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Effect of lactation period on fatty acid profile of breast milk

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Abstract

The study compares the fatty acid profiles of breast milk from full-term (FT) and pre-term (PT) infant mothers. Using gas-chromatographic technique, the breast milk secreted during the 1st and 4th weeks of lactation were used to analyse fatty acid composition. Myristic (C_{14}), palmitic (C_{16}), oleic ($C_{18:1}$) and linoleic ($C_{18:2}$) acids were the predominant fatty acids found in both FT and PT milk samples. FT milk, however contained higher percentages of unsaturated fatty acids ($C_{18:1}$ and $C_{18:2}$) when compared to PT milk samples ($P<0.05$). Saturated fatty acids generally decrease as lactation period increases in both PT and FT mothers' milk. Lactation period was found to have a significant effect on fatty acid profiles of mothers' milk. The high content of polyunsaturated fatty acids in the mothers' milk will be of advantage in terms of both energy needed for growth and nervous system development for both the PT and FT.

Key words: Lactation, fatty acid profile, neonates.

Introduction

With the recent resurgence of interest in breast-feeding, the quality of milk being secreted by the infant's mothers becomes very important. This is because the babies are expected to feed exclusively on breast-milk for at least six months. Breast-milk of a well nourished mother is believed to offer optimum physiological nourishment for her offsprings[1].

One of the qualities of breast-milk is the fat content. Milk-fat serves as source of energy, carrier of fat-soluble vitamins and also provides the essential fatty acids such as linoleic, oleic and arachidonic acids, which are needed for the development and growth of central nervous system or tissue[2]. Furthermore, the higher fat in the colostrum has been shown to act as a physico-chemical appetite control for the suckling baby [3].

Earlier estimates of fat content in breast-milk from well nourished communities of the United States of America and Britain gave an average of 0.045-0.048 g/ml [4,5]. However, results from poorly fed women in developing countries showed considerable variation and could sometimes be as low as 0.01 g/ml [6]. This shows a drastic reduction in the energy content of milk, which may result in protein-energy malnutrition (PEM) in the infants[7].

The fat content and the fatty-acid profile of breast-milk can be altered to some extent without affecting the milk volume by variation in the types of dietary fat [8]. The study showed that the milk fat resembled the fatty-acid pattern of dietary fat.

With greatly improved survival of premature babies, considerable attention has been directed at the type of milk best suited for their nutritional needs. The reports[9] showed that the concentration of protein is greater in expressed milk of women that delivered prematurely than in the milk of those who delivered at full term. Previous reports also confirmed the above among Nigerian mothers of pre-term (PT) and full-term (FT) babies[10]. However, information is scanty on the influence of pregnancy duration on fatty acid profile of breast milk particularly among Nigerian mothers. This study is therefore designed to investigate the fatty acid profile of breast milk in the first 4 weeks (28 days) of lactation, from both the pre-term (PT) and full-term (FT) mothers in Ile-Ife, Nigeria.

Materials and methods

Sample collection: Ten healthy lactating mothers (patients of Obafemi Awolowo University Teaching Hospital, Ile-Ife) volunteered to give breast-milk samples for the first 28 days after deliveries. This sampling period was chosen because milk secreted after four weeks (i.e 28 days) of lactation is believed to be relatively constant in composition [7]. Five of them gave birth at the 29th week while the other five gave birth at 40th week. For a period of 28 days, daily sample collections were done. Milk samples (2 ml) were obtained manually from each mother that gave birth prematurely, given a total collection of 123 samples (instead of 140 samples due to the death of one of the baby at 3 weeks after delivery). Also, five full-term infants' mothers gave a total collection of 140 samples. All births were single.

The container used for the sample collection is made of plastic material, sterilized with a screw cap. The samples were collected from the first expression done in the morning, and stored in the freezer at temperature of -20°C. At the end of sampling period, one week samples were pooled together. This was done for the first week lactation (i.e 1st -7th day delivery) and likewise for the fourth week secretion (i.e 21st -28th day of delivery). One-tail t- test at 95% confidence interval was used to test for any significant difference between the 29 days. As a result of pooling the samples, two groups emerged for each kind of milk (i.e. PT and FT). From each of these groups, aliquots were taken for milk-fat extraction.

***Milk-fat extraction and methylation*:** Milk-fat in a 20 ml sample was extracted in a mixture of diethyl ether and petroleum ether solution (1:1 vol/vol) and evaporated to dryness over hot water bath. Methylation of the fat was done according to the procedure of Guthrie et. al.[11]. Samples were methylated using 100 ml solution of 1% H_2SO_4 in methanol, refluxed for 1 hour, saturated with NaCl and then extracted in a separating funnel.

An appropriate quantity of methyl-esters were injected into gas-chromatography instruments (Varian 3700 model). The operation conditions of the instrument were according to the procedure of Insull et al.[12].

Table 1. Percentage composition of fatty acids identified in pre-term (PT) and full-term (FT) mothers' milk at first week of lactation.

Fatty acids	Percentage composition	
	PT	FT
Myristic (C14)	17.04 ± 2.11	7.66 ± 1.82
Palmitic (C16)	46.64 ± 3.30	40.32 ± 3.12
Palmitoleic (C16:1)	Trace	Trace
Stearic (C18)	Trace	Trace
Oleic (C18:1)	31.61 ± 3.21	39.92 ± 3.01
Linoleic (C18:2)	4.71 ± 1.92	12.10 ± 1.92
Linolenic (C18:3)	Trace	Trace
Ratio of unsaturated to saturated fatty acid composition	0.57	1.08

Table 2. Percentage composition of fatty acids identified in pre-term (PT) and full-term (FT) mothers' milk at fourth week of lactation.

Fatty acids	Percentage composition	
	PT	FT
Myristic (C14)	7.27± 1.01	4.62 ± 0.94
Palmitic (C16)	49.09 ± 2.01	30.77 ± 1.88
Palmitoleic (C16:1)	Nil	Trace
Stearic (C18)	Trace	Trace
Oleic (C18:1)	40.00 ± 1.97	46.15 ± 2.01
Linoleic (C18:2)	3.64 ± 0.64	18.46 ± 1.72
Linolenic (C18:3)	Trace	Trace
Ratio of unsaturated to saturated fatty acid composition	0.78	1.82

Results and Discussion

Although, both kinds of breast milk were found to contain similar pattern of fatty-acids, the relative proportion was however significantly ($P<0.05$) different as shown in Tables 1 and 2.

PT milk samples generally showed higher percentage of saturated fatty-acid than FT milk during the first and fourth weeks of lactation. The higher percentages of saturated fatty acids in PT milk over FT milk could be advantageous to the neonates (PT babies) since they serve as body insulator when deposited at the adipose tissue of the skin, thereby conserving the much needed heat by the neonates.

Previous reports have shown that daily energy requirement of FT babies is about 92 kcal/kg b.wt/day compared with a total energy requirement of 150 kcal/kg b.wt/day for PT babies[13]. Calorie requirement of a newborn however depends on baby metabolic need, physical activities, fecal loss, specific dynamic action (SDA) and growth among other factors[14].

Unsaturated fatty acids were found to increase in both PT and FT milk samples during the fourth week of lactation. The predominant unsaturated fatty acids were oleic ($C_{18:1}$) and linoleic ($C_{18:2}$) acids while linolenic ($C_{18:3}$) were only present in trace amounts (Table 2). The increase in unsaturated fatty acids may be due to a reduction in the endogenous production of saturated fatty acids. The unsaturated fatty acids ($C_{18:1}$ and $C_{18:2}$) that were found to be predominant in both PT and FT milk samples may be a reflection of the dietary fat of the lactating mothers as earlier reported [10-13]. It is worthy to note that the common cooking oils in the geographical location where this study took place is mostly vegetable oils derived from palm tree, melon-seed and peanut origins. These vegetable oils have been reported to contain high percentages of polyunsaturated fatty acids. Also, an increase in polyenoic acids (unsaturated fatty acids) of breast milk due to substitution of corn oil for lard in the maternal diet had earlier been reported [8]. FT milk generally contains higher essential fatty acid ($C_{18:2}$) concentration than PT milk during the first 4 weeks of lactation and deficiency of linoleic acid may result in growth failure and skin lesions. However, unsaturated fatty acids have been reported to be well absorbed by infants [14], though PT infants malabsorb fats when compared with FT infants.

Conclusions

This study showed that fatty acid profile of FT milk is markedly different from that of PT milk. The higher content of polyunsaturated fatty acids, as shown by the profiles, is of advantage since they have been implicated in the infants' nervous system development [15]. Also, high energy content observed in PT milk is advantageous; it meets the energy requirement of the neonates. Hence lactation period significantly affects the fatty acid composition of human breast milk during first four weeks of lactation.

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