THE LEARNING LEAD
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Wyeth Nutrition SCIENCE CENTER

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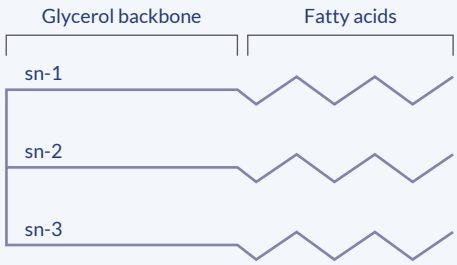
Fat Structure and Composition in Milk

Role of Dietary Fats in Early Nutrition

Infants have an immense energy requirement — this need is partially met by milk fat, an important component of breast milk, as well as milk formulas. Milk fat is an important energy source, providing about 45-55% of the total energy requirements of an infant.[1,2] Apart from this, milk fats also facilitate the delivery and absorption of essential fat-soluble vitamins, such as vitamins A, D, E and K, as well as polyunsaturated acids such as docosahexaenoic acid (DHA) and arachidonic acid (ARA), which are recognized to have a vital role in cognitive and visual development in infants. Dietary fats also impact the metabolism of lipoproteins, eicosanoids, docosanoids and other signalling molecules, and consequently affects cardiovascular functions, immune response and neurodevelopment.[1]

In breast milk, the majority of fats are in the form of triacylglycerols (TGs), i.e. three fatty acids are attached to a glycerol backbone at the sn-1, sn-2 and sn-3 positions [Figure 1].

Figure 1: A triacylglycerol is composed of three fatty acids attached to a glycerol backbone.



What is Palmitic Acid?

Palmitic acid is one of the most common saturated fatty acids found in breast milk, and thus constitute an important energy source for a rapidly growing infant.[2] In infant formula, the fat component mainly comes from vegetable oils; palm oil is typically used to increase the palmitic acid levels in formula milk closer to the high levels seen in breast milk. However, there still lies important stereospecific differences between the palmitic acids found in breast milk compared to those in standard formula.

Percentage of Palmitic Acids Content[2]

60%-70% breast milk > **~40%** cows' milk

The small, but significant difference in the position at which palmitic acid is bound to the glycerol backbone is believed to be the reason why breast-fed infants have higher mean frequency of stools and tend to produce larger, softer stools compared with infants fed with standard palm oil-based milk formula.

What Makes sn-2 Palmitate Different?

When milk fats undergo digestion, enzymes called lipases cleave the fatty acids in the sn-1 and sn-3 positions of the triacylglycerol molecule, resulting in two free fatty acids and a 2-monoacylglycerol [Figure 2.1].[3] These liberated fatty acids can be absorbed quickly if they are unsaturated and thus, water soluble.

However, long-chain saturated fatty acids, such as palmitic acid, are poorly soluble in water and are poorly absorbed. If palmitic acids occupy the sn-1 and sn-3 positions, upon cleavage from the glycerol backbone, they remain in the intestinal lumen, bind to calcium and form insoluble calcium soaps [Figure 2.2].

In contrast, sn-2 palmitate does not create calcium soaps in the intestine, as they are readily absorbed [Figure 2.1].[3]

Figure 2.1: Digestion and absorption of triacylglycerol and fatty acids in the intestine. Lipases cleave the fatty acids at the sn-1 and sn-3 positions, yielding readily absorbable FFA and palmitoyl monoglycerol.

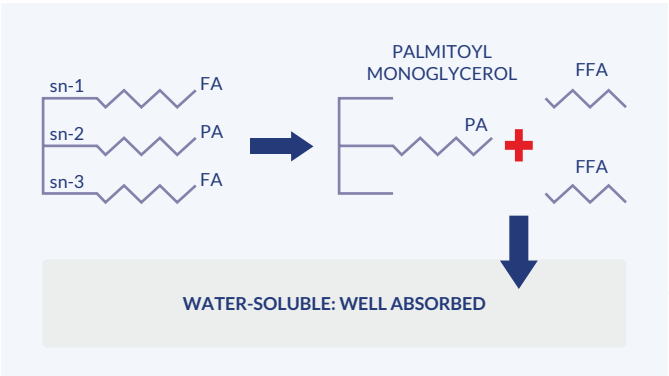
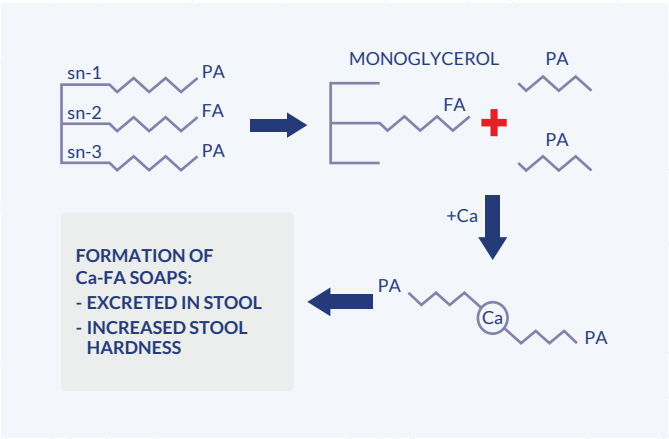


Figure 2.2: Digestion and absorption of triacylglycerol and fatty acids in the intestine. Lipases cleave the fatty acids at the sn-1 and sn-3 positions, yielding free palmitic acids, which form calcium soaps.



FA, fatty acids; **FFA,** free fatty acids; **PA,** palmitic acid; **Ca,** calcium.

Adapted from: Bronsky J, *et al. J Pediatr Gastroenterol Nutr.* 2019;68(5):742–760.

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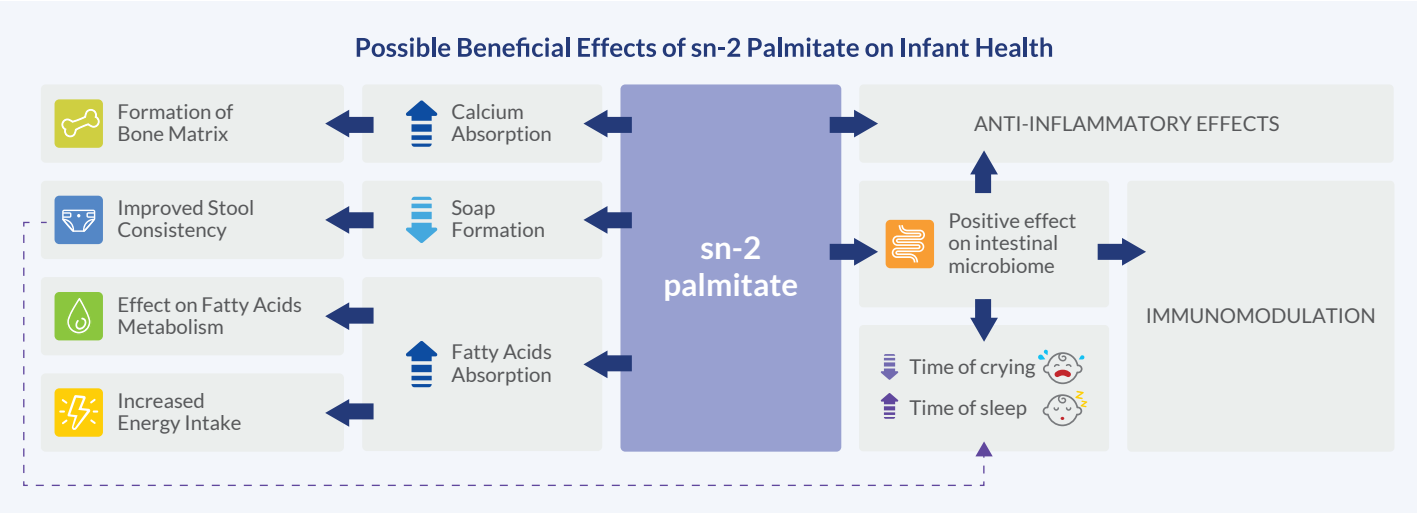
Beneficial Effects of sn-2 Palmitate on Early Childhood Health

Studies have shown that infants fed with formula that was high in sn-2 palmitate had better fat absorption and higher bone mineral content than those who received standard formula.[4,5] sn-2 palmitate in milk reduces calcium malabsorption and positively impacts bone development. This is particularly important during infancy when intensive growth and skeleton formation occurs.

The formation of calcium soaps can also lead to stool hardening, constipation and overall intestinal discomfort.[2,3] Infants on high sn-2 palmitate formula were shown to have softer stools and less calcium soaps in their stools compared with those on standard formula. Hard stools can be difficult to pass and infants may push or strain and may be fussier when having a bowel movement. High sn-2 palmitate formula can potentially alleviate these issues in formula-fed infants too.

Current evidence also suggests that formula with high sn-2 palmitate content may help reduce crying episodes in babies with colic,[6] encourage the development of a healthy gut microflora[7] and confer anti-inflammatory effects on the intestinal surface.[8]

Figure 3: Possible beneficial effects of sn-2 palmitate on infant health. Adapted from: Havlicekova, Z, *et al. Nutr J.* 2016;15:28.



Key Takeaways

- Palmitic acid is a major saturated fatty acid in milk and is an important energy source for a growing infant.
- During digestion, palmitic acids that are bound at the sn-2 position do not create calcium soaps in the intestine, as they are readily absorbed, thereby reducing fat and calcium malabsorption.
- sn-2 palmitate also improves stool consistency and reduces crying time in infants with colic.

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