NUTRITION

Infant nutrition and breastfeeding

Breast milk is the ultimate personalised nutrition

Ingredients by Fonterra Dairy for life

Breastfeeding

The World Health Organization (WHO) recommends exclusive breastfeeding from birth to 6 months of age for healthy growth, protection against infections, and brain development of the infant. Continued breastfeeding along with complementary foods up to 2 years of age or beyond is further advised. In 2016, only 38% of infants worldwide were exclusively breastfed up to 6 months of age; the WHO aims to increase this to 50% (WHO, 2015).

Infant nutrition

BREAST IS BEST

Breastfeeding should be initiated within the first hour after birth to protect the newborn from infections. Two hormones, prolactin and oxytocin, are involved in the production of milk. As the infant begins to suck, the "let-down reflex" or "milk ejection reflex", mediated by the hormone oxytocin, initiates milk flow. "Demand feeding" or "baby-led feeding" are important for adequate milk production. Milk volumes increase rapidly in the first week. The milk produced the first week is called colostrum. Milk is then called transitional milk and after 2 weeks, the milk is called mature milk (Casey et al, 1986).

The evidence for the benefits of breastfeeding for the infant is mainly based on observational studies. Breastfeeding is associated with short-term benefits, such as lower incidence of infections, necrotising enterocolitis and diarrhoea, and long-term benefits, such as lower risk of inflammatory bowel diseases, allergy, type 2 diabetes, cardiovascular disease (lower blood pressure and cholesterol concentration) and obesity (Agostoni et al, 2009; Le Huërou-Luron et al, 2010). Prolonged breastfeeding, for 6 months or longer, may contribute to better developmental performance, likely due to the positive effect of human milk lipids on brain composition and development (Agostoni et al, 2001; 2009).

Breastfeeding also has benefits for the mother beyond enhancing the mother-child bond. It is associated with a reduced risk of breast cancer, ovarian cancer and type 2 diabetes (Agostoni et al, 2009).

Infant nutrition and complementary feeding

Breast milk is the best source of nutrition for infants and provides 100% of the energy and nutrient needs, apart from Vitamin D and Vitamin K, for infants aged 0-6 months (Agostoni et al, 2009). Breastfed infants can self-regulate their milk intake, which may contribute to their lower growth rate in the first years of life (Le Huërou-Luron et al, 2010).

Continuation of breastfeeding is advised after the introduction of complementary foods (Agostoni et al, 2009). Breast milk can provide over half of the daily energy for 6-12 month infants and up to a third of the daily energy for toddlers aged 12-24 months. Healthy complementary foods with a variety of tastes and textures should be introduced no earlier than 4 months of age and by 6 months of age (Fewtrell et al, 2017).

BREAST MILK COMPOSITION

Breast milk composition is very dynamic and complex. It is the ultimate personalised food varying with time of the day, stage of lactation, gestational age, gender of the infant and from mother to mother (Agostoni et al, 2009; Le Huërou-Luron et al, 2010; Powe et al 2010). It provides on average 65 kcal/100 mL (Butte et al, 2001). The average milk intake increases from 673 mL/day at 1 month of age to 896 mL/day at 6 months of age (Dewey and Lönnerdal, 1983).

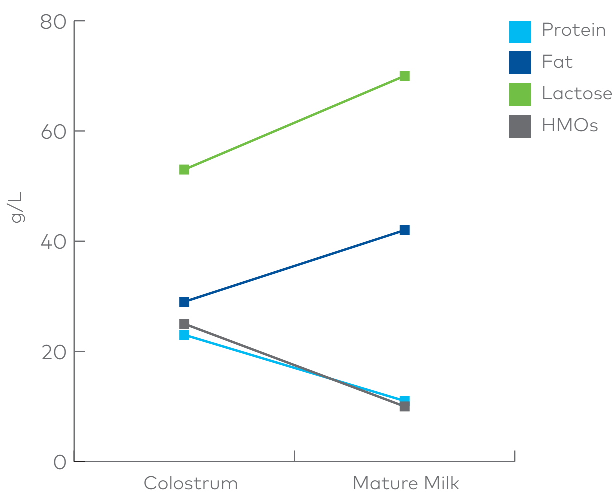


Figure 1. Change in macronutrient composition over lactation.

Colostrum is rich in immunologic nutrients such as secretory immunoglobulin A and lactoferrin (10 g/L compared with 3 g/L in mature milk) (Le Huërou-Luron et al, 2010; Ballard and Morrow, 2013). The protein content is highest in colostrum with an average of 2.2 g/100 mL and decreases with lactation stage, whereas lactose and fat contents are lowest in early lactation and then increase (Le Huërou-Luron et al, 2010; Ballard and Morrow, 2013).

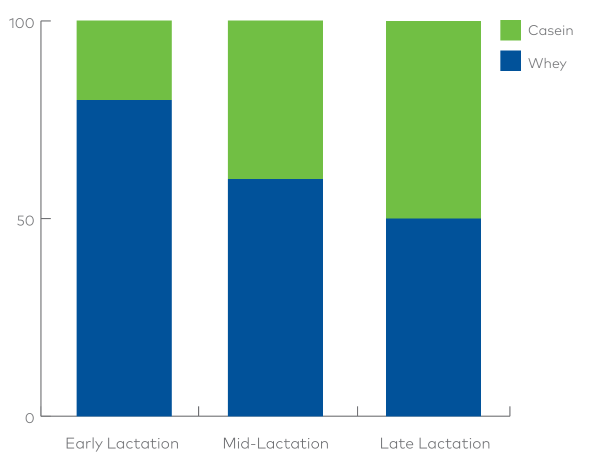


Figure 2. Change in whey:casein ratio over lactation.

The average protein content in mature milk is 1.0-1.2 g/100 mL. The whey:casein ratio decreases from 80:20 in early lactation to 60:40 at 2-3 months of lactation and 50:50 in late lactation (Le Huerou-Luron et al, 2010). Lactose is the least variable macronutrient in mature milk and is found at concentrations between 6.7 and 7.8 g/100 mL (Ballard and Morrow, 2013). Lactose represents 85% of the breast milk carbohydrates, the remaining 15% are indigestible complex human milk oligosaccharides (HMOs) which play a prebiotic role (Le Huërou-Luron et al, 2010). The fat content of mature human milk varies between 3.2 and 3.6 g/100mL. Night and morning milks contain less fat and foremilk has a lower fat content than hindmilk (Ballard and Morrow, 2013). Human milk fat structure and composition are quite striking with high levels of saturated fatty acids, including 20-25% of palmitic acid, independent of the maternal diet or milk fat content (Innis, 2011). More than 50% of the human milk fatty acids at the sn-2 position of the triglyceride are palmitic acid, which represents 70% of the total palmitic acid present in human milk fat (Innis, 2011). This unique feature of human milk fat allows efficient digestion and absorption of saturated fatty acids and calcium, by limiting the formation of calcium fatty acid soaps which cause hardness of the stools and perhaps discomfort (Innis, 2011).

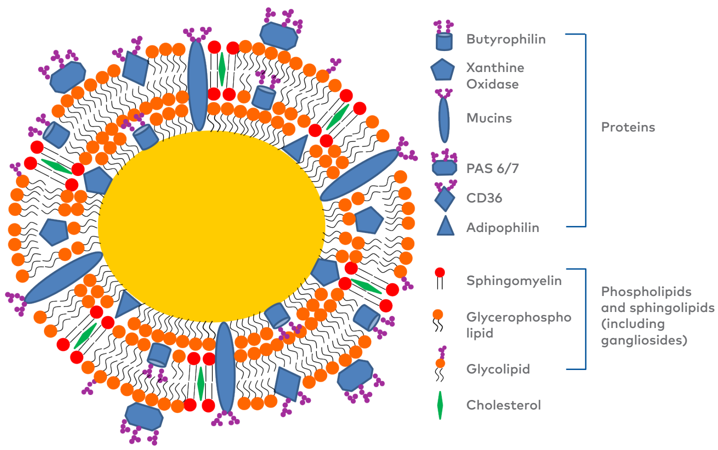
Breast milk also contains immunoglobulins, cytokines, growth factors, hormones, enzymes and non-protein nitrogen compounds such as nucleotides (Agostoni et al, 2009; Le Huërou-Luron et al, 2010; Ballard and Morrow, 2013), which contribute to infant gut maturation.

Human milk was considered sterile until recent studies showed that it contains staphylococci, streptococci, lactic acid bacteria and bifidobacteria. Most of them are probiotic bacteria and play a role in the colonization of the infant gut, contributing to the maturation of the immune system and protection against infections (Fernández et al, 2013).

BREAST MILK SECRETION AND STRUCTURE OF HUMAN MILK FAT GLOBULES

Lactation is a unique feature of all mammalian species (Oftedal, 2012). Lactose, proteins and fat are synthesized within the secretory cells of the mammary gland which are then packaged into secretory vesicles ready for release into the alveolar lumen (Sasaki et al, 1978; Oftedal, 2012).

The secretion of the milk fat globules is very unique. Lipid microdroplets are assembled in the secretory cells and are coated with a monolayer of phospholipids and proteins (Masedunskas et al, 2017). The microdroplets fuse together and the larger droplets are then pinched off from the secretory cell into the alveolar lumen, having been covered by the cell membrane bilayer. This results in a milk fat globule, with a mean diameter between 3 and 5 µm, covered by a trilayer of phospholipids, membrane proteins, cholesterol, and glycolipids such as gangliosides (Masedunskas et al, 2017).



(Gallier et al., 2014)

Figure 3. The complex structure and composition of the milk fat globule membrane.

BREAST MILK COMPOSITION INFLUENCED BY MATERNAL FACTORS

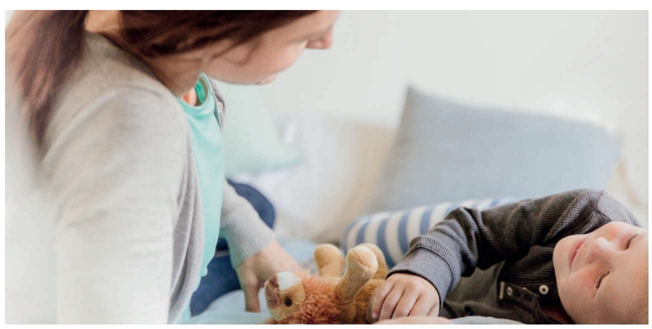
The maternal diet affects the fatty acid profile of breast milk, especially the content of the long-chain polyunsaturated fatty acids (LC-PUFAs) docosahexaenoic acid (DHA) and arachidonic acid (ARA) (Ballard and Morrow, 2013). Levels of DHA and ARA are affected by the maternal dietary intake of animal protein, in particular fish and seafood which contain high levels of LC-PUFAs in tissue lipids (Innis, 2014). A diet high in trans fatty acids from foods containing hydrogenated vegetable oils results in trans fatty acid levels higher than the typical level present in human milk (Innis, 2014). Some vitamins and minerals, such as vitamin A, vitamin D, some water-soluble vitamins (vitamins B6 and B12 and folate for example), iodine and selenium vary with maternal diet (Innis, 2014).

Linoleic acid (LA), phospholipid and gangliosides are affected by lactation stage and infant gender (Thakkar et al, 2013; Ma et al, 2015a; 2015b; 2017), whereas palmitic and oleic acids, the two main human milk fatty acids, are not affected by lactation stage or gender (Thakkar et al, 2013).

HMOs amount and composition vary between women but also with stage of lactation. Colostrum contains up to 20-25 g/L of HMOs, whereas mature milk contains 5-20 g/L (Bode, 2012). HMOs are made of sugars: glucose, galactose, N-acetylglucosamine, fucose and sialic acid (including N-acetylneuraminic acid) (Bode, 2012).

Conclusion

Breast milk has been designed by nature to meet the nutritional needs and support growth, immune function and development of the new born. Its composition and the structure of its components inspire infant formula development to ensure those infants not able to be breastfed can be offered a suitable alternative.



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