



Advanced Lipids

- Joint Venture of AAK and Enzymotec -

InFat™ the speciality fat for infant formula with high sn-2 palmitic acid.

Nutritional benefits;

- closer to mother's milk
- better energy uptake
- less constipation
- improved calcium absorption

Customised composition

InFat™
– Closer to mother's milk

InFat™ is an advanced basic-fat ingredient, developed to meet the specific needs of the growing infant. It has a fat composition mimicking that of human milk fat, thereby enabling optimised uptake of calcium and energy and easy digestion. These benefits are the results of the fatty acid composition on the glycerol backbone, which ensures high level of palmitic acid at the middle (sn-2) position. The significance of this fatty acid and its position is evident from the fact that this is conserved in all women, regardless of race or nutrition, unlike the general fatty acid profile of human milk.

InFat™ – Mimicing

Human milk-fat composition

In human breast milk, and in most infant formulas, about 50% of the dietary calories are supplied to newborns as fat. More than 98% of this fat is in the form of triglycerides, which contain saturated and unsaturated fatty acids esterified to glycerol (1). Fatty acids in human milk-fat have a highly specific positional distribution on the glycerol backbone (2). This specific configuration is known to have a major impact on the efficacy of this nutrient absorption. Palmitic acid (C16:0) is the predominant saturated fatty acid, constituting 17-25% of the fatty acids in mature human milk. Of the palmitic acid, 70-75% is esterified to the sn-2 position of the triglyceride (2). In contrast, palmitic acid present in standard vegetable oils is esterified to the sn-1 and sn-3 positions while the sn-2 position is predominantly occupied by unsaturated fatty acids (3).

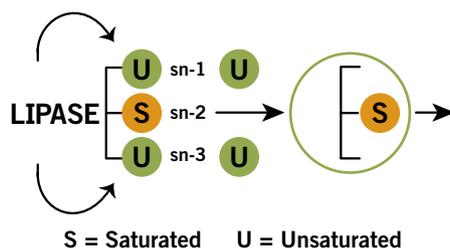
Human milk-fat absorption

When an infant is breast fed, the hydrolysis of dietary triacylglycerols by endogenous lipases produces sn-2 monoacylglycerols and free fatty



acids (4). The importance of the positional distribution of the fatty acids in human milk or infant formula fat applies particularly to palmitic acid since it is one of the major constituents and is relatively poorly absorbed. The unsaturated and short chain saturated fatty acids are well absorbed regardless of their positional distribution (5). The coefficient of absorption of free long chain saturated fatty acids, i.e. palmitic acid and longer, is relatively low (6). This in part due to their melting point above body temperature (~63°C), thus the tendency of these fatty acids is to form hydrated fatty acid soaps with minerals such as calcium or magnesium at the pH of the intestine (7).

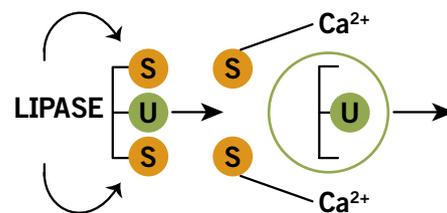
Figure 1 Human Milk



Absorption of human milk-fat compared to standard infant formula

The superior absorption of human milk fat over standard infant formula has been demonstrated in both human (8-10) and animal models (5, 11). These studies showed that palmitic acid is absorbed from human milk as sn-2 monoacylglycerol (9), and conserved as such through digestion, absorption, and chylomicron triacylglycerol synthesis (10) (Figure 1). Palmitic acid esterified at the sn-1 and 3 positions of the glycerol backbone, as is the case in most standard infant formula, was shown to be poorly absorbed and secreted into faeces as insoluble calcium soaps. This leads to loss of both fatty acids (energy) and calcium (12, 13) (Figure 2).

Figure 2 Vegetable Oil



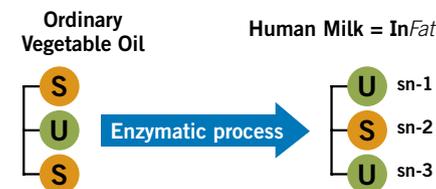
Calcium soap formation may lead to problems with constipation

Formation of calcium soaps in the gut could be associated with the considerable differences of bowel habit and stool consistency between human milk and formula-fed infants (14). Formula feeding is associated with constipation in both term and preterm infants which, for the latter, can lead to life-threatening complications. In contrast, constipation is rare in breast fed term infants, suggesting different handling of saturated fatty acids.

InFat™ – closer to mother's milk

By using a patented enzymatic process, **InFat™** has been developed to resemble the unique structure of the fat in mother's milk. **InFat™** is based purely on vegetable oils, but the triglyceride structure has been transformed to mimic mother's milk – leading to better fat and calcium absorption by the infant.

Figure 3



mother's milk



The palmitic acid in **InFat™** is to a large extent positioned in the second (sn-2) position on the triglyceride, just as in mother's milk (Figure 3). Clinical studies have shown that infants fed formula based on structured fats with a high level of palmitic acid in the sn-2 position have softer stools compared to infants fed standard vegetable oil formula (15). It has also been shown that the absorption of palmitic acid is improved when using structured fats, as is calcium absorption (8, 16-19). Evidently palmitic acid in the sn-2 position leads to efficient fat absorption and avoidance of soap formation with calcium (20).

There is also an effect on the whole-body bone mass of the infants; it is significantly increased compared to a standard vegetable oil infant formula (15). This suggests that the formula composition may affect the skeletal mineral deposition in infants.



InFat™ ensures better uptake of energy and calcium

It is evident that using **InFat™** in their formulas gives infant formula producers real opportunities to solve many of the problems associated with formula feeding. Not only does it make life easier for the parents by reducing constipation, but it also ensures that the infant gets all the energy and calcium it needs. Infants fed **InFat™** also benefit from significantly higher whole body bone mass, compared to infants fed standard vegetable oil based formula.

References

- Giovannini, M., E. Riva, and C. Agostoni, Fatty acids in pediatric nutrition. *Pediatr Clin North Am*, 1995. 42(4): p. 861-77.
- Breckenridge, W.C., L. Marai, and A. Kuksis, Triglyceride structure of human milk fat. *Can J Biochem*, 1969. 47(8): p. 761-9.
- Mattson, F.H. and R.A. Volpenhein, The specific distribution of fatty acids in the glycerides of vegetable fats. *J Biol Chem*, 1961. 236: p. 1891-4.
- Mattson, F.H. and R.A. Volpenhein, The Digestion and Absorption of Triglycerides. *J Biol Chem*, 1964. 239: p. 2772-7.
- Tomarelli, R.M., et al., Effect of positional distribution on the absorption of the fatty acids of human milk and infant formulas. *J Nutr*, 1968. 95(4): p. 583-90.
- Jensen, C., N.R. Buist, and T. Wilson, Absorption of individual fatty acids from long chain or medium chain triglycerides in very small infants. *Am J Clin Nutr*, 1986. 43(5): p. 745-51.
- Small, D.M., The effects of glyceride structure on absorption and metabolism. *Annu Rev Nutr*, 1991. 11: p. 413-34.
- Lopez-Lopez, A., et al., The influence of dietary palmitic acid triacylglyceride position on the fatty acid, calcium and magnesium contents of at term newborn faeces. *Early Hum Dev*, 2001. 65 Suppl: p. S83-94.
- Innis, S.M., R. Dyer, and C.M. Nelson, Evidence that palmitic acid is absorbed as sn-2 monoacylglycerol from human milk by breast-fed infants. *Lipids*, 1994. 29(8): p. 541-5.
- Nelson, C.M. and S.M. Innis, Plasma lipoprotein fatty acids are altered by the positional distribution of fatty acids in infant formula triacylglycerols and human milk. *Am J Clin Nutr*, 1999. 70(1): p. 62-9.
- Innis, S.M., et al., Palmitic acid is absorbed as sn-2 monopalmitin from milk and formula with rearranged triacylglycerols and results in increased plasma triglyceride sn-2 and cholesteryl ester palmitate in piglets. *J Nutr*, 1995. 125(1): p. 73-81.
- Nelson, S.E., et al., Palm olein in infant formula: absorption of fat and minerals by normal infants. *Am J Clin Nutr*, 1996. 64(3): p. 291-6.
- Nelson, S.E., J.A. Frantz, and E.E. Ziegler, Absorption of fat and calcium by infants fed a milk-based formula containing palm olein. *J Am Coll Nutr*, 1998. 17(4): p. 327-32.
- Quinlan, P.T., et al., The relationship between stool hardness and stool composition in breast- and formula-fed infants. *J Pediatr Gastroenterol Nutr*, 1995. 20(1): p. 81-90.
- Kennedy, K., et al., Double-blind, randomized trial of a synthetic triacylglycerol in formula-fed term infants: effects on stool biochemistry, stool characteristics, and bone mineralization. *Am J Clin Nutr*, 1999. 70(5): p. 920-7.
- Lucas, A., et al., Randomised controlled trial of a synthetic triglyceride milk formula for preterm infants. *Arch Dis Child Fetal Neonatal Ed*, 1997. 77(3): p. F178-84.
- Carnielli, V.P., et al., Structural position and amount of palmitic acid in infant formulas: effects on fat, fatty acid, and mineral balance. *J Pediatr Gastroenterol Nutr*, 1996. 23(5): p. 553-60.
- Carnielli, V.P., et al., Feeding premature newborn infants palmitic acid in amounts and stereoisomeric position similar to that of human milk: effects on fat and mineral balance. *Am J Clin Nutr*, 1995. 61(5): p. 1037-42.
- Koo, W.W., E.M. Hockman, and M. Dow, Palm olein in the fat blend of infant formulas: effect on the intestinal absorption of calcium and fat, and bone mineralization. *J Am Coll Nutr*, 2006. 25(2): p. 117-22.
- Lien, E.L., et al., The effect of triglyceride positional distribution on fatty acid absorption in rats. *J Pediatr Gastroenterol Nutr*, 1997. 25(2): p. 167-74.

Advanced Lipids

- Joint Venture of AAK and Enzymotec -

Advanced Lipids is a Joint Venture between Enzymotec and AAK, established in 2007. The cooperation between the two companies goes back to 2003. The Joint Venture offers a unique package, combining both Groups' advantages in R&D, manufacturing logistics and quality.



- ◆ AAK is a leading manufacturer of high value-added speciality vegetable fats and oils.
- ◆ From seven plants in Europe, North and South America the company supplies the global food and confectionery industry. A dedicated plant for the manufacture of **InFat™** was opened in Karlshamn, Sweden in 2008.
- ◆ AAK shares are listed on the OMX Nordic Exchange in Stockholm.

AarhusKarlshamn Sweden AB
Västra Kajen
SE-374 82 Karlshamn, Sweden
Phone +46 454 820 00
Fax +46 454 828 10
Mail info@aak.com
www.aak.com



- ◆ Enzymotec develops and produces innovative lipid based bio-functional ingredients for advanced infant nutrition, clinical nutrition and food supplements.
- ◆ Enzymotec's unique ingredients are designed to address the health needs associated with the whole life cycle, starting from babies up to seniors.
- ◆ The company was established in 1998 and is based in Migdal HaEmeq, Israel, with offices, R&D laboratories and production facilities.

Enzymotec Ltd.
Sagee 2000 Industrial Park
P.O. Box 6
Migdal HaEmeq 23106, ISRAEL
Phone + 972 74 7177 177
Fax + 972 74 7177 001
Mail info@enzymotec.com
www.enzymotec.com

