

Essential nutrition for babies

By Adrian Mainstone

Abstract

There is no doubt that human breastmilk is the perfect formulation for growth, development and the establishment of an infant's immunity. Sometimes breastfeeding is not an option so if a mother chooses to partially or totally feed her baby with formula there is no reason for her to feel guilty. The research that has been carried out by formula manufacturers ensures that a baby is fed the next best thing to breastmilk. If an infant is intolerant to either breastmilk or formula, a mother can be confident that there is an alternative suitable for her baby. This article examines some of the essential ingredients in breastmilk and lists the ingredients incorporated in formula feed as a comparison. It also identifies certain specialist feed for babies with ingredient intolerance.

Encouraging a mother to feed her baby with her own milk has its roots way back in history. In the first century, Aulus Gellius (c. A.D. 123-169), in his work entitled *The Attic Nights of Aulus Gellius*, recounts how he accompanied his friend, the philosopher Favorinus, to the home of a senator of noble birth where the birth of a newborn son had taken place. On arrival Favorinus enquired after details of the length and difficulty of the labour and on finding that the girl was asleep due to exhaustion, turned his attention to the girl's mother:

"I have no doubt, he said, 'that she will nurse the baby with her own milk'. But when the girl's mother said that her daughter should be spared this and that nurses were provided so as not to add the burdensome and difficult task of nursing to the pains of childbirth, he said, 'I pray you, woman, let her be completely the mother of her own child. What sort of half-baked, unnatural kind of mother bears a child and then sends it away? To have nourished in her womb with her own blood something she could not see, and now that she can see it, not to feed it with her own milk, now that it's alive and human, crying for its mother's attentions? Or do you think, he said, 'that women have nipples for decoration and not for feeding their babies?'" (Rolfe, 1927)

Being outspoken about the virtues of breastfeeding has echoed down through the avenues of time. But although opinion was then enrobed in the cloak of opinion, now it is

suited in the fashion of scientific research. With our current knowledge of genetics, and the manacles of political correctness, we may respond to Favorinus' observation of the cultural opinion of his day. He commented:

"But it's not important, I hear said, 'as long as the baby is alive and well-fed whose milk it drinks. Why in heaven's name corrupt that nobility of body and mind of the newborn human being, which was off to a fine start, with the alien and degraded food of the milk of a stranger? Especially if the person you use to supply milk is, as is often the case, from a foreign and barbarian nation, or if she is dishonest, or ugly, or immodest, or unchaste, or a drinker; usually the only qualification for the post is that of having milk'" (Rolfe 1927)

In Gallius's time it was breast versus wet nursing and today breast versus formula feed.

The National Institute for Health and Clinical Excellence (NICE) is an independent organization responsible for providing national guidance on promoting good health and preventing and treating ill health. NICE is committed to producing guidance that meets the needs of patients, carers and the public and involves patients, carers and the public in its development. NICE's patient, carer and public involvement policy seeks the views of patients, carers and the public, as well as doctors, nurses, other healthcare professionals and managers in their work (NICE, 2008). However, when accessing breastfeeding guidelines one is taken to the Babyfriendly Initiative organization's website. There is a heavy influence from the Baby Friendly Initiative on the one hand and numerous blogs from mothers who, for a variety of reasons, cannot or will not breastfeed and have written copiously to dissipate the sense of guilt many have succumbed to. This 'guilt' phenomenon is recognized by professionals and they seek to address this by proposing 'approaches for acting to prevent and to treat shame and guilt'. (Labbok, 2008) Although recognizing that mothers can experience physical reasons for not breastfeeding, the Baby Friendly Initiative responds with:

'Many new mothers who want to breastfeed give up in the early days because it is so painful or because they are told they are not producing enough milk, leaving them feeling inadequate and disappointed, and meaning the baby misses out on the invaluable benefits of breastfeeding.

Unfortunately, many midwives and health visitors have had little or no training in how to breastfeed, and so problems of "latching on" ... and failure to feed on demand ... is common, leading to mastitis, cracked or bleeding nipples, and an inadequate supply of milk.

Adrian Mainstone is Lecturer in Psychology and Health & Social Care and Freelance Writer

But given the right advice and help from the start by trained health professionals breastfeeding should be a painless experience, and problems of milk supply should rarely occur.’ (Unicef, 2008))

Midwives may take exception to their ‘lack of training’, but opinion does appear divided over whether every mother can physically breastfeed. However for many reasons it remains that breastfeeding, although the best method, is not always an option and the mother relies on her midwife for unbiased expert guidance. Choosing to use formula then becomes vital for the health of the baby. So what makes breastmilk so good and where breastfeeding is not an option, what does formula contain that will help keep their babies healthy?

As well as benefits during the lactation period, there are reported long-term benefits for the child such as immunity and a decreased risk of metabolic syndrome and obesity. There is also the suggestion that the cognitive development of breastfed babies is superior to artificially fed babies. (Savino and Lupica, 2006) However other research concludes that:

‘while breast feeding has many advantages for the child and mother, enhancement of the child’s intelligence is unlikely to be among them’. (Der et al, 2006)

Savino and Lupica (2006) also point out that the hormones and growth factors in breastmilk include leptin, ghrelin, insulin and the insulin-like growth factor (IGF-I) that functions in food intake regulation, metabolism and body composition. It is suggested that leptin may:

‘provide a physiological explanation for a number of advantages seen in reaching proper growth and energy balance in breastfed infants compared with formula fed ones’.

They also suggested that:

‘breastfeeding requires a supplementation of vitamin D and K for some months and a correct weaning program is needed from the 5th-6th months of life to prevent iron deficiency’.

With the exception of soy formula, most infant formula comes from cow’s milk that during the manufacturing process has been reconstructed with some components left out and others added.

Human milk is obviously designed to be the perfect formula to nourish human babies so to examine what makes it so effective for growth, development and immunity, its ingredients will be discussed.

As well as hormones, breastmilk facilitates infant growth with a series of nutrients such as protein, fats, carbohydrates, minerals, vitamins, and fluids. Elements for immunity are also supplied. (Lane, 2006).

Nutrients

Proteins

Proteins are the building blocks for human growth. Breastmilk contains lactalbumin, the albumin contained in milk and is obtained from whey, which is easily digested.

Fat

To help the baby gain weight quickly, breastmilk contains a

As well as benefits during the lactation period, there are reported long-term benefits [of breastfeeding] for the child such as immunity and a decreased risk of metabolic syndrome and obesity.

high fat content with a high calorific value. To help the fats breakdown for easy digestion, breastmilk contains lipase. Ironically, the higher cholesterol levels in breast milk may help protect against high cholesterol issues later in life (Lane, 2006)

Carbohydrates

A further supply of calories comes from carbohydrates. The primary carbohydrate is lactose but also there are additional sugars that may help to protect the baby’s digestive tract with a higher acid content to prevent bacteria thriving. A small number of infants may be intolerant to lactose.

Calcium-phosphorus

In order to grow healthy bones breastmilk contains a calcium-phosphorus ratio of 2:1. It also contains a low level of iron, an essential trace element and element of enzymes, which facilitates the transportation of gases.

Vitamins

Breastmilk contains most of the essential vitamins that are necessary for a baby’s development. Vitamin C along with lactose help babies digest iron better.

Fluid

Breast milk is also a source of fluid as it contains 87% water and so it is suggested (Lane, 2006) that feeding the baby additional water will decrease its desire to nurse.

Immunity

White blood cells

B-lymphocytes

Although a baby obtains a certain level of immunity via the placenta before birth, breastmilk contains a rich supply of antibodies which can be divided into two sections: white blood cells and other factors. In the former section, B-lymphocytes form ‘memory’ cells that recognize and target specific pathogens.

T-lymphocytes

T cells derive their name from their source of origin, the

thymus gland. They are part of the cell-mediated immunity system which, instead of involving antibodies, involves the activation of antigen-specific macrophages, and natural killer cells (NK cells). Their cytotoxicity will destroy malignant and infected cells.

Macrophages

The term macrophage means 'big eaters' and originates from the Greek word makros meaning 'large', and phagein meaning 'eat'. Their function is to phagocytose or engulf and then digest cellular debris and pathogens. They also stimulate lymphocytes and other immune cells for support.

Neutrophils

Neutrophils are neutrophil granulocytes and the most numerous type of white blood cell. Their name derives from their staining characteristics. When stained with hematoxylin and eosin, instead of turning dark blue or bright red, they stain a neutral pink. Within an hour of tissue injury they will, by a directional stimulus called chemotaxis, have migrated to sites of inflammation and when outside of the vascular system contribute towards the yellow/white appearance of pus (Cohen and Burns, 2002).

Other factors

Other molecules to be found in breastmilk include secretory IgA, bifidus factor, and oligosaccharides. Fatty acids, lactoferrin and mucins (Lane, 2006).

Secretory Immunoglobulin A (IgA)

IgA occurs in a higher quantity than the other antibody types combined. (Fagarasan and Honjo, 2003). The secretory form is present in colostrum and provides protection against pathogens in the baby by lining the mucosa of tear ducts, respiratory epithelium and the alimentary canal. Being resistant to the enzyme degradation of the gut, it survives to protect against the microbes that multiply in bodily secretions and preventing them transferring from the gut into a baby's system (Junqueira et al, 2003).

Bifidus factor

Bifidus factor (or bifidogenic factor) specifically enhances the growth of bifidobacteria in either a product or in the intestines of humans and/or animals. Bifidobacterium aids digestion and is associated with reducing allergies (Björkstén et al, 2001). They also prevent some forms of tumor growth (Guarner and Malagelada, 2003). In products, some bifid bacteria are being used as probiotics. Before the 1960s, bifidobacterium species were collectively referred to as 'lactobacillus bifidus'. Bifidus factors have subsequently been isolated and identified as amino-sugar-containing oligosaccharides and glycoproteins (Atkinson and Lonnerdal, 1989).

Oligosaccharides

An oligosaccharide is a saccharide polymer containing component or simple sugars that either stimulate or suppress intestinal microflora (Anon, 2006). They adhere to bacteria and other harmful cells to prevent them from attaching to mucosal surfaces (Lane, 2006).

Fatty acids

Fatty acids are acids produced when fats are broken down and can be used for energy by most types of cells. They can also help keep skin healthy and in later life help prevent early aging. They may even promote weight loss by helping the body process cholesterol and help rid the arteries of cholesterol build up. They also assist the adrenal and thyroid glands, which may also help regulate weight (Holetzky, 2008).

Lactoferrin

Lactoferrin is also found in tears and saliva and known as lactotransferrin (LTF). It is a multifunctional anti-microbial protein and plays an important role in a baby's immune system. It is at its highest concentration in colostrum followed by the subsequent human milk. It has a tendency to combine with iron and prevents harmful bacteria from using the iron to grow (Lane, 2006).

Mucins

Mucous cells have a dense 'sugar coating' that gives them considerable water-holding properties which secrete mucin. The mucosa traps pathogens inhibiting their activities.

Breastmilk alternative

Cow's milk is not suitable for human babies as the baby will have trouble digesting it due to its high level of saturated fat. It is also low in monounsaturates, the main fats in human milk. Formula is based on cow's milk but during manufacture all the fat is removed and the resulting skim milk is heated, then, if it is going to be in powdered form is dehydrated. New fats in the form of vegetable oil blends are added along with proteins, lactose and other nutrients, vitamins and minerals to similar levels found in breastmilk. As the proportion of casein to whey is higher in cow's milk than human milk, manufacturers reduce these proteins and add more whey to replicate breastmilk proportions. To prevent separation or decomposition of the mixture, further ingredients are added. For premature babies enhanced levels of nutrients are added to specialized formulas. Before marketing, all formulas are clinically tested and must comply with safety and nutritional standards.

To find out what formula contains, one has only to look on the packaging (*Table 1*). The standard first milk can have over 50 ingredients in specific quantities to provide a healthy diet as a non-breastfed baby can have. These formulas are the result of much scientific testing and research. However some babies have specific feeding problems such as being intolerant to lactose, gluten and cow's milk protein. To nourish these infants, specialist formulas have been meticulously researched and designed. A mother with such an infant should feel confident that her midwife can give sound advice and recognize the specific symptoms. For those babies unable to digest lactose, found in both breastmilk and formula, the symptoms are similar to those of colic but the tell-tale symptoms of lactose intolerance are a swollen abdomen and acidic diarrhoea (Infacol, 2008).

Infants with lactose intolerance or a milk protein allergy cannot drink standard cow's milk-based formula. Soy-

Table 1. Example contents of infant formula

Arachidonic acid	Arachidonic acid (AA, sometimes ARA) is an omega-6 fatty acid
Beta-carotene and selenium	Important dual function as nutrients necessary for immune modulation and as antioxidants
Biotin	Cofactor in the metabolism of fatty acids and leucine, and in gluconeogenesis
Calcium	Essential for cell physiology. A major material used in mineralization of bones
Carbohydrates	For storage and transport of energy (starch, glycogen) and structural components. Play major roles in the working process of the immune system, fertilization, pathogenesis, blood clotting, and development
Casein	Casein is the predominant phosphoproteins that account for nearly 80% of proteins in milk and cheese
Chloride	Essential metabolism (the process of turning the food you eat into energy). Helps keep the body's acid-base in balance. The amount of chloride in the blood is carefully controlled by the kidneys
Copper	An essential trace nutrient found primarily in the bloodstream and as a co-factor in various enzymes
Docosahexaenoic acid (DHA)	An omega-3 essential fatty acid
Fats	An important part of the human diet
Iron	An essential trace element and element of enzymes and facilitates transportation of gases
Fibre	Indigestible portion of plant foods that move food through the digestive system, absorbing water and easing defecation
Fish	Contains omega 3 fatty acids
Fluoride	Can act as enzyme inhibitors
Iodine	Essential for good thyroid function. Iodine deficiency during pregnancy and early infancy can result in severe motor impairments and irreversible mental retardation (cretinism)
Lactose	Disaccharide milk sugar consisting of molecules of galactose and glucose bonded together
LCPs (AA & DHA).	Long chain polyunsaturated essential fatty acids: AA- linoleic acid -omega 6 & DHA - docosahexaenoic acid Omega 3
Manganese	An antioxidant nutrient important in the breakdown of amino acids and the production of energy, the metabolism of Vitamin B-1 and Vitamin E and for activating digestion enzymes
Magnesium	Facilitates metabolic functions, muscle contraction and relaxation, energy production and transportation, synthesis of protein and assists enzyme function
Minerals	Chemical elements necessary for the health and maintenance of bodily functions.
Natural soya	A source of high quality protein that is low in saturated fats and is cholesterol free
Nucleotides	The structural units of DNA and RNA
Niacin	Multifunctional organic compound involved in cell metabolism, DNA repair, and the production of steroid hormones in the adrenal gland
Phosphorus	Component of DNA and RNA
Polyunsaturates	Component part of the fats and oils in our food comprising of a combination of fatty acids and glycerol
Potassium	Important in neural impulses, muscle contraction and in maintaining fluid and electrolyte balance
Prebiotics	Carbohydrates such as oligosaccharides that promote the growth of beneficial colonic bacteria
Protein	The building blocks of cells and therefore human growth due to their ability to bind specifically tightly to other molecules
sIgA	Plays an essential role in mucosal immunity
sIgG	Binds to and neutralizes the toxins of pathogens
Sodium	Sodium ions are essential for blood and body fluid regulation, metabolic functions, heart activity and nerve impulse transmission
Taurine	A non-essential amino acid which is the key component of bile, strengthens cardiac contractility and boosts vision
Vegetable oils	Source of unsaturated fat
Vitamin A	Helps maintain the health of skin and mucus linings, strengthens immunity from infections and vision in dim light
Vitamin B – choline	Required for liver and gall bladder regulation, metabolism, preventing fat accumulation in the liver and other organs and transmission of nerve and brain impulses
Vitamin B1 – thiamine	Converts carbohydrates into energy and is essential for the functioning of the heart, muscles, and nervous system

Table 1. Example contents of infant formula (continued)

Vitamin B2 – riboflavin	Plays a key role in energy metabolism and is required for the metabolism of fats, carbohydrates, proteins and ketone bodies
Vitamin B5 – pantothenic acid	Helps to prevent acne and improves hair care
Vitamin B6	Plays a vital role as the cofactor of a large number of essential enzymes
Vitamin B9 – folic acid	Generates new cells and can prevent major spinal or brain birth defects
Vitamin B12	Important in blood formation, brain and nervous system function, the metabolism of all body cells and affects DNA synthesis and regulation. Also in fatty acid synthesis and energy production
Vitamin C	An essential nutrient for metabolic reactions, is a cofactor in several vital enzymatic reactions and protects the body from oxidative stress
Vitamin D	Regulates the calcium and phosphorus levels in the blood, promotes bone formation and mineralization, inhibits parathyroid hormone secretion, promotes phagocytes, anti-tumour activity and immunodulatory functions
Vitamin D3 – cholecalciferol	Involved in bone formation
Vitamin E	Helps to protect cell membranes by acting as an antioxidant
Vitamin K	Involved in blood clotting, wound healing and bone strengthening
Whey	Contains lactose, vitamins, minerals and fat. It can help regulate blood sugar levels by increasing insulin secretion
Zinc Sulphate	Essential for growth, good vision and helps with the senses of taste and smell

Definitions from Wickipedia.org; eatwell.gov.uk/healthydiet/nutritionessentials/; nlm.nih.gov/medlineplus/; vegansociety.com; Scientific Advisory Committee on Nutrition; anewlife.co.uk/

based formulas do not contain milk protein. Formulas for premature and low birth weight infants have extra calories and minerals to meet their needs. There are other specialized formulas, such as those for infants with heart disease, malabsorption syndromes, inability to digest fat, and other conditions. (O'Reilly, 2007)

Details of comparisons between different brands of specialized infant formula are published online by the Scientific Advisory Committee on Nutrition (2003): http://www.sacn.gov.uk/pdfs/smcn_03_06.pdf.

There is no doubt that human breastmilk, being specifically designed for human babies, is perfect for infant growth and development, however, formula should not be ignored just because it is not breastmilk. All mothers should be given correct information to enable them to make an informed feeding method decision. There are a number of reasons why mothers choose not to continue with breastfeeding and they should not feel guilty. If an infant is intolerant to either breastmilk or formula, a mother can be confident that there is an alternative suitable for her baby.

BJM

Atkinson, SA, Lönnerdal, B (1989) Protein and Non-Protein Nitrogen in Human Milk, CRC Press, ISBN:0849367956

Anon (2006) *Oligosaccharide*. <http://www.bookrags.com/wiki/Oligosaccharide> [Accessed 27 August 2008]

Björkstén B, Sepp E, Julge K, Voor T, Mikelsaar M (2001) Allergy development and the intestinal microflora during the first year of life. *Journal of Allergy and Clinical Immunology* **108** (4): 516–520

Cohen S, Burns RC (2002) Pathways of the Pulp 8th edn. St. Louis: Mosby, Inc: 465

Der G, Batty GD, Deary IJ (2006) Effect of breast feeding on intelligence in children: prospective study, sibling pairs analysis, and meta-analysis. *BMJ* doi:10.1136/bmj.38978.699583.55

Fagarasan S, Honjo T (2003) Intestinal IgA Synthesis: Regulation of Front-line Body Defenses. *Nat. Rev. Immunology* **3**: 63–72. doi:10.1038/nri982.

Guarner F, Malagelada JR (2003) Gut flora in health and disease. *The Lancet* **361**(9356): 512–519

Holetzky S (2008) What are fatty acids? <http://www.wisegeek.com/what-are-fatty-acids.htm> [Accessed 24 July 2008]

Infacol (2008) Lactose intolerance <http://www.infacol.co.uk/lactose-intolerance.cfm> [Accessed 24 July 2008]

Junqueira LC, Kelley RO, Carneiro J (2003) Basic Histology, McGraw-Hill. ISBN 0838505902

Labbok M (2008) Exploration of Guilt Among Mothers Who Do Not Breastfeed: The Physician's Role. *Journal of Human Lactation* **24**(1): 0–4

NICE (2008) <http://www.nice.org.uk/nicemedia/pdf/PH011guidanceword.doc>

Lane B (2006) Breast milk – Best food for baby. http://pregnancychild-birth.suite101.com/article.cfm/breastmilk__the_best_food_for_baby [Accessed 27 August 2008]

O'Reilly (2007) *Infant formulas*. <http://www.nlm.nih.gov/medlineplus/ency/article/002447.htm> [Accessed 27 August 2008]

Rolfe JC (1927) The Attic Nights of Aulus Gellius. Loeb Classics Edition Translated by John Rolfe in 1927: Harvard University Press

Savino F, Lupica MM (2006) Breast milk: biological constituents for health and well-being in infancy. *Recent Prog Med.* **97**(10): 519–27

UNICEF (2008) Baby Friendly Initiative [http://www.babyfriendly.org.uk/items/item_detail.asp?item=402&nodeid=\[Accessed 23 July 2008](http://www.babyfriendly.org.uk/items/item_detail.asp?item=402&nodeid=[Accessed 23 July 2008)

Key Points

- Breastfeeding, although the best method, is not always an option for some mothers.
- Breast milk is obviously designed to be the perfect nutrition fro babies.
- Formula feeding should not be ignored just because it not breastfeeding.
- Formulas are the result of much scientific testing and research.

Copyright of British Journal of Midwifery is the property of Mark Allen Publishing Ltd and its content may not be copied or emailed to multiple sites or posted to a listserv without the copyright holder's express written permission. However, users may print, download, or email articles for individual use.