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Dietary fat Quality and Infant Nutrition

Sheila M. INNIS

Department Pediatrics, University Of British Columbia,
950 West 28th Avenue, Vancouver, B.C., Canada V5Z 4H4

Fat is of major siginficance in infant nutrition as a source of energy, representing about 45-50% energy in human milk and formula, and of fatty acids for growth of membrane lipids and adipose tissue. The composition of fat in the infant diet is known to influence the composition of developing organ lipids, and in tissues such as the central nervous system (CNS) deficiency of essential n-6 and n-3 fatty acids may have effects on maturing functions which are not readily reversed.

The fat composition of human milk has been extensively studied. The major component is triglyceride (98%), with smaller amounts of phospholipid (1.3%) and cholesterol (0.4%). The major fatty acid components are (% total) palmitic acid (16:0) 20-25%, stearic acid (18:0) 5-8%, oleic acid (18:1) 30-37%, linoleic acid (18:2n-6) 10-16%, linolenic acid (α 18:3n-3) 0.2-0.5%, arachidonic acid (20:4n-6) 0.3-0.7%, and docosahexaenoic acid (22:6n-3) 0.2-0.9%. Medium chain fatty acids 8:0, 10:0, and 12:0 usually represent <0.5%, 1.0% and 4%, respectively and 14:0 about 6-8% total fatty acids. Levels of 20:4n-6 and 22:6n-3 are very high in the non-myelin memranes of CNS. Decreades 20:4n-6 and 22:6n-3 in the CNS of developing animals, casused by feeding diets deficient in 18:2n-6 or 18:3n-3, resepectively has been found to cause altered learning and visual functions. The adequacy of infant diets with regard to n-6 and n-3 fatty acids for CNS growth is, therefore, of particular importance.

The fat in infant formula is a blend of one or more vegetable oils sometimes with the inclusion of animal fat. The fat blend determines the composition and relative proportions of saturated, monounsatured and n-6 and n-3 fatty acids. In general, the blood lipids of infants fed infant formulas or human milk reflect the differences in fatty acid composition of the formula or milk diet. How these differences in circulating blood lipids relate to the composition of developing organ lipids cannot be determined in the human. The suitability of various fat blends to support structural lipid growth in the CNS and liver, adipose depot fat, and the effects on blood lipid fatty acids has been studied in piglets. This species has a similar natural milk composition, perinatal brain growth and lipid metabolism to the human.

Formula with fat blends supplying about 1.7% Kcal 18:3n-3 from soybean or canola oil supported appropriate deposition of 22:6n-3 in the piglet brain, its synaptic terminal membrandes and retina. Fat blends with about 0.3% Kcal 18:3n-3 from corn or high oleic sunflower blends supplied inadequate levels of n-3 fatty acids for normal CNS compositional growth. Cerebrum, but not body, weight and brain and liver saturated fatty acid 16:0 was lower in piglets fed formulas with high 18:3n-3 from soy or canola oils. All of these formulas contained saturated fat from coconut oil (12:0+14:0) as is found in some term infant formula products, rather than 16:0 as is found in milk.

Studies comparing the effect of saturated fatty acid chain length in infant formula have now shown that metabolism and tissue assimilation of n-6 and n-3 fatty acids is influenced by the dietary non-essential fatty acid components. Piglet adipose tissue 8:0, 12:0, 14:0, 16:0, 18:1, 18:2n-6 and 18:3n-3 were positively correlated ($p<0.01$) with the proportion of the particular fatty acid in the milk or formula diet. Platelet fatty acids were positively correlated with plasma lipid fatty acids, which in turn also correlated with the formula or milk fat composition. Formulas low in 16:0 with saturated fat from MCT or coconut oil, (8:0+10:0, 12:0+14:0) with 18:1, 18:2n-6 and 18:3n-3 from canola oil resulted in decreased platelet counts and increased platelet volumes. When canola oil was blended with palm oil or structured triglycerides containing 16:0 the platelet characteristics were normal. Blood and liver lipid 18:1, n-6 and n-3 fatty acid compositions also resembled that of the milk fed piglets more closely when the fat blends supplied similar proportions of 16:0 to milk than when shorter chain fatty acids were fed with similar amounts of 18:1 and 18:2n-6 in the formula.

These studies show that in order to achieve appropriate lipid biochemistry of developing tissues, formulas should provide a similar non-essential saturated and monounsaturated fatty acid composition to milk, as well as adequate levels of n-6 and n-3 fatty acids. The requirements of the developing term gestation piglet brain and retina for n-6 and n-3 fatty acids seems to be met by vegetable oils like soybean and canola oil when blended to give 5% or more Kcal 18:2n-6 and about 1% Kcal 18:3n-3. Canoal oil offers advantage in that it contains high proportions of 18:1 and modest 18:2n-6, similar to milk. Such vegetable oils, however, must be blended with appropriate saturated fats in order to prevent excess unsaturated fat levels in tissues, and possible changes in platelet characteristics.