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Paper Synopsis

Human Milk Lipids. 2016

Koletzko. Ann Nutr Metab 69 Suppl 2:28-40

The review describes functions beyond infants' needs for energy and micro-essentials, milk fat globule membrane structures, long-chain polyunsaturated fatty acids and other lipophilic bioactive compounds. That may be correlated with cognitive development and immune functions. The author affirms his view that ARA is important for infant development and cautions against products compliant with the European legislation revision (in force since February 2020) until further data on safety of such products is available. The new legislation states that infant and follow-on formula must contain 20-50 mg DHA per 100 kcal without setting a minimum requirement of ARA, making this important fatty acid an optional component, only [1].

Energy profile

Infants receive a major portion - approximately 45% - of total energy from human milk (HM) lipids. HM lipid concentrations vary throughout one feeding, the day and the entire course of lactation and are influenced by maternal diet, ethnicity and climate. Fat is released slowly during a feeding so that this hindmilk is rich in fat and fat-soluble vitamins.

Milk is an emulsion

Because fat is not water soluble, milk fat is released in a complex structure called milk fat globules (MFG). This structure allows that the fat is distributed within the watery secretion instead of forming a film on the water surface. Only in expressed milk, at resting and in time, will the fat layer rise to the surface and cream.

Milk fat globules and their membrane

MFG are relatively large constructs with a triple-layered membrane formed of polar phospholipids and cholesterol and a core filled predominantly with triglycerides and other non-polar lipids. The membrane also contains a number of bioactive compounds. These bioactive compounds are thought to contribute meaningfully to the infant's brain development.

A series of publications from a randomized controlled clinical study with 160 subjects showed that infant development and infection risk are favourably affected by preparations enriched by MFG membranes in comparison to vegetable oil only based ones [2,3,4]. The group receiving a test formula with low protein (1.2 g/100 ml), low energy (60 kcal/100 ml) with an addition of bovine MFG membrane and therefore enriched in cholesterol and phospholipids, showed improved cognitive outcomes at 12 month of age closer to the breastfed reference group than the standard formula group (1.27 g/100 ml, 66 kcal/100 ml). Other studies are discussed.

Cholesterol

The review explains functions of cholesterol embedded in the MFG membrane. In breastfed infants, cholesterol seems to imprint for a favourable serum lipid profile later in life. This effect could not be mirrored by adding cholesterol to infant formulas. Only when embedded in MFG membranes in formula the short-term lipid profile was comparable to that of breastfed infants. The long-term effects of this intervention have not (yet) been investigated.

Triglyceride structure

The positioning of certain fatty acids within the triglyceride affect absorption and digestion. This is due to lipase action and the explanation why formula fed infants with non-modified plant based oils often have harder stools than breastfed infants where palmitic acid (palmitate) is specifically positioned in HM triglycerides.

Fatty acids and n-3/n-6 ratio

The essential fatty acids linoleic (18:2 n-6) and alpha-linolenic acid (18:3 n-3) stem from maternal diet and her body stores; the majority of DHA is almost exclusively linked to maternal diet. In contrast, ARA levels are genetically regulated via the fatty acid desaturase (FADS) gene cluster and stem to 90% from body stores.

Exclusively breastfeeding women need a minimum intake of 200 mg DHA per day to provide their infant with the required DHA supply of approximately 100 mg/day. A formula should additionally provide 140 mg ARA per day.

Conversion from essential fatty acids to LCPUFA is explained as is the dietary shift towards more n-6 rich fats and its consequences. Since the 1940's intake of n-6 fatty acids (omega-6) is increasing whereas intake of n-3 fatty acids stays similar. This change of the ratio is seen as metabolically unfavourable because both groups of fatty acids are modified in competing mechanisms often by the same enzymes or cancel the effects of the other's metabolites.

LCPUFA importance and the European legislation of 2020

Because of the interplay between n-3 and n-6 fatty acids and their involvement in many physiological processes, the author delves into the importance of ARA and DHA for neurodevelopment, vision, and growth.

The updated European legislation [5] is debated critically because it only defines high DHA amounts as mandatory but not ARA*, although most evidence has been generated with a mixture of both. Providing DHA alone and at high amounts is not considered advisable by the author unless safety data for such products is provided.

*still applicable as of JUL 2020

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References

[1] Koletzko B. Human milk lipids. 2016 Ann Nutr Metab 69 Suppl 2:28-40. doi: 10.1159/000452819.

[2] Timby N, Hernell O, Vaarala O, Melin M, Lönnerdal B, Domellöf M. Infections in infants fed formula supplemented with bovine milk fat globule membranes. 2015 J Pediatr Gastroenterol Nutr 60(3):384-389. doi: 10.1097/MPG.0000000000000624.

[3] Timby N, Lönnerdal B, Hernell O, Domellöf M. Cardiovascular risk markers until 12 mo of age in infants fed formula supplemented with bovine milk fat globule membranes. 2014 Pediatr Res 76(4):394-400. doi: 10.1038/pr.2014.110.

[4] Timby N, Domellöf E, Hernell O, Lönnerdal B, Domellöf M. Neurodevelopment, nutrition, and growth until 12 mo of age in infants fed a low-energy, low-protein formula supplemented with bovine milk fat globule membranes: a randomized controlled trial. 2014 Am J Clin Nutr 99(4):860-868. doi: 10.3945/ajcn.113.064295.

[5] Commission delegated regulation (EU) 2016/127 of 25 September 2015 supplementing Regulation (EU) No 609/2013 of the European Parliament and of the Council as regards the specific compositional and information requirements for infant formula and follow-on formula and as regards requirements on information relating to infant and young child feeding. 2016 Official Journal of the European Union.