 4 months of lactation from Saudi mothers. None of the mothers were vegetarians. The mothers were requested to express one (right) breast with a manual pump at 9-10 a.m. The milk samples were transported to the laboratory in ice and frozen immediately on arrival and stored at -20°C until analyzed.

Table 1. Fat sources of the various formulas used in the present study

Formula	Manufacturer	Fat source	% Total fat (Mean±SD)
Starting formulas			
Nan	Nestle (Netherland)	whole milk, milk fat, corn oil	25.93±0.098
Similac	Ross, Abott Laboratories (USA)	non fat milk, vegetable oil	28.00±0.141
S-26	Wyeth (Ireland)	mixed palm, soya, and coconut oils, olein, non-fat milk	28.25±0.494
Guigoz-1	Nestle (Switzerland)	skimmed milk, milk fat, palm olein, coconut oil, sunflower oil, soya lecithin	23.35±0.494
Bebelac-1	Lyempf (Holland)	vegetable fat, skimmed milk solid	25.98±0.21
Babina plus	Santis (Switzerland)	vegetable oil, skimmed milk powder	27.05±0.21
Mamex	APS (Copenhagen)	whey, palm, coconut and soya oil, skimmed cow milk	27.93±0.233
Follow-up formulas			
Bebelac-2	Lyempf (Holland)	skimmed milk, vegetable fat	22.10±0.141
Guigoz-2	Nestle (Switzerland)	skimmed milk, milk fat, corn oil	18.30±0.417
Babina priina	Santis (Switzerland)	skimmed milk powder, vegetable oil	25.25±0.212
Nutrilon (follow-up)	N.V. Nutricia (Holland)	partially skimmed milk, vegetable oil	20.42±0.311
Promil	Wyeth (Ireland)	skimmed milk, oleic acid, soya, palm and coconut oils	19.36±0.339
Mamil	APS (Copenhagen)	whole cow milk	18.64±0.339
Special formula:			
Nutrilon (low lactose)	N.V. Nutricia (Holland)	vegetable fats, partially skimmed milk	29.25±0.353

Lipid analysis

Lipid extraction and determination: The lipids were extracted according to the method of Folch *et al.* [16]. The formulas and breast milk samples were shaken in chloroform:methanol (2:1) for an hour. Triplicate extractions were carried out for each sample. The lower chloroform layer was transferred into separating funnel and was shaken with water. The lower chloroform layer was dried over anhydrous sodium sulfate, filtered, and evaporated to constant weight under gentle stream of nitrogen to determine total lipid content.

Preparation of fatty acid methyl esters (FAME)

FAME were prepared as described by Harzer *et al.* [17]. Aliquots of lipid extracts were saponified with methanolic KOH (0.5 N) solution by refluxing for 15 min at 90°C. After addition of 3 ml borontrifluoride-methanol reagent (20% BF₃ in methanol), the samples were incubated for another 5 min at 90°C. The fatty acid methyl esters were extracted three times with hexane and dried through anhydrous sodium sulfate.

Gas-liquid chromatography

Fatty acid methyl esters were analyzed by gas liquid chromatography using gas chromatograph GC 17A, equipped with CR6A integrator (Shimadzu Co., Japan) and a fused silica capillary column, (Supelcowax 10, 30m×0.32) id, 0.50 µm film thickness (Supelco, Bellefonte, PA). The oven temperature was programmed from 110 to 185°C at 2°C/min, and hold it for 5 min., then increased to 220°C at rate of 4°C/min. with a final hold time 20 min. at 220°C. Injector port and flame ionization detector temperatures were 250 and 260°C, respectively.

Helium was used as a carrier gas at inlet pressure 1.5 kg/cm². Identification and quantification of individual fatty acid methyl esters were achieved by comparison with reference standards. Pentadecanoate was used as an internal standard.

Statistical analysis

All data were subjected to statistical analysis by using the Statistical Analysis System (SAS) [18]. Data are presented as mean ±SD. Means were tested by one way analysis of variance (ANOVA). Value of probability at 5% was used to indicate significance.

Results

Table 1 indicates the sources of fat in various infant formulas as indicated on the package. Corn oil is the sole source of vegetable oil in 3 formulas, while mixtures of soybean, palm, and coconut oils along with oleic acid are employed in 3 formulas. Vegetable oil from an unspecified source is used in 7 formulas. One formula (Guigoz-2) contains sunflower and coconut oils, olein and milk fat.

The fat content of the formulas ranged from 18.3 to 29.3 g per 100 g formula (Table 1). However, breast milk contained 20.1 g per 100 g dry milk. The fatty acid compositions of the formulas and breast milk are shown in Tables 2-4. No short chain fatty acids (< C8:0) were detected in all the formulas. All the formulas and breast milk contain medium chain (C8:0 through C14:0) fatty acids. Palmitic acid (C16:0) was the major saturated fatty acid in all the formulas and breast milk except Similac where lauric acid (C12:0) was the major saturated fatty acid. Total saturated fatty acids ranged from 42% to 61% of total fatty acids. Of the 14 infant formulas, 7 formulas contain more than 25% of total fatty acids as C16:0 (Table 2).

Oleic acid (C18:1) was the most abundant monounsaturated fatty acid in all cases (Table 3). Total monounsaturated fatty acid content varied between 16.38% to 46.44% of total fatty acids. It is the lowest in Similac but the highest is the special formula, Nutrilon (low lactose). C18:1 content of breast milk was 32.17%, and two formulas: Bebelac-1 and Bebelac-2 of the 14 tested have C18:1 level similar to that found in breast milk.

Table 2. Saturated fatty acid composition of breast milk and infant formulas*

No.	Formula	Fatty acid (%total fatty acids)					
		C8:0	C10:0	C12:0	C14:0	C15:0	C16:0
1	BM	0.60±0.07 ^{gh}	3.39±0.46 ^{ab}	6.80±2.06 ^{dc}	6.53±1.67 ^{cd}	0.34±0.18 ^a	21.10±2.17 ^{fg}
2	Nun	3.12±0.25 ^{bcdef}	3.05±0.29 ^{abc}	3.12±0.39 ^h	8.22±0.76 ^{ab}	0.31±0.06 ^a	24.67±2.03 ^{cde}
3	Similac	9.27±2.49 ^a	3.98±1.23 ^a	22.40±1.1 ^a	8.22±0.33 ^{ab}	--	9.75±0.69 ^h
4	S-26	1.56±0.31 ^{fgh}	1.36±0.53 ^{ef}	8.74±1.69 ^{cd}	3.82±0.36 ^{efg}	--	21.34±0.67 ^{efg}
5	Guigoz-1	5.35±1.51 ^b	3.49±0.83 ^{ub}	5.88±0.30 ^{ef}	8.01±0.41 ^{ab}	0.34±0.07 ^a	29.13±0.43 ^b
6	Bebelac-1	5.01±1.27 ^{bcd}	1.91±0.43 ^{cdc}	13.42±0.41 ^b	5.66±0.23 ^d	0.31±0.13 ^a	25.08±0.34 ^{cd}
7	Babina plus	0.17±0.01 ^h	0.35±0.06 ^f	3.56±0.36 ^{gh}	2.32±0.11 ^h	--	38.23±0.12 ^a
8	Mamex	2.97±2.49 ^{bcdefg}	0.94±0.48 ^{ef}	5.23±2.10 ^{efg}	2.67±2.10 ^{fg} ^h	0.45±0.06 ^a	28.86±1.57 ^b
9	Bebelac-2	4.42±1.29 ^{hcde}	1.50±0.41 ^{def}	13.01±0.61 ^h	5.47±0.42 ^d	--	26.09±0.42 ^{bc}
10	Guigoz-2	5.06±0.28 ^{bc}	3.40±0.85 ^{ab}	2.45±0.63 ^h	8.40±0.87 ^{ah}	0.53±0.29 ^a	24.10±0.96 ^{cdef}
11	Babina prima	0.36±0.06 ^h	0.50±0.40 ^f	4.52±0.36 ^{fg} ^h	2.57±0.24 ^{gh}	--	36.61±0.53 ^a
12	Nutrilon	2.60±1.62 ^{cdefgh}	2.72±0.92 ^{bcd}	2.77±0.30 ^h	7.19±0.34 ^{bc}	0.21±0.15 ^a	21.96±0.59 ^{defg}
13	Promil	2.01±0.09 ^{efgh}	1.11±0.42 ^{ef}	9.83±0.18 ^c	4.12±0.03 ^c	--	22.32±0.49 ^{defg}
14	Mamil	2.45±0.46 ^{defgh}	3.09±0.37 ^{abc}	2.96±0.08 ^h	8.76±0.34 ^a	--	26.64±2.74 ^{bc}
15	Nutrilon (low lactose)	3.54±0.88 ^{bdcef}	1.56±0.43 ^{def}	8.57±0.92 ^{cd}	3.87±0.22 ^{ef}	--	18.87±0.04 ^g

* Values are means ± SD. Values in the same column with common superscript(s) are not significantly different ($p < 0.05$). BM = Breast milk.

Formulas from 2 to 8 are starting for first age formulas.

Formulas from 9 to 14 are follow-up formulas.

Formula no. 15 is special formula.

The lowest level of C18:1 was found in Similac (16.13±1.45%) while the highest level was found in Nutrilon (low lactose) (45.56±0.72%). Linoleic acid (C18:2) being the major polyunsaturated fatty acid ranged from 9.29% in Babina Plus to 26.18% in Similac as compared to 10.73% in breast milk. The level of C18:2 in Babina Plus, Mamex, Nutrilon (low lactose), Bebelac-2, Guigoz-1 and 2, Babina Prima and Mamil was comparable with that found in breast milk. The remaining six formulas contained significantly higher C18:2 levels than in breast milk.

Table 2 (contd.)

No.	Formula	Fatty acid (%total fatty acids)					Total
		C17:0	C18:0	C20:0	C22:0	C24:0	
1	BM	0.34±0.13 ^a	4.90±0.25 ^d	2.01±0.82 ^{abcd}	0.27±0.04	0.30±0.25	46.58±8.10
2	Nan	0.34±0.07 ^a	8.16±1.32 ^{bc}	2.35±0.56 ^{abc}	--	--	53.34±5.73
3	Similac	--	2.26±0.06 ^g	0.30±0.22 ^e	--	--	56.18±6.12
4	S-26	--	4.15±0.41 ^{de}	2.06±0.85 ^{abcd}	--	--	43.03±4.64
5	Guigoz-1	0.40±0.13 ^a	7.68±0.07 ^c	1.02±0.35 ^{bcde}	--	--	61.3±4.10
6	Bebelac-1	0.36±0.13 ^a	3.12±0.06 ^{fg}	0.93±0.32 ^{bcde}	--	--	55.8±3.32
7	Babina plus	--	3.98±0.32 ^{ef}	0.93±0.01 ^{bcde}	--	--	49.54±0.99
8	Mamex	0.45±0.01 ^a	3.08±0.29 ^{fg}	0.43±0.05 ^e	--	--	45.09±9.15
9	Bebelac-2	--	3.45±0.42 ^{ef}	0.67±0.30 ^{dc}	--	--	54.61±3.87
10	Guigoz-2	0.42±0.14 ^a	8.74±0.51 ^b	3.39±1.77 ^a	--	--	56.49±6.30
11	Babina prima	--	4.01±0.05 ^{def}	0.78±0.07 ^{dc}	--	--	49.35±1.71
12	Nutrilon	0.34±0.02 ^a	7.74±0.61 ^c	2.56±0.96 ^a	--	--	48.09±4.59
13	Promil	--	3.75±0.14 ^{ef}	0.91±0.03 ^{cde}	--	--	44.05±1.38
14	Mamil	--	9.82±0.08 ^a	2.32±0.92 ^{abc}	--	--	56.04±4.99
15	Nutrilon (low lactose)	--	3.20±0.07 ^{fg}	2.41±0.60 ^{ab}	--	--	42.02±3.16

Values are means ± SD. Values in the same column with common superscript(s) are not significantly different (p<0.05).

BM = Breast milk.

Formulas from 2 to 8 are starting for first age formulas.

Formulas from 9 to 14 are follow-up formulas.

Formula no. 15 is special formula.

The concentration of C20:2 found only in four formulas (S-26, Babina Plus, Mamex, and Babina Prima) was significantly lower than that in breast milk (Table 4). The amount of PUFA supplied by infant formulas ranged from 10.18% in Guigoz-1 to 26.98% in Similac as compared with 15.31% in breast milk. The ratio of 18:2 to 18:3 varied considerably among the infant formulas. The ratio for most formulas was very high except for Mamil where it was 7.49. The ratio found in breast milk was 9.94.

Table 3. Monounsaturated fatty acid composition of breast milk and infant formulas*

No. Formula	Fatty acid (% total fatty acids)						Total
	C14:1	C16:1	C17:1	C18:1	C20:1	C22:1	
1 BM	0.16±0.08 ^b	4.25±1.24 ^a	0.41±0.10 ^a	32.17±4.55 ^c	0.93±0.58 ^a	0.06±0.06	38.08±7.33
2 Nan	0.79±0.37 ^{ah}	1.70±0.48 ^{bc}	0.23±0.04 ^a	26.09±3.50 ^d	--	--	28.81±4.39
3 Similac	--	--	--	16.13±1.45 ^c	0.25±0.06 ^a	--	16.38±1.51
4 S-26	--	--	--	38.34±0.71 ^b	0.83±0.13 ^a	--	39.17±0.84
5 Guigoz-1	0.67±0.38 ^{ab}	0.60±0.45 ^c	0.27±0.02 ^a	26.98±0.36 ^d	--	--	28.52±1.21
6 Behelac-1	--	--	0.32±0.09 ^a	29.66±0.18 ^{cd}	0.81±0.08 ^a	--	30.82±0.36
7 Babina plus	--	--	--	39.72±0.15 ^b	0.45±0.12 ^a	--	40.17±0.27
8 Mamex	--	--	0.36±0.07 ^a	41.16±3.08 ^b	0.18±0.97 ^a	--	41.7±4.12
9 Behelac-2	--	--	--	31.68±0.52 ^c	1.21±0.43 ^a	--	32.89±1.95
10 Guigoz-2	0.72±0.34 ^{ab}	1.88±0.20 ^{bc}	0.33±0.06 ^a	26.98±0.56 ^d	0.61±0.25 ^a	--	30.52±1.41
11 Babina prima	--	--	--	39.18±0.36 ^b	0.25±0.04 ^a	--	39.43±0.40
12 Nutrilon	0.72±0.22 ^{ah}	1.65±0.11 ^{bc}	0.29±0.04 ^a	26.67±0.72 ^d	1.17±0.44 ^a	--	30.50±1.53
13 Pronal	--	--	--	39.18±0.29 ^b	--	--	39.18±0.29
14 Mamil	0.84±0.05 ^a	2.38±0.02 ^b	--	28.15±0.46 ^{cd}	--	--	31.37±0.53
15 Nutrilon (low lactose)	--	--	--	45.56±0.72 ^a	0.88±0.26 ^a	--	46.44±0.98

* Values are means ± SD. Values in the same column with common superscript(s) are not significantly different ($p < 0.05$).

BM = Breast milk.

Formulas from 2 to 8 are starting for first age formulas.

Formulas from 9 to 14 are follow-up formulas. Formula no. 15 is special formula.

Discussion

Palmitic acid (C16:0) is the most important saturated fatty acid and accounts for 20-25% of the total fatty acids of breast milk [19]. The level of C16:0 found in breast milk is within the range reported by Innis [19]. In contrast, our results indicate that C16:0 levels vary considerably among the various infant formulas. The level of C16:0 in five formulas (S-26, Guigoz-2, Nutrilon, Promil, Nutrilon "low lactose") was comparable to that found in breast milk. On the other hand, the level of C16:0 in one formula (Similac) was significantly lower ($P>0.05$) than that found in breast milk.

Table 4. Polyunsaturated fatty acid composition of breast milk and infant formulas*

No.	Formula	Fatty acid (%total fatty acids)				
		C18:2	C18:3	C20:2	C20:3	C20:4
1	BM	10.73±1.40 ^{efg}	1.08±0.76 ^{abc}	1.11±0.13 ^a	0.80±0.12	0.80±0.43
2	Nan	16.26±0.07 ^c	1.45±0.40 ^{ab}	--	--	--
3	Similac	26.18±2.13 ⁿ	0.80±0.05 ^{abc}	--	--	--
4	S-26	16.05±0.90 ^c	1.10±0.85 ^{abc}	0.64±0.03 ^b	--	--
5	Guigoz-1	9.90±0.59 ^g	0.28±0.18 ^c	--	--	--
6	Bebelac-1	13.01±0.03 ^d	0.41±0.23 ^c	--	--	--
7	Babina plus	9.29±0.51 ^g	0.53±0.02 ^{abc}	0.46±0.06 ^b	--	--
8	Mamex	12.14±0.65 ^{def}	0.46±0.13 ^c	0.53±0.11 ^b	--	--
9	Bebelac-2	12.06±1.38 ^{def}	0.42±0.36 ^c	--	--	--
10	Guigoz-2	12.73±1.27 ^{de}	0.26±0.19 ^c	--	--	--
11	Babina prima	10.53±0.41 ^{fg}	0.45±0.01 ^c	0.24±0.02 ^c	--	--
12	Nutrilon	20.81±0.87 ^b	0.56±0.32 ^{abc}	--	--	--
13	Promil	15.99±0.34 ^c	0.37±0.07 ^c	--	--	--
14	Mumil	11.09±0.30 ^{defg}	1.48±1.36 ^a	--	--	--
15	Nutrilon (low lactose)	10.69±0.54 ^{fg}	0.84±0.31 ^{abc}	--	--	--

Table 4. (contd.)

No.	Formula	Fatty acid (% total fatty acids)				C18:2/ C18:3
		C20:5	C22:5	C22:6	Total	
1	BM	0.23±0.17	0.25±0.11	0.31±0.01	15.31±3.13	9.94
2	Nan	--	--	--	17.71±0.54	11.21
3	Similac	--	--	--	26.98±3.08	32.73
4	S-26	--	--	--	17.79±1.78	14.59
5	Guigoz-1	--	--	--	10.18±0.77	35.36
6	Bebelac-1	--	--	--	13.42±0.26	31.73
7	Babina plus	--	--	--	10.28±0.59	17.53
8	Mamex	--	--	--	13.13±0.89	26.39
9	Hebelac-2	--	--	--	12.48±1.74	28.71
10	Guigoz-2	--	--	--	12.99±1.46	48.96
11	Babina prima	--	--	--	11.22±0.43	23.40
12	Nutrilon	--	--	--	21.37±1.19	37.16
13	Promil	--	--	--	16.36±0.41	43.23
14	Mamil	--	--	--	12.57±1.66	7.49
15	Nutrilon (low lactose)	--	--	--	11.53±0.85	12.73

* Values are means ± SD. Values in the same column with common superscript(s) are not significantly different ($p < 0.05$). BM = Breast milk.

Formulas from 2 to 8 are starting for first age formulas.

Formulas from 10 to 15 are follow-up formulas.

Formula no. 15 is special formula.

The concentration of C18:2 in infant formulas was either similar to or higher than that found in breast milk. The level of C18:2 found in breast milk (10.73%) is lower than the value found in American women breast milk (14 to 16%) [20]. On the other hand, Gibson and Kneebone [21] reported a level of C18:2 (11%) which is comparable with that found in the present study. Sanders *et al.* [22] reported 32% of C18:3 in the breast milk of English vegan women as compared to 7% in omnivore controls. The level of C18:2 in breast milk and eight of the studied formulas is comparable with that stated by American Academy of Pediatrics, Committee on Nutrition [23] who reported that C18:2 comprises 8-10% of the fat in breast milk.

Neuringer and Conner [12] reported that the optimal ratio of C18:2, n-6 to C18:3, n-3 for a balanced synthesis of their long chain metabolites is 10:1, taking the composition of breast milk as the gold standard. The ratio found for breast milk in the present study complies well with that reported by Neuringer and Connor [12]. Whereas, the majority of (13 of 14) of the formulas studied had C18:2, n-6/C18:3, n-3 ratio higher

than the optimal ratio according to Neuringer and Connor [12]. European Society for Pediatric Gastroenterology and Nutrition (ESPGAN) recommended that the ratio should be between 5 and 15 [15]. According to ESPGAN recommendations, there are five of the fourteen formulas which comply with the recommendations. The low level of C18:3, n-3 in most of the formulas creates a major imbalance in relation to the high content of C18:2, n-6. Our findings are consistent with Jorgensen *et al.* [15] who reported high C18:2, n-6/C18:3, n-3 ratios in 10 commercial infant formulas.

The present findings indicated that all formulas contained no LCPUFA of C20:3, C20:4, C20:5, C22:5 and C22:6, whereas few formulas had small amount of 20:2. On the other hand, the present study found that long chain metabolites of C18:2, n-6 constituted 3.37% of the total fatty acids while long chain metabolites of 18:3, n-3 constitute 1.4% of the total fatty acids of breast milk. Uauy *et al.* [24] suggested that C22:6, n-3 is essential for the development of newborn infants and that preterm neonates who have deficient stores of C22:6, n-3, show deficits in visual function unless fed breast milk or formula supplemented with marine oil containing eicosapentaenoic acid C20:5, n-3 and C22:6, n-3. Moreover, Uauy *et al.* [24] indicated that the desaturation steps necessary for the synthesis of C22:6, n-3 from C18:3, n-3 are inefficient in neonates, suggesting that C22:6, n-3 is a required nutrient.

The results of the present study along with others revealed that the available infant formulas have no LCPUFA. More efforts should be made to produce infant formulas containing LCPUFA resemble to breast milk. In this regard fish harvested from warm waters which yield oils containing both n-3 and n-6 LCPUFA [25] may prove useful. Triglycerides from egg yolk have also been suggested as a feasible source of LCPUFA [26]. In general, most of the infant formulas contained low proportions of oleic acid and higher levels of linoleic and saturated fatty acids.

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مقارنة تركيب الأحماض الدهنية في مسحوق حليب الأطفال المصنع من حليب الأمهات

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(قدم هذا البحث للنشر في ١٣/٦/١٤١٨ هـ؛ وقبل للنشر في ٣٠/٦/١٤١٩ هـ)

ملخص البحث. الغرض من هذه الدراسة هو مقارنة تركيبة الأحماض الدهنية لأربع عشرة عينة من مسحوق حليب الأطفال المصنع مع حليب الأمهات. مسحوق الحليب تم شراؤه من السوق المحلي. أما حليب الأمهات فقد تم تجميعه من عشر أمهات مرضعات يتمتعن بصحة جيدة، ويرضعن من ٣-٤ أشهر. سبع من حليب الأطفال في سن الرضاعة، وست منها لما بعد سن الرضاعة، وواحدة حليب خاص (قليل اللاكتوز). تم قياس الأحماض الدهنية في حليب الأمهات وعينات الحليب المصنع باستخدام جهاز الكروماتوجراف الغازي السائل. وجد أن مستوى حامض البالميتيك يتراوح ما بين ٩,٧٥-٣٨,٢٣٪ في حليب الأطفال المصنع مقارنة بـ ٢١,١٠٪ في حليب الأمهات. وكان تركيز حامض اللينوليك (٢: 6١٨-n) في ثماني عينات من الحليب المصنع، وفي حليب الأمهات مطابقة لما ذكر في الأكاديمية الأمريكية للأطفال (مجموعة التغذية). كان ثلاث من عينات مسحوق الحليب المصنع مع حليب الأمهات مطابقة لتوصيات الاتحاد الأوربي لأمراض المعدة والتغذية للأطفال (ESPGAN) بنسبة حامض اللينوليك/حامض اللينولينييك. يحتوي دهن حليب الأمهات على الأحماض الدهنية طويلة السلسلة متعددة اللإشباع (LCPUFA)، بينما لا توجد هذه الأحماض في مسحوق حليب الأطفال، لذا فإنه من الضروري إنتاج حليب أطفال متوازن مع حليب الأمهات وخاصة في الأحماض طويلة السلسلة متعددة اللإشباع (LCPUFA).