Human breast milk supplies vital nutrients to infants and is the gold standard to which all infant formulas are compared. While many infant formulas supply necessary nutrients comparable to breast milk, the type of fat can differ significantly. Human breast milk fat largely contains a unique placement of palmitic acid on the sn-2 position of the triglyceride and although infant formulas can contain palmitic acid, the placement of palmitic acid at the sn-2 position is much lower. High sn-2 palmitic acid is the same triglyceride structure found in human milk fat and serves as a functional ingredient when added to infant formulas. Studies show that high sn-2 infant formula (High sn-2 IF), much like breast milk, leads to increased fatty acid absorption, increased calcium absorption, reduced formation of fecal calcium soaps, and softer stools vs. fat sources used in common commercial infant formulas.
For exclusively breastfed infants, human breast milk is the sole source of nutrients during the first several months. As human breast milk supplies all the nutrients required for growth, development and immune support, it is often considered the gold standard in infant nutrition. Breastfeeding is not always practiced and commercial infant formulas exist which can serve as suitable substitutes. Over the years, infant formulas have become more sophisticated regarding nutrient additions which naturally appear in human breast milk and include prebiotic oligosaccharides, nucleotides, carotenoids and probiotic bacteria. However, there is one key ingredient which appears in human breast milk that has not been widely applied to infant formula and that is the distinctive fat structure.

**KEY WORDS:** INFANT FORMULA, FAT, HUMAN BREAST MILK, PALMITIC ACID, STRUCTURED TRIGLYCERIDES, CALCIUM ABSORPTION, STOOLS
The fat structure in human breast milk is unique and serves a functional purpose (1,2). Human breast milk is made up of only about 3-4% fat; however, the fats make up 50-60% percent of the energy intake for infants and are involved in nutrient absorption (1). Thus, the fat in human breast milk plays an essential role in infant nutrition and digestion. In nature, fat molecules exist as fork-shaped triglycerides which can have different fatty acids bound to the sn-1, sn-2, or sn-3 position on a glycerol backbone (Figure 1).

**FIGURE 1** TRIGLYCERIDE STRUCTURE WITH THREE FATTY ACIDS ATTACHED.

sn-1 and sn-3 are the outer fatty acid positions and sn-2 the mid-position fatty acid. (sn means stereospecific numbering)
THE OPO FAT STRUCTURE ALLOWS BABIES TO ABSORB MORE PALMITIC ACID AND CALCIUM
Fatty acids are classified into one of three types, called saturated fatty acids, mono unsaturated fatty acids (MUFA), or polyunsaturated fatty acids (PUFA). Fatty acids can vary in chain lengths from short (<C:6) medium(C:6-C:12) or long (C:12-C:20) or very long (C:22) (Figure 2).

<table>
<thead>
<tr>
<th></th>
<th>Saturated</th>
<th>Monounsaturated</th>
<th>Polyunsaturated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Palmitic acid</td>
<td>16:0</td>
<td>Oleic acid</td>
<td>n-6 Linoleic</td>
</tr>
<tr>
<td>Stearic acid</td>
<td>18:0</td>
<td></td>
<td>18:2 Arachidonic</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>20:4 n-6</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Alpha linolenic</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>20:5 Eicosapentaenoic</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>22:6 Docosahexaenoic</td>
</tr>
</tbody>
</table>

**FIGURE 2 DIFFERENT TYPES OF DIETARY FATTY ACIDS.**
Human breast milk contains various fatty acids, including palmitic acid (C16:0) which makes up 20-25% of the total fatty acids (2). In human breast milk, palmitic acid largely exists (about 70%) on the sn-2 (or middle) position whereas the sn-1 and sn-3 positions are commonly occupied by unsaturated fatty acids such as oleic (18:1) and linoleic (18:2) (3). A similar fatty acid profile to human breast milk can be achieved in infant formulas via the use of vegetable oils and algal oils. However, the specific placement of palmitic acid on the triglyceride in human breast milk differs from most infant formulas and cannot be matched by the addition of vegetable oils. While palmitic acid exist primarily in the sn-2 position in human milk fat, in most infant formula palmitic acid exists largely (about 80%) in either the sn-1 or sn-3 position (3). This difference in palmitic acid placement on the triglyceride plays a crucial role in the uptake, digestion, and metabolism of milk fat for infants (4).

Betapol® (High sn-2 Infant Formula (IF)) from IOI Loders Croklaan is a structured triglyceride mixture derived from vegetable oils and that is identical to the structure of the major triglyceride found in human breast milk. It is manufactured by using position-specific enzymatic interesterification process using palm oil triglycerides and oleic acid fatty acids. Unlike common triglycerides found in most infant formulas, High sn-2 IF is more like human milk fat and has up to 60% of its palmitic acid attached to the sn-2 position with sn-1 and sn-3 positions occupied by unsaturated fatty acids. Studies have shown that the addition of High sn-2 IF as the fat source of an infant formula can play a beneficial role in lipid absorption, energy availability, mineral absorption and stool softness in both preterm and term infants vs. commercial formulas that contain low levels of sn-2 palmitic acid (4-9). In addition, novel infant formulas which contain High sn-2 IF and other ingredients naturally found in human breast milk such as oligosaccharides have shown benefits such as softer stools, alleviation of constipation and increased probiotic bifidobacteria in the gut (10-14). Table 1 summarizes efficacy of High sn-2 IF research.
Lipid absorption is essential for the energy requirements of the growing infant. In addition, some lipids found in breast milk such as DHA, EPA and rumenic acid also serve roles in other key biological functions such as cognition and immune function (15-17). The rate of lipid absorption is influenced by both the type of fatty acid and the position of fatty acid on the triglyceride backbone (3). When triglycerides are consumed, the fats bound in the sn-1 and sn-3 positions are freed by digestive enzymes leaving the fatty acid in the sn-2 position as a monoglyceride where each can be absorbed in the small intestine.

Generally, short or medium chain fatty acids are more quickly absorbed than long chain fatty acids and unsaturated fatty acids are better absorbed than saturated fatty acids (3,18). Palmitic acid is favorably absorbed in the sn-2 position as a monoglyceride rather than a free fatty acid from the sn-1 or sn-3 position (19-21). Free palmitic acid tends to complex with minerals such as calcium and form insoluble soaps which cannot be absorbed in the small intestine and are thus excreted in the feces (1,22) as illustrated in Figure 3.
1. Fatty acids and calcium from diet
2. Fatty acids released from positions sn-1 and sn-3
3. Unsaturated fatty acids at position sn-2 are absorbed
4. Palmitate from sn-1 and sn-3 combines with calcium. Both are excreted

A. Palmitate at the sn-1 and sn-3 positions

1. Fatty acids and calcium from diet
2. Fatty acids released from p
3. Palmitate at position sn-2 is absorbed
4. Unsatuated fatty acids and calcium are absorbed

B. Palmitate at the sn-2 position (Betapol TM)
TABLE 1/3 SUMMARY OF CLINICAL STUDIES PERFORMED ON HIGH SN-2 IF OR HIGH SN-2 IF WITH A COMBINATION OF INGREDIENTS.

<table>
<thead>
<tr>
<th>Reference</th>
<th>No. Infants</th>
<th>Duration</th>
<th>Intervention IF</th>
<th>Control IF</th>
<th>Outcomes</th>
</tr>
</thead>
</table>
| Carnielli 1995 | 24 (preterm) up to 38 days of age | 1 week crossover | 58% Sn-2 palmitic acid | 9.8% Sn-2 palmitic acid | 28% decrease in fecal calcium (p<0.05)  
Significant increase in intestinal absorption of myristic, palmitic and stearic acid (p<0.01)  
Significant decrease in fecal myristic, palmitic and stearic acid content (p<0.004) |
| Carnielli 1996 | 27 (term) male infants up to 5 weeks of age | 5 weeks | 66% (Beta) and 47% (Intermediate) Sn-2 palmitic acid | 13% (regular) Sn-2 palmitic acid | Significant decrease in fecal calcium and significant increase in intestinal calcium absorption with the Beta formula.  
Significant decrease in fat excretion with Beta formula (p<0.001)  
Significant decrease in fecal lauric, myristic, palmitic and stearic acid content (p<0.001) with the Beta formula  
Significant difference in stool consistency (p=0.03) |
| Lucas 1997 | 24 (preterm) up to 10 days of age | 3 weeks | 74% (Betapol®) and 28% (Diet B) sn-2 palmitic acid | 8% (Diet A) Sn-2 palmitic acid | Significant increase in calcium absorption with High sn-2 IF formula (p<0.03)  
Significantly less fecal fatty acid soaps with High sn-2 IF formula (p<0.03)  
Significant increase in palmitic acid absorbed with High sn-2 IF formula (p<0.03) |
<table>
<thead>
<tr>
<th>Reference</th>
<th>No. Infants</th>
<th>Duration</th>
<th>Intervention IF</th>
<th>Control IF</th>
<th>Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kennedy 1999</td>
<td>203 (term) up to 8 days of age</td>
<td>12 weeks</td>
<td>50% (Betapol&lt;sup&gt;®&lt;/sup&gt;) Sn-2 Palmitic acid</td>
<td>12% (Control) Sn-2 Palmitic acid</td>
<td>Significant increase in BMC (p&lt;0.02) and BMD with High sn-2 IF formula (p&lt;0.009)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Significantly lower soap fatty acids (p&lt;0.001) and total fatty acids in feces (p&lt;0.05) with High sn-2 IF formula</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Significantly less hard or formed stools at six weeks with High sn-2 IF formula (p&lt;0.004)</td>
</tr>
<tr>
<td>Lopez-Lopez 2001</td>
<td>36 (term) from birth</td>
<td>8 weeks</td>
<td>Breast fed (66% Sn-2 palmitic acid)</td>
<td>Alpha formula19% (control) Sn-2 palmitic acid</td>
<td>Significantly less fecal palmitic acid in the breastfed and beta formula groups</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Beta formula (44% Sn-2 palmitic acid)</td>
<td></td>
<td>Significantly less fecal calcium in breast fed group vs. alpha and beta formula</td>
</tr>
<tr>
<td>Bongers 2007</td>
<td>38 (term) Constipated infants up to 29 weeks in age</td>
<td>3 week crossover</td>
<td>41% Sn-2 palmitic acid Contains oligosaccharides and Whey hydrolyzed protein (New formula)</td>
<td>11.5% Sn-2 palmitic acid, no oligosaccharides, no hydrolyzed whey protein (Standard formula)</td>
<td>Significant improvement in stool consistency for new formula (p=0.04)</td>
</tr>
<tr>
<td>Reference</td>
<td>No. Infants</td>
<td>Duration</td>
<td>Intervention IF</td>
<td>Control IF</td>
<td>Outcomes</td>
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<tr>
<td>Savino 2005</td>
<td>168 (term) infants with regurgitation of constipation problems up to four months of age</td>
<td>14 days</td>
<td>High sn-2 IF, prebiotic oligosaccharides and partially hydrolyzed whey protein</td>
<td>Listed as standard IF</td>
<td>Increased stool frequency on day 7 (0.48, p=0.02) and day 14 (0.40, p=0.07)</td>
</tr>
<tr>
<td>Savino 2003</td>
<td>232 infants with constipation up to 90 days of age</td>
<td>14 days</td>
<td>High sn-2 IF, prebiotic oligosaccharides and partially hydrolyzed whey protein</td>
<td>None</td>
<td>141 (of 201) infants (70%) had less regurgitation symptoms at the end of the study (p&lt;0.005). 147 (of 232) infants (63%) demonstrated an increase in daily stool number (0.42, p&lt;0.05). Stool frequency was increased from day 1 to day 7 (0.41, p&lt;0.05).</td>
</tr>
<tr>
<td>Savino 2006</td>
<td>199 infants with infantile colic age up to four months of age</td>
<td>14 days</td>
<td>High sn-2 IF, prebiotic oligosaccharides and partially hydrolyzed whey protein</td>
<td>Listed as Standard formula and simethicone</td>
<td>Colic episode were less after 1 week (p&lt;0.001) and crying episodes were less after 2 weeks (p&lt;0.001)</td>
</tr>
</tbody>
</table>

TABLE 1  SUMMARY OF CLINICAL STUDIES PERFORMED ON HIGH SN-2 IF OR HIGH SN-2 IF WITH A COMBINATION OF INGREDIENTS.
The presence of fecal palmitic acid represents a needless loss of available dietary energy for the infant. Effects of improved lipid absorption by High sn-2 IF have been shown in preterm term infants where nutrient absorption is paramount as they have a less developed digestion systems vs. full term infants (2,23,24).

A five-day study in 24 preterm infants compared the lipid absorption of High sn-2 IF (73% palmitic acid in the sn-2 position) vs. two other triglycerides with only 28% or 8% of palmitic acids in the sn-2 positions (4). The study found that 91% of the palmitic acid was absorbed from High sn-2 IF vs. 79% of the palmitic acid from the other two triglycerides (p<0.01).

A similar 1-week crossover trial in 12 preterm infants (born after gestation of 20-32 weeks) using infant formula with High sn-2 IF vs. control infant formula (with only 13% of palmitic acid in the sn-2 position) found significantly greater intestinal absorption of the saturated fatty acids palmitic (43.1%), myristic (12.5%), and stearic (6.7-fold increase) with High sn-2 IF with respect to the commercial infant formula (p<0.01) (5).
The effects of High sn-2 IF on lipid absorption have also been shown in full term infants. A five-week study in full term infants compared infant formula containing High sn-2 IF (up to 60% palmitic acid in the sn-2 position) to a conventional infant formula (13% palmitic acid in the sn-2 position) and also to an intermediate formula (39% of palmitic acid in the sn-2 position) (6). The infant intestinal absorption of saturated fatty acids lauric (25.4%), myristic (7.6-fold), palmitic (23.5%) and stearic (20.7%) acids was significantly greater (p<0.01) after consumption of High sn-2 IF formula vs. the standard and intermediate formulas. The amount of fatty acids recovered in feces was significantly lower in the formula containing High sn-2 IF (150 mg/kg/day) vs. the conventional (680 mg/kg/day, p<0.05) and intermediate formulas (440 mg/kg/day, NS).

Another study was performed in 36 term infants consuming human breast milk for two months (Group A, 66% sn-2 palmitic acid estimated), conventional infant formula for two months (Group B, 19% sn-2 palmitic acid), and Group C which was fed the formula from Group B for one month and then a High sn-2 IF (44.5% sn-2 palmitic acid) for the second month (9). After two months, the authors reported significantly less fecal palmitic acid in Groups A and C (which had larger amounts on sn-2 palmitic acid for either one or two months) than Group B, indicative of increased palmitic acid absorption.

High sn-2 IF triglyceride structure significantly increases absorption of fatty acids and leads to a lower amount of excreted fatty acids in both preterm and term infants vs. triglycerides with low sn-2 palmitic acid found in common infant formulas.
Calcium absorption is important as calcium is a vital mineral involved in bone building and also serving as a cellular signal in several biological processes. When saturated fatty acids are bound to the sn-1 and sn-3 positions on a triglyceride, they can be released to form free fatty acids during digestion. These free fatty acids can bind to minerals such as calcium to form soaps which are excreted in feces thus decreasing the amount of calcium available for absorption for the infant. Indeed, fecal calcium content is positively correlated with fecal saturated fatty acid content in infants and not mono or polyunsaturated fatty acids (5). A study in preterm infants consuming infant formula with High sn-2 IF (position found that fecal calcium was significantly lower (58.8 mg/kg/day) in the High sn-2 IF containing infant formula vs. the control formula (82.0 mg/kg/day) (p<0.05) (5). Another study in preterm infants comparing formula containing High sn-2 IF (72% sn-2 palmitic acid) with formulas containing only 8% (formula A) and 28% (formula B) palmitic acid in the sn-2 position respectively found a higher absorption of dietary calcium in the High sn-2 IF formula (57%) vs. the A and B formulas (44% and 40% respectively) (p<0.03) (4). Also found was a significantly lower amount of fecal calcium soaps for the High sn-2 IF formula (3.3%) vs. the B formula (7.2%) (p<0.03).
Similar effects on calcium absorption with High sn-2 IF have been observed in term infants. In a study of full term infants consuming infant formula containing High sn-2 IF had significantly lower amounts of fecal calcium (43mg/kg/day) and significantly higher calcium absorption (53%) vs. a conventional infant formula (68mg/kg/day; 33% absorption) (p<0.05) (6).

Another study was performed in 36 term infants (12 infants per group), which compared the effects of breast milk and two other infant formulas with different sn-2 palmitic acid percentages for two months (9). The breast milk contained approximately 66% sn-2 palmitic acid (Group A) and the two other groups consumed conventional infant formula (Group B, 19% sn-2 palmitic acid), and Group C which was fed the formula from Group B for one month and then a higher palmitic acid sn-2 formula (44.5% sn-2 palmitic acid) for the second month. After 1 month, there was a significant difference in fecal calcium in the breast fed group vs. Group B (0.42 mg/100g vs. 1.27 mg/100g). After two months there was a significant difference in fecal calcium in the breast fed group vs. Group B and Group C, (0.23 mg/100g vs. 1.22 mg/100g and 1.01mg/100g).

Calcium absorption in infants is especially important due to its critical role in bone formation and development. The increased calcium absorption of High sn-2 IF leads to improved bone development. A study in 323 infants fed a formula containing High sn-2 IF, a conventional infant formula with sn-2 palmitic acid or breast fed found that there was a 5% increase in both bone mineral density (BMD) (p<0.009) and bone mineral content (BMC) (p<0.02) in the High sn-2 IF fed infants vs. the conventionally fed infants (7). The BMD and BMC in the High sn-2 IF fed group was similar to the breast fed group.
When saturated fatty acids in the sn-1 or sn-3 position are freed during digestion and bind with minerals, not only does this reduce the amount of available minerals such as calcium, but the resultant fatty acid-calcium soaps accumulate in the feces resulting in harder stools which may lead to constipation or obstruction. Breastfed infants typically have lower amounts of fecal calcium soaps and softer stools than formula fed infants. Quinlan et al (8) visually tested stools from 30 infants and found breast fed infants to have softer stools than formula fed infants. More analytically, they further found that formula fed infants had approximately 9 times the amount of fatty acid calcium soaps in the feces vs. breast fed infants. This amount of calcium soaps in the formula fed infants accounted for nearly 30% of the dry weight of the stool vs. only 3% for the breast fed group. High sn-2 IF is similar to breast milk regarding effects on infant stool softness.

A study using infant formula containing High sn-2 IF (66% sn-2 palmitic acid) on term infants found significantly softer stools by a subjective scoring method based on photographs using four levels of consistency compared with a conventional infant formula with 13% sn-2 palmitic acids (p=0.03). The degree of stool softness observed in this study was independent of water content and directly proportional to the amounts of fatty acid soaps in the stool. Another study showed the stool softness and proportion of fatty acid soaps of infants at 6 and 12 weeks consuming High sn-2 IF to be similar to breast fed infants (7). At 6 weeks the percentage of hard or formed stools was significantly less (p=0.004) than a typical conventional infant formula. Stool hardness can lead to pain and discomfort, constipation, and potential further health problems for the infant. High sn-2 IF has been shown to reduce the amount of fatty acid soaps excreted in the feces and lead to softer stools similar to breast fed infants.
Infant formula manufacturers endeavor to discover and include more ingredients into infant formula which are naturally found in breast milk. One example is oligosaccharides which are non-digestible carbohydrates that appear naturally in breast milk and when added to infant formula have been shown to soften stool, increase numbers of probiotic bacteria and may also have some immune benefits as well (10-14,25). Thus, the inclusion of both High sn-2 IF and oligosaccharides in infant formulas yields a closer match to human breast milk.

Studies have been performed in infants using a combination of High sn-2 IF, oligosaccharides and other ingredients. An infant formula containing fructo and galacto-oligosaccharides, partially hydrolyzed whey proteins, low levels of lactose and High sn-2 IF was used in a study to reduce constipation in 232 infants for fourteen days (10). After seven days, 147 infants (63%) demonstrated a significant increase in the daily number of stools (p<0.05).

In a similar study, 168 full term infants with digestive problems such as constipation were fed an infant formula containing High sn-2 IF, prebiotic oligosaccharides and partially hydrolyzed whey protein (11). A standard infant formula was used as a control. Stool consistency and frequency were measured on days 1, 7 and 14 of the study. On day seven, infants on the High sn-2 IF / oligosaccharide/partially hydrolyzed whey formula had a higher number of evacuations vs. the standard formula (day 1-1.79 vs. 1.31, p=0.02). The difference between the two groups in the number of evacuations from the beginning of the study until day 7 and day 14 was 0.60 (p=0.004) and 0.53 (p=0.015) per day respectively.
A study used a combination of High sn-2 IF, prebiotic oligosaccharides and partially hydrolyzed whey protein evaluated the effects on term infants with constipation vs. a conventional infant formula (12). The study consisted of 38 constipated infants aged 3-20 weeks and randomized to the High sn-2 IF / oligosaccharides formula or the standard formula. After three weeks, defecation frequency increased greater in the High sn-2 IF / oligosaccharides group from 3.5 defecations per week to 5.6 defecations per week post treatment vs. the standard infant formula group which increased from 3.6 defecations per week to 4.9 defecations per week post treatment. Improvement of hard stools to soft stools was found more in the High sn-2 IF / oligosaccharides group (90%) vs. the standard infant formula group (50%) but did not reach statistical significance.

However a significant improvement of stool consistency was noted for the High sn-2 IF/oligosaccharide group (p=0.04). In addition, a two-week study using this same formula to measure comfort in infants less than 4 months old found decreases in colic (at 1 week, p<0.001) and crying episodes (after 2 weeks, p<0.001) in 199 infants with infantile colic compared to a standard (low sn-2 palmitic acid) infant formula (13).

Another study found further benefits of the combination of High sn-2 IF with oligosaccharides. In a clinical trial in 102 healthy full term infants for twelve weeks, stool softness and probiotic bifidobacteria growth was measured in an infant formula containing High sn-2, oligosaccharides and hydrolyzed protein vs. an infant formula without palmitic acid, oligosaccharides or hydrolyzed protein. At six weeks, the formula with High sn-2 IF, oligosaccharides and hydrolyzed protein produced softer stool (p=0.005) and produced higher counts of probiotic bifidobacteria (p<0.005) than the control formula (14). Bifidobacterium are non pathogenic bacteria and are major inhabitants of the intestine which may aid in digestion and benefit the immune system (26).

Although the IF in the above mentioned studies were efficacious for various endpoints, the objective of each of these studies was not to determine the efficacy of individual ingredients. Nonetheless, these studies suggest that adding components which appear in breast milk such as High sn-2 fat and oligosaccharides can be beneficial for the infants vs. IF which do not contain them.
In conclusion, breast milk supplies vital nutrients to infants and is the gold standard to which all infant formulas are compared. While many infant formulas supply necessary nutrients comparable to breast milk, the type of fat can differ significantly. Although infant formulas can contain palmitic acid, the unique placement of palmitic acid on the sn-2 position of the triglyceride in breast milk is not representative of most infant formulas. High sn-2 palmitic acid is the same triglyceride structure found in human milk fat and serves as a functional ingredient when added to infant formulas. Studies show that High sn-2 IF, much like breast milk, leads to increased fatty acid absorption, increased calcium absorption, increased BMC and BMD, reduced formation of fecal calcium soaps, and softer stools vs. fat sources which contain palmitic acid used in common commercial infant formulas. As infant formula manufactures continue to add novel ingredients to infant formulas to make them closer to human breast milk, it is vital to also include the same type of fat that is found naturally in breast milk, which is High sn-2 palmitic acid. The noted beneficial effects on nutrient absorption, softer stools, reduced constipation and probiotic bacteria from High sn-2 IF along with other ingredients found in breast milk can lead to a healthier and happy infant. No infant formula is superior to breast milk, however the nutritional similarities of High sn-2 IF to human milk fat shown vs. other types of triglycerides demonstrates the importance of High sn-2 IF to be included in all infant formulas.
REFERENCES


Oils and fats are our core business, and have been for more than a century. Today, IOI Loders Croklaan is not only a reliable and leading global supplier of commodity and specialty oils and fats, but also offers customers an unprecedented combination of lipids knowledge and application expertise to respond to their specific market needs. The company has regional operations in Malaysia, the Netherlands and the United States, plus another eight sales offices worldwide. Since December 2002, IOI Loders Croklaan is part of IOI Corporation Berhad, a leading Malaysian company, which is listed on the Kuala Lumpur Stock Exchange, with its own plantations, thus securing a fully integrated supply chain from Tree to Customer.