



FrieslandCampina 

Ingredients

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DOMO®



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Ingredients

Vivinal® GOS in Infant Nutrition



DOMO®
For a great start in life.

This information is intended for industrial customers only
and not intended for consumers.

Vivinal® GOS: the prebiotic¹⁻⁵ ingredient derived from milk

All parents want the best available nutrition for their children to provide a solid basis for the rest of their lives. Human milk is the best nutrition for newborns, giving them everything they need for their bodies to develop. Oligosaccharides are a major component of human milk⁶. They are thought to make a special contribution to the development and natural protection of an infant's health. When breast milk is not available, cow's milk-based infant formula is the best alternative. Cow's milk, the base for infant formula, hardly contains oligosaccharides^{6, 7}. To reach the intended levels of oligosaccharides in infant formula, FrieslandCampina Domo developed an ingredient that can be supplemented to infant nutrition: Vivinal GOS. Addition of Vivinal GOS can result in different health benefits.

Oligosaccharides in human milk and infant formula

In human milk, oligosaccharide concentrations vary from 0.7-1.5 gram per 100 ml^{9,10}. The structure of human milk oligosaccharides (HMOs) is very complex; about 200 different HMOs are present in human milk¹⁰. HMOs have various biological functions; they stimulate the growth of beneficial intestinal flora, reduce the risk on bacterial and viral infections and stimulate the immune system^{6, 11}. Cow's milk hardly contains HMOs, therefore oligosaccharides are added to infant formula to reach the levels of HMOs in human milk^{6, 7}. Because of the complex structure, HMOs are not available as ingredient for infant formula⁶. Hence as alternative, commercial oligosaccharides, like Vivinal GOS, are available to add to infant formulas.

Vivinal GOS contains galacto-oligosaccharides (GOS) which have similarities with the core molecule structure of the oligosaccharides in human milk⁷. Oligosaccharides in human milk are composed of a variety of monosaccharides. Two of those monomers are glucose and galactose. GOS are soluble non-digestible carbohydrates structured as chains of galactose with a glucose end piece (figure 1). The composition of the GOS fractions varies in chain length and type of linkage between the monomer units (figure 2). Galacto-oligosaccharides in Vivinal GOS are produced through the enzymatic conversion of lactose, a component of milk^{6,7}. As GOS are non-digestible, they are hardly broken down by human digestive enzymes, and therefore reach the intestine almost completely intact. Here, they are fermented by the present microflora^{5,10}. In addition, scientific studies have shown that GOS can result in a beneficial microflora^{1,3,8}, which can result in a broad range of health benefits, which

are essential for a new-born child¹²⁻¹⁴. The described health promoting effects of GOS are generated either through a direct influence on the composition of the microflora, or more indirectly via the fermentation of GOS^{1,15}.

FrieslandCampina Domo

FrieslandCampina Domo is part of the Ingredients (B-to-B) division of FrieslandCampina. It specialises in the production of ingredients, base formulas and total formulas for the infant nutrition industry worldwide. Our aim is to supply ingredients that add value to our customers' products and enrich people's lives. We are fascinated by all the nutrients contained in milk. Vivinal GOS is developed from one of these components and is a prebiotic¹⁻⁵ ingredient, containing galacto-oligosaccharides.

FrieslandCampina Domo was the first company to introduce galacto-oligosaccharides (GOS) to the infant nutrition market. It is marketed under the name Vivinal GOS. Over 60 million babies worldwide have been fed infant formula containing Vivinal GOS since its introduction in 1999. Vivinal GOS can help to differentiate your product and is seen as a premium ingredient in the market.

FrieslandCampina Domo has built an extensive dossier on research into the benefits of GOS. We will continue our research into the benefits of Vivinal GOS in order to find potential new health benefits and new opportunities in areas of application. We can also offer you strong regulatory and application support for Vivinal GOS in your formula. Vivinal GOS is produced in the Netherlands and Australia, thereby offering you contingency benefits.

Galacto-oligosaccharides are soluble non-digestible carbohydrates that are not digested by human digestive enzymes but are fermented in the intestine^{5,10}.

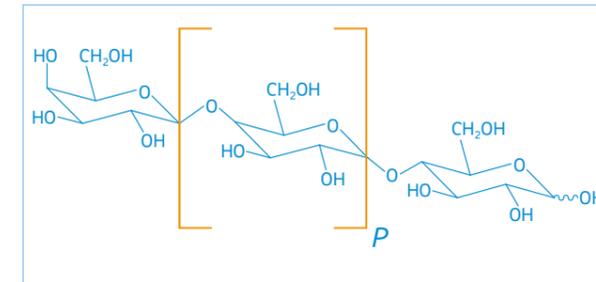


Figure 1: Structure of galacto-oligosaccharides (p = 0 – 6).

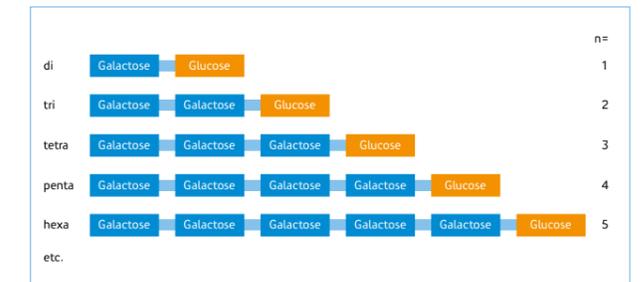


Figure 2: Chain lengths in galacto-oligosaccharides.

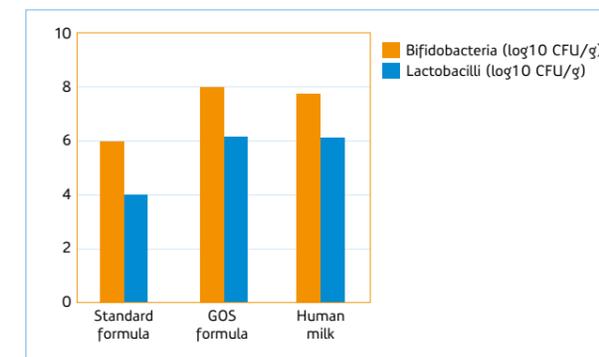


Figure 3: Consumption of infant nutrition enriched with galacto-oligosaccharides for 6 months resulted in a significant growth of Bifidobacteria and Lactobacilli in infants³³.

Promotion of growth of bifidogenic bacteria

The adult gastrointestinal tract contains about 10¹⁴ microbiota, with over 1,000 diverse bacterial types, mostly in the colon³⁰. In contrast, the unborn foetus has not yet developed a gut microflora¹. During birth and shortly afterwards, the bacteria from the mother and the surrounding environment colonise the infant's gut^{30,31}. Shortly after delivery, the infant's gut flora reaches bacterial numbers of 10⁸ to 10¹⁰ per gram faeces³². In the first months of life, diet is very important for the development of the microbiota³¹. Gut microflora can be divided into bacteria that are known to be health promoting (e.g. Bifidobacteria and Lactobacilli) and those that might become harmful if they proliferate (e.g. Clostridia)³⁰. Breast-fed infants are known to have a gut microflora with higher contents of Bifidobacteria compared to bottle-fed infants^{8,32}. This difference is attributed to the presence of bifidogenic growth factors in human milk,

Described beneficial effects of Vivinal GOS*

- Promotes growth of Bifidobacteria and Lactobacilli^{8, 33, 39}
- Contributes to human natural defences¹⁷⁻²⁰
- Supports normal gut transit²¹⁻²⁴
- Improvement of mineral absorption²⁵⁻²⁹

among which HMOs^{1,9,32}. Bifidobacteria and Lactobacilli are fermenting GOS, resulting in stimulation of the growth of these bacteria in the colon⁵.

Several studies with bottle-fed infants have shown that infant nutrition enriched with Vivinal GOS resulted in a significant increase in Bifidobacteria, in comparison to infants receiving a standard formula without GOS, (figure 3)^{8, 33, 39}. Furthermore, comparable studies whereby the effect of mixtures of oligosaccharides, among which GOS, on the microflora of infants was studied, showed similar effects^{21, 24, 34-38, 40, 41}. In addition, an in-vitro study showed that, in comparison to several carbohydrates, Vivinal GOS was shown to support the most favourable growth characteristics for Bifidobacteria and Lactobacilli⁴².

To summarize, Vivinal GOS can play an important role in the colonization of the new-born microbiota by promoting the growth of bifidogenic bacteria⁸.

* Beneficial effects related to galacto-oligosaccharides are effects as described in scientific literature. These effects are not proven as health claim.

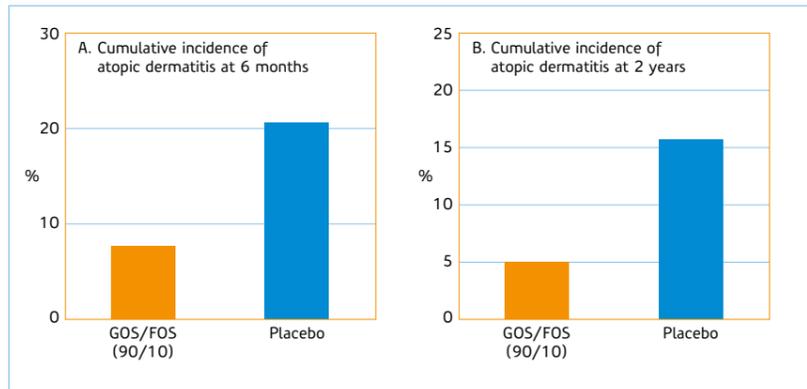


Figure 4: Consumption of infant formula with a prebiotic mixture (GOS/FOS 90/10) reduced the incidence of atopic dermatitis in infants at risk of developing an allergy ($p < 0.05$) A. at six months⁴⁷ and B. after a two-year follow-up¹⁹.

Contribution to natural defences

The gut and immune system form a complex structure providing defence against ingested toxins and pathogenic bacteria⁴³. The oligosaccharides present in human milk play a major role in the development of this immune system^{6,10}. Some researchers suggest that addition of oligosaccharides among which GOS to infant nutrition contribute to healthy gut function in infants, meaning a good functioning intestinal barrier, which reduces the risk of infections and allergies^{22,23}. Studies have shown that the use of oligosaccharides, among which GOS, has the potential to reduce the risk of allergic diseases and infections during childhood (figure 4)^{19,20,32,44-50}. Oligosaccharides, among which GOS, can influence or contribute to natural defences via several routes, among which:

- Indirectly by inhibiting the binding and/or survival of *Escherichia Coli*, *Clostridia* and *Cholera* toxin in the body, reducing the risk of getting infected^{16-18,51}.
- Indirectly through the production of antimicrobial substances, the products of GOS fermentation, which can reduce the proliferation of pathogens thus positively influencing the immune system^{13,52}.
- Directly through interaction with immune cells. For example, commercial available oligosaccharides, among which GOS, have been shown to increase the number of NK cells⁴⁹, reduce mast cell degranulation⁵³, increase the levels of serum IgA⁵⁴, and reduce the plasma levels of IgE and IgG⁵⁰.

These data suggest that GOS can have a beneficial effect on the immune system and contribute to natural defences.

Supports normal gut transit

The characteristics of the infants' stools depend on several factors. One of these factors is the type of feeding: breast or bottle. Formula feeding is associated with constipation. Stools from formula-fed infants are found to be significantly harder compared to stools of breast-fed infants⁵⁵. After consumption of a GOS-containing infant formula, infant stools were found to become softer and the frequency increased^{24,33,36,41,56}. These changes may be of practical importance since they reduce the adverse effects associated with a higher incidence of hard stools⁵⁵.

Improvement of mineral absorption

The minerals Calcium (Ca), Magnesium (Mg) and Phosphorus (P) are important for bone mineralisation. Adequate bioavailability of minerals is critical to achieve optimal bone mass. The consumption of calcium is essential at all stages of life⁵⁷. It is known that 75% of the Ca in human milk is absorbed by infants, while only up to 20% of the Ca in milk-based infant formulas is absorbed⁵⁸. GOS has been shown to increase the Ca absorption in animals, children and adults^{25,26,28,29}. Not only calcium absorption is positively influenced, there are indications that the absorption of magnesium can be improved as well²⁷.

Synbiotic properties

Vivinal GOS belongs to a group of non-digestible oligosaccharides with prebiotic potential¹⁵ to enhance the benefits of probiotics. Combinations of pre- and probiotics with synergistic effects are often referred to as synbiotics.

Vivinal GOS is an ingredient rich in galacto-oligosaccharides, which are soluble non-digestible carbohydrates. Vivinal GOS promotes the growth of beneficial bacteria in the intestinal tract^{8,33,39}.

Human studies with infants and children who consumed GOS in combination with a probiotic mixture, demonstrated increased levels of *Bifidobacteria* and resistance to respiratory infections during the first two years of life^{59,60}. The combination of GOS with a probiotic had a more prominent effect compared to the probiotic alone⁵⁹. It can therefore be concluded that Vivinal GOS is an excellent component for development of synbiotics.

Product varieties that meet your needs

Vivinal GOS is available in syrup and powder forms. Vivinal GOS Syrup is a clear liquid with 75% dry matter and 59% galacto-oligosaccharides expressed on dry matter basis. It has a neutral, slightly sweet taste. Powder varieties are available when a liquid option is not suitable. Vivinal GOS Powder WPC is a co-spray-dried product of Vivinal GOS Syrup and whey protein concentrate. Vivinal GOS Powder Maltodextrin is a co-spray-dried product of Vivinal GOS Syrup and Maltodextrin. Our most recent addition to the product portfolio is a Vivinal GOS Powder, which has a galacto-oligosaccharides content of 71% expressed on dry matter basis.

Vivinal GOS products from FrieslandCampina Domo are Halal certified. We can also produce Kosher Vivinal GOS. For the typical values you can check our available product data sheets or contact us directly for information.





Stable and easy to use

Vivinal GOS is very stable under all process and storage conditions involving infant nutrition. The galacto-oligosaccharide content is retained during processing and storage. Our Vivinal GOS range is easy to blend and dissolve; therefore it is easy to use the Vivinal GOS in different production processes. For wet processes, both our syrup and powder products can be utilized. For dry mixing or blending, we recommend our powder options - Vivinal GOS Powder, Vivinal GOS Powder WPC or Vivinal GOS Powder Maltodextrin. The use of Vivinal GOS Powder WPC, a combination of Vivinal GOS and a whey protein, allows you to simultaneously add both galacto-oligosaccharides and protein to your formulation. Vivinal GOS Powder Maltodextrin can be used when protein is not desired in the formulation. Compared to the blended GOS powders, Vivinal GOS powder has a decreased glucose content. It is versatile to use due to its higher purity.

The Vivinal GOS range of products can be used in your full product range of infant food products:

- Infant Formula Powder
- Infant Formula Liquid
- Follow-on Formula (FOF)
- Growing Up Milk (GUM)
- Baby and toddler nutrition
- Other baby and toddler food

Safety and legislation of Vivinal GOS

Vivinal GOS is used world-wide as an ingredient in standard and premium infant formulas, follow-on formulas and growing-up milk. GOS has been extensively tested in infant and adult studies all over the world. Only recently, in subjects with pre-existing allergies, a very limited number of Vivinal GOS-related allergic reactions was reported in Singapore⁶¹. After completing extensive scientific research and safety studies, Vivinal GOS received GRAS (Generally Recognised as Safe) approval for use in infant food and food in the USA in 2008. Furthermore, the European Union Scientific Committee on Food accepted galacto-oligosaccharides in infant and follow-on formulas, and GOS is now regulated in the EU Directive 2006/141. Galacto-oligosaccharides are also accepted in food and infant formulas of other countries, such as Australia, China, Canada, Brazil, Argentina, Russia, Singapore, Malaysia and Mexico.

Contact

If you have any questions about Vivinal GOS, regarding registration and other legislative topics, or if you wish to receive more information about applications, described benefits or any other topic, FrieslandCampina Domo has a dedicated and experienced team who can help support your company's specific needs. [Please visit our websites www.domo.nl](http://www.domo.nl) and www.vivinalgos.com or send an email to info.domo@frieslandcampina.com.

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Potential consumer benefits are not to be considered as health claims. They should be considered as potential leads that might be developed into health claims complying with the local legal requirements.