Infant Formulas: An Update

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During the past decades, there have been accumulated data on appropriate nutrients in terms of quality and types in infant formulas for young infants. Most data are availed from the studies of the effects of each composition in human milk of healthy, well-nourished women. Thus, the compositions of infant formulas are gradually modified in accordance well according the findings from the studies of the benefits of each nutrient. Recently, the International Expert Group (IEG) held a meeting and reviewed all nutrients levels in infant formula by taking into account the available scientific evidence, including the recent reviews performed by the Life Science Research Office (LSRO) of the American Societies of Nutritional Sciences and the Scientific Committee on Food of the European Commission (SCF).[1,2,3]

Since it was developed, the contents of the infant formulas have been gradually changed according to the new scientific findings. The energy contents of all infant formulas are in the ranges of 67 to 68 kcal, the same levels as in breast milk. Fat contents in the formula are in between 3.5 to 3.8 g/dl. The fat in the formula is mostly from different kinds of vegetable oil, based on fatty acids analysis of each oil. Most of the formula try to mimick the fatty acids content as found in human milk. Now, protein contents of the formulas have been reduced closely to that in breast milk which are in the ranges of 1.2 to 1.5 g/dl. Also, the whey: casein ratio in the formula is adjusted to 60:40 as found in breast milk. However, the allergenicity of the cow milk protein in the formula is still high.

Lactose content in all infant formula was increased to 7 g/dl up to the level found in human milk. More lactose content in the formula will result in more acidity of the stool of the infants.

Both linoleic acid and linolenic acids are essential fatty acids. All formulas contain linoleic acid and linolenic acids in the amounts of 400-700 mg/dl and 40 to 70 mg/dl, respectively.

There are 12 minerals should be included in the infant formula which are calcium, phosphorus, magnesium, sodium, potassium, chloride, iron, zinc, copper, iodine, manganese and selenium. The minimum and maximum levels of these minerals are now advocated as in Table 1. Likewise, the calcium:phosphorus ratio should be between 1:1 to 2:1. It is the first time that iron content is mentioned and should be in the ranges of 0.3 to 1.3 mg/100 kcal. But the iron content in the soy-based formula should be increased in the ranges of 0.45 - 2.0 mg/100 kcal.

Furthermore, choline, myo-inositol and L-carnitine are recommended to be added in the infant formula at least 7, 4 and 1-2 mg/100 kcal, respectively.

Table 1 shows the proposed compositional requirement of infant formula which results from a lengthy discussion of the IEG. The infant formula prepared ready for consumption shall contain per 100 ml no less than 60 kcal and no more than 70 kcal of energy, and it shall contain per 100 kcal the nutrients, with minimum and maximum levels where applicable, as listed in Table 1.

Table 2 shows the proposed levels of optional ingredients. These nutrients can be added but should not exceed the maximum values. If DHA (22:6n-3) is added to infant formula, AA (20:4n-6) contents should reach at least the same concentration as DHA. The content of EPA (20:5n-3) should not exceed the content of DHA.

Table 3 shows the nutritional compositions of infant formulas currently available in the Thai market. Some formulas contain DHA and AA.

Optional ingredients

Nucleotides

Although there are reports on beneficial effects of the addition of nucleotides to infant formula,[2,3] the IEG did not find sufficient data to support the additional benefits from increasing intakes to levels greater than 5 mg/100 kcal.

Long-chain polyunsaturated fatty acids (LC-PUFA)

It is noteworthy that at this moment there is no sufficient documentation of the benefits and safety of the addition of DHA to infant formula at levels >0.5% of total fat content, or of DHA without concomitant addition of AA.

In conclusion, infant formula should only contain components in such amounts that serve a nutritional purpose or provide another benefit. The inclusion of unnecessary components, or unnecessary amounts of components, may put a burden on metabolic and other physiologic functions of the infant. So it is not wise to buy an infant

TABLE 1. Proposed compositional requirements of infant formula.[1]

Component		Unit	Minimum	Maximum
Energy		kcal/100 ml	60	70
Proteins				
	Cows' milk protein	g/100 kcal	1.8*	3
	Soy protein isolates	g/100 kcal	2.25	3
	Hydrolyzed cows' milk protein	g/100 kcal	1.8†	3
Lipids				
	Total fat	g/100 kcal	4.4	6.0
	Linoleic acid	g/100 kcal	0.3	1.2
	α-linolenic acid	mg/100 kcal	50	NS
	Ratio linoleic/α-linolenic acids		5:1	15:1
	Lauric + myristic acids	% of fat	NS	20
	Trans fatty acids	% of fat	NS	3
	Erucic acid	% of fat	NS	1
Carbohydrates				
	Total carbohydrates‡	g/100 kcal	9.0	14.0
Vitamins				
	Vitamin A	μg RE/100 kcal§	60	180
	Vitamin D_3	μg/100 kcal	1	2.5
	Vitamin E	mg α-TE/100 kcal‖	0.5¶	5
	Vitamin K	μg/100 kcal	4	2.5
	Thiamin	μg/100 kcal	60	300
	Riboflavin	μg/100 kcal	80	400
	Niacin#	μg/100 kcal	300	1500
	Vitamin B_6	μg/100 kcal	35	175
	Vitamin B_{12}	μg/100 kcal	0.1	0.5
	Pantothenic acid	μg/100 kcal	400	2000
	Folic acid	μg/100 kcal	10	50
	Vitamin C	mg/100 kcal	8	30
	Biotin	μg/100 kcal	1.5	7.5
Minerals and trace elements				
	Iron (formula based on cows' milk protein and protein hydrolysate)	mg/100 kcal	0.3**	1.3
	Iron (formula based on soy protein isolate)	mg/100 kcal	0.45	2.0
	Calcium	mg/100 kcal	50	140
	Phosphorus (formula based on cows' milk protein and protein hydrolysate)	mg/100 kcal	25	90
	Phosphorus (formula based on soy protein isolate)	mg/100 kcal	30	100
	Ratio calcium/phosphorus	mg/mg	1:1	2:1
	Magnesium	mg/100 kcal	5	15
	Sodium	mg/100 kcal	20	60
	Chloride	mg/100 kcal	50	160
	Potassium	mg/100 kcal	60	160
	Manganese	μg/100 kcal	1	50
	Fluoride	μg/100 kcal	NS	60
	Iodine	μg/100 kcal	10	50
	Selenium	μg/100 kcal	1	9
	Copper	μg/100 kcal	35	80
	Zinc	mg/100 kcal	0.5	1.5
Other substances				
	Choline	mg/100 kcal	7	50
	Myo-inositol	mg/100 kcal	4	40
	L-carnitine	mg/100 kcal	1.2	NS

*The determination of the protein content of formulae based on non-hydrolyzed cows' milk protein with a protein content between 1.8 and 2.0 g/100 kcal should be based on measurement of true protein ([total N minus NPN] x 6.25).

†Formula based on hydrolyzed milk protein with a protein content less than 2.25 g/100 kcal should be clinically tested.

‡Sucrose (saccharose) and fructose should not be added to infant formula.

§1 μg RE (retinol equivalent) = 1 μg all-trans retinol = 3.33 IU vitamin A. Retinol contents shall be provided by preformed retinol, while any contents of carotenoids should not be included in the calculation and declaration of vitamin A activity.

‖1 mg α -TE (α–tocopherol equivalent) = 1 mg d-α–tocopherol.

¶Vitamin E content shall be at least 0.5 mg α -TE per g PUFA, using the following factors of equivalence to adapt the minimal vitamin E content to the number of fatty acid double bonds in the formula: 0.5 mg α -TE/g linoleic acid (18:2n-6); 0.75 mg α -TE/g linoleic acid (18:3n-3);); 1.0 mg α -TE/g arachidonic acid (20:4n-6); 1.25 mg α -TE/g eicosapentaenoic acid (20:5n-3); 1.5 mg α -TE/g docosahexaenoic acid (22:6n-3).

#Niacin refers to preformed niacin.

**In populations where infants are at risk of iron deficiency, iron contents higher than the minimum level of 0.3 mg/100 kcal may be appropriate and recommended at a national level.

NS. Not specified.

TABLE 2. Proposed levels of optional ingredients, if added.[1]

Optional ingredients	Unit	Minimum	Maximum
Taurine	mg/100 kcal	0	12
Total added nucleotides	mg/100 kcal	0	5
Cytidine 5′-monophosphate (CMP)	mg/100 kcal	0	1.75
Uridine 5′-monophosphate (UMP)	mg/100 kcal	0	1.5
Adenosine 5′-monophosphate (AMP)	mg/100 kcal	0	1.5
Guanosine 5′-monophosphate (GMP)	mg/100 kcal	0	0.5
Inosine 5′-monophosphate (IMP)	mg/100 kcal	0	1.00
Phospholipids	mg/100 kcal	0	300
Docosahexaenoic acid*	% of fat	0	0.5

*If docosahexaenoic acid (22:6n-3) is added to infant formula, arachidonic acid (20:4n-6) contents should reach at least the same concentration as DHA. The content of eicosapentaenoic acid (20:5n-3) should not exceed the content of docosahexaenoic acid.

formula which is much more expensive than others which have nutritional compositions as currently recommended by the IEG.

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TABLE 3. Nutritional compositions of infant formulas currently available in Thai market

Nutrients /100ml		Dumex HiQ	EnfalacA+	Enfalac	Lactogen 1	Nan 1	Similac	S_{26} Gold	S_{26}	Snow Nuo
Energy	kcal	67	67	67	67	67	68	67	67	67
Fat	g	3.6	3.8	3.8	3.5	3.6	3.7	3.6	3.6	3.6
Linoleic â	mg	418	600	600	533	516	676	580	580	460
Linolenic â	mg	42	54	54	61	64	72	NA	NA	49
AA	mg	13	23	-	4	8	38.3	10.9	-	NA
DHA	mg	7.2	11.4	-	4	8	25.8	7.1	-	NA
Protein	g	1.5	1.5	1.5	1.5	1.2	1.4	1.5	1.5	1.6
Whey	g	0.9	0.9	0.9	0.75	0.84	0.84	0.9	0.9	0.82
Casein	g	0.6	0.6	0.6	0.75	0.36	0.56	0.6	0.6	0.55
Lactose	g	7.2	6.7	6.7	7.4	7.5	7.1	7.2	7.2	7.1
Taurine	mg	5.0	4	4	5.3	5.4	4.5	4.7	4.7	4.6
Carnitine	mg	1.1	NA	NA	1.1	1.1	NA	NA	NA	8.5
Sialic â	mg	-	25	25	-		-			25.4
Nucleotide	mg	2.6	2.2	2.2	-	3.1	7.2	3	3	0.7
Vitamin A	IU	201	197	197	234	232	203	250	250	203
D_3	IU	41	45	45	40	40	40	43	43	48
E	µg	1.9	1.2	6.4	0.8	0.8	2.1	1.1	1.1	0.6
K_1	µg	6.5	6.4	4.5	5.3	5.4	5.4	6.7	6.7	5.5
B_1	µg	68	50	50	47	46	68	100	100	35.9
B_2	µg	103	100	100	100	101	101	150	150	78
Niacin	µg	774	810	810	663	671	710	500	500	650
B_6	µg	58	45	45	51	50	40	60	60	52
Folic â	µg	10	10.8	10.8	6	6	10	8	8	6.5
Pantothenic â	µg	323	380	380	299	297	304	300	300	260
Biotin	µg	1.9	1.9	1.9	1.4	1.5	3.0	2	2	1.1
B_{12}	µg	0.3	0.27	0.27	0.2	0.2	0.11	0.2	0.2	0.13
C	mg	7.7	15.4	15.4	6.6	6.7	6.0	9	9	6.2
Inositol	mg	5.8	NA	NA	3.4	3.4	3.2	3.3	3.3	NA
Choline	mg	10	10.8	10.8	6.6	6.7	10.8	9.3	9.3	7.3
Calcium	mg	49	50	50	42	41	53	46	46	45.5
Phosphorus	mg	25	33	33	23	21	28	33	33	30
Magnesium	mg	6.1	6	6	5	4.6	4.1	6.4	6.4	4.3
Sodium	mg	17	18.8	18.8	16	15	16	16	16	17.6
Potassium	mg	58	79	79	59	59	71	70	70	59.8
Chloride	mg	40	50	50	37	43	44	36.5	36.5	41
Iron	mg	0.8	1.2	1.2	0.9	0.8	1.2	0.8	0.8	0.9
Zinc	mg	0.5	0.7	0.7	0.5	0.5	0.5	0.6	0.6	0.4
Copper	µg	44	47	47	40	10	61	56	56	40.6
Iodine	µg	9.0	10.1	10.1	10	10	4.1	10	10	3.6
Manganese	µg	13	9.7	9.7	4.2	5.0	6.0	5	5	3.9
Selenium	µg	0.6	2.2	2.2	0.8	1.3	1.5	1.4	1.4	NA
Oligosaccharides	g	0.1	0.36	0.36	-	-	-	-	-	0.07