

Ingredients in infant milks

Fat content of infant milks

The fat component of human milk is highly variable and changes according to the duration of feed, stage of lactation and the dietary habits of the mother (Agostoni et al, 1999). Where infants are exclusively fed on mature human milk, fats supply about 50% of their energy and as such fats are added to supply around 50% of the energy in infant formula. Vegetable oils are commonly used as the added source of fat in infant milks however, some manufacturers also use egg lipid or animal fat. As the fatty acids present in human milk differ in composition and structure to those of either vegetable oils, cows' or goats' milk fat, multiple fat sources are often used in infant milks in an attempt to recreate a fatty acid profile similar to breastmilk.

Vegetable oils

Vegetable oils used as a source of fat in infant formula include palm oil, palm kernel oil, rapeseed oil, coconut oil, sunflower oil or other individual oils or blended mixes. Whilst most infant milks use a blend of vegetable oils, the specific oils used may vary as worldwide vegetable oil prices fluctuate. Canola oil (also known as food grade rapeseed oil, rapeseed 00 oil, low erucic acid rapeseed oil or LEAR) is a variety of rapeseed oil which has been bred to contain a much lower proportion of erucic acid than standard rapeseed oil. Erucic acid has no known nutritional benefit and observations in animals have indicated potential myocardial alterations. Erucic acid levels in formula should not exceed 1% of fat content (Koletzko et al, 2005).

Long chain polyunsaturated fatty acids (LCPUFA)

Humans have the capacity to synthesise LCPUFA, from simpler fatty acid precursors. However, they cannot synthesise fatty acids with a double bond at the n-3 or n-6 position and therefore rely on these fatty acids (FAs) to be supplied in the diet. Linoleic acid (LA, C18:2 n-6) and α -linolenic acid (ALA, C18: n-3 LCPUFA) are the most commonly occurring dietary sources of n-3 and n-6 PUFAs (polyunsaturated fatty acids). In mammals these FAs are further metabolised by enzyme systems to LCPUFAs. The most important metabolites of LA are dihomo-gamma-linolenic acid (DHGLA, C20:3 n-6) and arachidonic acid (ARA, C20:4n-6) and those of ALA are eicosapentaenoic acid (EPA, C20:5 n-3) and docosahexaenoic acid (DHA, C22:6n-3) (Lauritzen et al, 2001).

ARA and DHA are the main n-3 and n-6 FAs of neural (brain) tissues and DHA is a major fatty acid in phospholipids of the photoreceptor cells of the retina in the eye. Human milk contains small concentrations of DHA and ARA. Trials which have examined the potential beneficial effects of using formula supplemented with DHA and ARA on visual function and neurodevelopmental outcomes in either pre-term and/or term infants have had mixed results, and there is a lack of consistency between the recommendations of several expert panels and committees on whether or not infant formula for term infants should contain added DHA and ARA (Koletzko et al, 2001; LSRO, 1998; FAO/WHO, 1994).

The EFSA *Scientific opinion on the essential composition of infant and follow-on formulae* (EFSA, 2014) presents a useful summary of all the evidence relating to fatty acids in human and artificial milks, but concludes that, whilst they still believe that DHA should be added to

infant and follow-on formulae in similar amounts as are present in breastmilk as a 'prudent measure':

"There is currently no conclusive evidence for any effects beyond infancy of DHA supplementation in any of the health outcomes studied." (EFSA, 2014)

DHA is now a mandatory ingredient in infant formula, follow-on formula and FSMPs. ARA is commonly added but is not mandatory. The sources of the LCPUFAs used are generally fish and fungal and algal oils (produced from single cell micro-organisms). The use of fish oils means that many milks are not suitable for vegetarians. Additionally, supplementation of formula with LCPUFA can increase the retail price by 5%-25%. There are therefore considerable cost implications for welfare food schemes and families now that DHA is an essential ingredient all infant formula.

A review by Kent considering how fatty acid use in infant formula has been regulated in the USA concluded that there is inadequate regulation of the use of fatty acid additives such as DHA and ARA (Kent, 2014). It is suggested that infants are exposed to potential risks as manufactured versions of fatty acids have been inadequately tested for safety and efficacy. The same system of allowing additives to be added to formula without systematic assessment by Government is also the case in the UK.

Longer-term impacts of supplemented milks have not yet been established. PUFAs in infant milk can react with lysine (an amino acid) upon oxidation and this may lead to the production of undesirable compounds such as furfurals (which can modify the nutritional value of proteins and alter the taste and smell of milk). There are at present no established limits for furfural concentrations in infant formula, and few studies look at the long-term implications of additions to infant formula. Furthermore, a 10-year follow-up of a randomised control trial of DHA-supplemented formula in pre-term infants found that girls were heavier and had higher blood pressure than the breastfed group (Kennedy et al, 2010), suggesting that the long-term implications of formula additions may not always be known.

Structured triglycerides

The function of fatty acids is impacted not only by their chain length, but also by the structure and position of the fatty acids in the triacylglycerol molecule. The fatty acid palmitate accounts for about 25% of the fatty acids in human milk and about 70% of this palmitate is attached in the middle (*sn-2*) position of the triacylglycerol molecule. The palmitate in cows' milk fat is also mainly attached in the middle (*sn-2*) position. The advantage of this position is that, when the enzyme pancreatic lipase cleaves the fatty acid molecules at the *sn-1* and *sn-3* positions, the palmitate is still attached to the glycerol backbone and, along with the freed fatty acids, can be easily absorbed through the intestine. In vegetable oils, which are the main source of fats in standard infant formula, the palmitate is predominantly in the *sn-1* and *sn-3* positions so that, when hydrolysed by lipase, it becomes free palmitate in the intestine. Free palmitate can form complexes with calcium and these complexes are poorly absorbed (Kennedy et al, 1999). Their formation may reduce the amount of energy available from fatty acids and reduce calcium absorption due to bound calcium being excreted from the intestine. This may also have the effect of hardening the stools, leading to constipation and colic.

Structured vegetable oils which are vegetable oils that have been enzymatically modified to include a greater proportion of palmitate attached at the *sn-2* position are now commercially

available for use in infant formula milks. Betapol is a structured vegetable oil manufactured by Loders Croklaan which has 40%-70% of the palmitic acid attached at the *sn*-2 position. It was first added to infant formula in the UK in the early 2000s and its use appears to have been confined to formula designed to relieve minor digestive problems. Studies into the efficacy of Betapol in aiding constipation and improving calcium absorption have had mixed results and after considering all the evidence available, the EFSA *Scientific opinion on the essential composition of infant and follow-on formulae* (EFSA, 2014) concluded that:

“There is no convincing evidence for beneficial effects of the use of structured triglycerides with palmitic acid predominantly in the sn-2 position in infant and/or follow-on formula.”

Animal Fat (from goats’ and cows’ milk)

Historically, cows’ milk fat was the main source of fat in infant milks, however cows’ milk fat has higher quantities of the saturated fatty acids lauric acid and myristic acid, which may impact on serum cholesterol levels and lipoprotein concentrations, and the amount of these fatty acids in formula is restricted. Trans fatty acids are also naturally present in cows’ milk fat and may have negative health implications in high amounts, so there are also restrictions on trans fatty acids, which should not exceed 3% of total fat content in formula (Koletzko et al, 2005). Most infant milk manufacturers therefore use a blend of vegetable oils to ensure that their products meet the fat requirements specified in current regulations (EU 2016/127).

In both cows’ milk and goats’ milk fat, the majority of the palmitate is esterified in the *sn*-2 position which has the benefit of being more easily absorbed after digestion than the palmitate in vegetable oils which can form poorly absorbed complexes with calcium and have the effect of hardening stools. In order to increase the proportion of palmitate in the *sn*-2 position, some manufacturers now add a proportion of fat to their products in the form of animal milk fat. This is added as either dried whole cows’ or goats’ milk, or as anhydrous milk fat, which is simply milk fat (butter fat) that has had all water removed. Claims that have been made for the addition of some anhydrous milk fat in infant milks include that it aids fat and calcium absorption, however there is a lack of evidence to support this.

Phospholipids

Phospholipids are an integral part of cell membranes, providing both structural and metabolic function. In breastmilk they act as fat globule membranes and have a high content of LCPUFAs compared to the fats in the core of the milk globule. They have a role in the emulsification of fat in the infant gut, promoting digestion, absorption and transport and so it has been suggested that infant formula could supply long chain polyunsaturated fatty acids in phospholipids, rather than as triacylglycerol (Abrahamse et al, 2012).

The recent EFSA *Scientific opinion on the essential composition of infant and follow-on formulae* (EFSA, 2014) reports that there is no convincing evidence for a beneficial effect of using LCPUFAs supplied as phospholipids. Current regulations permit the addition of phospholipids to infant formula and follow-on formula to a maximum concentration of 0.2g/100ml. Egg lipid is now added as a source of phospholipids in addition to other sources of LCPUFA in some infant milks. Soya lecithin, which also contains phospholipids is also added to some infant milks, however it is used primarily as an emulsifier. Both egg and soya are allergens and their addition to products must be clearly highlighted in bold in the ingredients lists on packaging.

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