Fatty Acid Composition of Taiwanese Human Milk

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Background: The purpose of this study was to analyze quantitatively the fatty acid composition of the milk of Taiwanese women.

Methods: Two hundred and sixty-nine human milk specimens were obtained from 240 Taiwanese mothers, aged 19–41 years, and subjected to chromatographic analysis.

Results: Milk specimens were pooled by the mothers' districts of residence and lactation stages, at 0–11 days, 22–45 days, 46–65 days and 66–297 days after delivery. The fatty acid composition was expressed as weight percentage of all fatty acids detected with C8–C24 chain length. More than 80% of the fatty acids were composed of lauric, myristic, palmitic, stearic, oleic and linoleic acids. The amount of saturated fatty acid was 36.7%. With regard to essential fatty acids, the amount of linoleic acid (LA) was 22% and that of linolenic acid (ALA) was 1.8%, both levels being higher than in human milk from Western countries. However, the ratio of LA/ALA remained at 13:1 for the whole duration of lactation. It has been reported that mothers with high fish consumption have a high content of docosahexaenoic acid and eicosapentaenoic acid in their milk, and we found this phenomenon occurring in our study. The percentage of docosahexaenoic acid and eicosapentaenoic acid in Taiwanese human milk was 0.79% and 0.17%, respectively.

Conclusion: Fatty acid composition in human milk varies during lactation. With regard to essential fatty acids, the amount of LA was 22% and that of ALA was 1.8%, both levels being higher than in human milk from Western and other Asian countries. [*J Chin Med Assoc* 2010;73(11):581–588]

Key Words: docosahexaenoic acid, fatty acid, human milk, polyunsaturated fatty acid

Introduction

During the first 4–6 months of life, breast milk is recommended as the first choice of food for infants.[1] Breast milk is considered the ideal food for healthy infants born at term because it meets the nutritional necessities for babies at this time. During this crucial period, an infant accumulates up to 1,500–1,600 g of lipid,[2] which represents about 90% of all energy retained in the growing tissue. This lipid accumulation not only serves as an exchangeable energy store in adipose tissue, but also has a structural function in all tissues.[3] The biological significance of fatty acid composition of human milk for newborns and their development has led to widespread investigation. Recently, the role of long-chain polyunsaturated fatty acids (LCPUFAs) has drawn special attention because of the potential source of anatomic and functional development of the central nervous system in early life.[4] Linoleic acid (LA; C18:2 n-6) and linolenic acid (ALA; C18:3 n-3), for instance, are converted to LCPUFAs. These metabolites of the n-6 and n-3 series of fatty acids have been shown to affect the biophysical state of the cell membrane,[5,6] and to be an important precursor of prostaglandins.[7]

Although there have been many studies on fatty acid composition of human milk from Western countries, there is little information about that in the Taiwanese population. The nutritional status, cultural traditions, geographic region, socioeconomic status, and dietary habits of Taiwan are completely different from those found in Western countries. These differences might affect the fatty acid composition of human milk. In this study, we analyzed the fatty acid composition of Taiwanese human milk.

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Methods

Three hundred and three human milk specimens were obtained from 240 mothers aged between 19 and 41 years, who were living in Taipei, northern Taiwan and Kaohsiung, southern Taiwan. The predetermined conditions were as follows: (1) the milk specimens were collected between 10:00 hours and 18:00 hours to avoid circadian changes; (2) delivery was normal, and the baby was not born with a low birth weight; (3) the baby was healthy and growing well; and (4) the mother was healthy and had a balanced diet. We selected 264 milk specimens because 39 specimens did not meet all the standards above. We prepared 32 pooled milk samples according to lactation periods and the districts where the mothers lived. There were no statistical differences among the groups, except for lactation days (Table 1). Informed consent was obtained from the participants, and our study was approved by the Taipei Veterans General Hospital Institution Review Board.

Total lipids were extracted from 3-mL human milk samples with 20 mL methanol/chloroform (1:2 vol/vol). Fatty acid methyl esters were prepared with addition of 1 mL 2N KOH/methanol to the lipid fraction, and dissolved in *n*-hexane. Chromatographic analysis was performed with a Hewlett Packard type HP5890 chromatograph (Hewlett Packard, Wilmington, DE, USA), equipped with a fused silica DB-WAX capillary column (0.25 mm × 30 mm; J and W Scientific, Folsom, CA, USA) and Flame Ionization Detector (Hewlett Packard), under the following conditions: the column temperature was programmed at 140–230°C at an increasing rate of 2°C per minute; helium was used as a carrier gas at 1 mL/min flow rate; the injection temperature was 250°C; and the split ratio was 70:1.

Independent samples *t* test was used for statistical analysis. A p value < 0.05 was considered to be statistically significant.

Results

Our method allowed for sensitive analysis of 48 fatty acids by gas chromatography. The distribution and variation of fatty acids during lactation is shown in Table 2. The results were similar to the normal distribution for major fatty acids. More than 80% of the total fatty acids were composed of C12:0 (lauric acid), C14:0 (myristic acid), C16:0 (palmitic acid), C18:0 (stearic acid), C18:1n-9 (oleic acid) and C18:2n-6 (LA). Among the saturated fatty acids, we noted increases in the proportion of C10:0, C12:0 and C18:0, and decreases in C14:0 and C16:0 during lactation days 46–65 (Figure 1). The major saturated fatty acid, palmitic acid (C16:0), constantly accounted for 20% of total fatty acids. For the unsaturated fatty acids, the proportions of C18:2n-6, C18:3n-6, C18:3n-3 (ALA) were increased, and C20:3n-6, C20:4n-6 (arachidonic acid; AA), C22:4n-6 and C22:6n-3 (docosahexaenoic acid; DHA) were decreased from lactation days 0–7 to 46–65 (Figure 2). The proportion of C18:1n-9 (oleic acid) was 28% of the unsaturated fatty acids. Fluctuation of the proportion of C20:5n-3 (eicosapentaenoic acid; EPA) from lactation days 0–7 to 46–65 was found and remained stable thereafter. It comprised approximately 0.2% of the total fatty acids. Most of the other proportions of minor fatty acids were higher at lactation days 0–7. With regard to essential fatty acids, our data showed high proportions of LA and ALA, and the ratio of LA to ALA was higher in the 1st week of lactation. The total ratio of n-6 series LCPUFAs increased, while the ratio of the n-3 series was decreased throughout lactation.

When comparing the breast milk of women living in Taipei with those living in Kaohsiung, the proportions of EPA and DHA were significantly higher in women living in Kaohsiung than in those living in Taipei (Figure 3). However, there was no difference in the other fatty acids, including LA.

Discussion

Studies on the fatty acid composition of human milk from mothers in a variety of geographical locations have been reported. It is well documented that the fatty acid composition of human milk is affected by dietary habits.[8–10] Dietary differences between different

Table 1. Basic information of the mothers and infants

Lactation period (d)	Specimens (*n*)	Age of mothers (yr)	Birth weight (g)	Order of birth
0–11	63	30.0	3,280	1.6
22–45	76	31.6	3,231	1.7
46–65	36	31.6	3,236	1.6
66–297	69	31.8	3,261	1.6