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Physicochemical composition of human milk at 0 to 4 months and its relationship with maternal diet and microbial content

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INTRODUCTION & AIM

It is difficult to specify the exact composition of human milk because it's composition changes. It varies with stage of lactation, breastfeeding pattern, gestational age, and parity. Maternal nutrition is an obvious variable that can influence human milk composition. More in-depth studies should be made on appreciating the potential effects of the environment such as maternal diet, maternal characteristics such as weight and age, postpartum time, breastfeeding behaviors, genetics, maternal health etc. on milk composition. Thus, the physicochemical composition of human milk (total protein, total fat, moisture, ash, pH, total soluble solids, and carbohydrate) from Filipino women with varied body mass indices (BMIs) and its correlation with the mother's diet and microbiological content (total plate count, Staphylococcus, lactic acid bacteria, and Bifidobacteria) were assessed at 0 to 4 months of lactation. The data generated may be used in planning and modifying nutritional recommendations for lactating Filipino women in the future. Information as to whether breast-feeding women are consuming diets adequate to support the ideal physicochemical and microbial characteristics of breast milk must always be available and monitored regularly. These data may be used in formulating dietary guidelines or updating dietary reference intakes such as the Philippine Dietary Reference Intakes (PDRI).

METHOD

Breast milk samples, sociodemographic data, and dietary recalls were gathered from 34 healthy breastfeeding Filipino women who were categorized based on their BMIs (underweight n=7; normal weight n=16; overweight n=11) using a cohort, semi-longitudinal study design. The proximate (total protein, total fat, moisture, ash, & carbohydrate by difference), physicochemical (pH and total soluble solids [TSS]) and microbial (total plate count, *Staphylococcus aureus, Lactobacillus spp,* Bifidobacteria *spp*, total coliform and *Escherichia coli*) compositions of the human milk samples were analyzed. All 34 lactating participants were interviewed three times each month for their 24-hour food recalls. Descriptive statistics were used to describe the study population, physicochemical and microbial characteristics of the milk samples, and the dietary intake of the participants. Pearson's Chi-square was utilized to determine the association between variables.

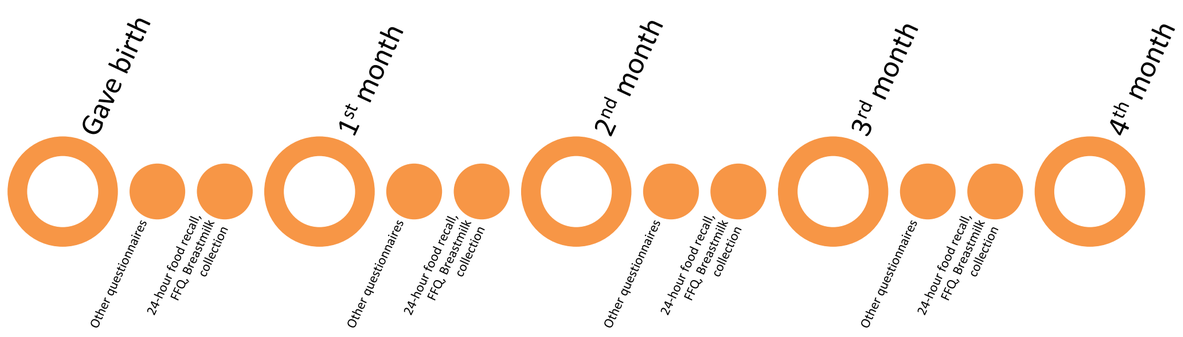

Figure 1. Breast milk and data collection points during the 4 months study period.

RESULTS & DISCUSSION

Table 1. Characteristics of the participants (n=34).

Characteristics	All (n=34)
Classification per BMI	
Underweight	7 (20.59%)
Normal weight	16 (47.06%)
Overweight	11 (32.35%)
Age (years old)	25.59 ±4.71
Household size	6.00 ±2.82
Female in the household	3
Male in the household	3
Female:Male Ratio in the household	1:1
Occupation	
Homemakers	28 (82.35%)
Self-employed	2 (5.88%)
Employed (Full time)	4 (11.77%)
Civil Status	
Married	8 (23.53%)
Cohabitation	26 (76.47%)
Number of children (other than the newborn)	
0	7 (20.59%)
1 – 2	22 (64.70%)
3 – 4	5 (14.71%)
Parity (years)	1.41 ±1.10
Frequency of the household to eat out per month	2.32 ±1.57
Number of meals consumed by the household per day	4.44 ±0.82
Usual cooking method employed by the household	
Fry	18 (52.94%)
Sauté	4 (11.77%)
Boil	11 (32.35%)
Grill	1 (2.94%)

Table 1 shows the characteristics of the participants (n=34). In terms of BMI classification, 47.06% of the participants were of normal weight, 32.35% overweight, and 20.59% underweight. Most of the participants had 2-3 children with parity of 1.41 ±1.10 years. All participants have an average of 6.00 ±2.82 household members with equal numbers of male and female in the household. Their households consume on the average 4 meals per day with frying as the major cooking method.

RESULTS & DISCUSSION

Table 2. Measures of physicochemical properties of human milk.

Physicochemical properties of breastmilk	Month 1			Month 2			Month 3			Month 4		
	UW (n=7)	NW (n=16)	OW (n=11)	UW (n=7)	NW (n=16)	OW (n=11)	UW (n=7)	NW (n=16)	OW (n=11)	UW (n=7)	NW (n=16)	OW (n=11)
Total Carbohydrates (%)	9.23 ±2.09[x]	8.78 ±1.02[x]	8.75 ±1.54[x]	8.32 ±0.67[x]	8.58 ±1.16[x]	9.13 ±1.80[x]	8.59 ±1.22[x]	8.98 ±1.57[x]	8.81 ±1.55[x]	8.18 ±1.48[x]	8.20 ±0.80[x]	8.51 ±0.62[x]
Total Fat (%)	2.44 ±0.99[x]	2.62 ±0.74[x]	2.42 ±0.87[x]	2.41 ±1.49[x]	2.42 ±0.88[x]	2.04 ±0.67[x]	2.43 ±0.99[x]	2.34 ±1.14[x]	1.39 ±0.37[y]	1.94 ±0.90[x]	2.37 ±0.78[x]	2.17 ±0.93[x]
Total Protein (%)	1.49 ±0.25[x]	1.58 ±0.39[x]	1.38 ±0.38[x]	1.24 ±0.27[x]	1.28 ±0.22[x]	1.16 ±0.21[x]	1.32 ±0.23[x]	1.16 ±0.14[y]	1.16 ±0.24[y]	1.17 ±0.17[x]	1.17 ±0.22[x]	1.24 ±0.26[x]
Ash (%)	0.26 ±0.11[x]	0.25 ±0.15[x]	0.21 ±0.05[x]	0.18 ±0.03[x]	0.20 ±0.04[x]	0.19 ±0.21[x]	0.21 ±0.04[x]	0.19 ±0.03[x]	0.20 ±0.02[x]	0.19 ±0.03[x]	0.19 ±0.05[x]	0.19 ±0.04[x]
Moisture (%)	86.57 ±1.63[x]	86.77 ±1.14[x]	87.25 ±1.01[x]	87.85 ±1.96[x]	87.49 ±1.36[x]	87.47 ±1.47[x]	87.45 ±1.96[x]	87.43 ±1.77[x]	88.45 ±1.41[x]	88.52 ±2.41[x]	88.08 ±1.05[x]	87.88 ±0.86[x]
pH	6.87 ±0.34[y]	7.01 ±0.39[x]	6.66 ±0.38[z]	6.87 ±0.43[x]	6.81 ±0.43[x]	6.57 ±0.38[y]	6.44 ±0.26[y]	6.81 ±0.32[x]	6.65 ±0.30[x]	6.51 ±0.17[y]	6.70 ±0.30[x]	6.77 ±0.37[x]
Total soluble solids (TSS) °Bx	10.12 ±0.46[x]	9.54 ±1.40[x]	10.17 ±0.49[x]	9.69 ±0.38[y]	9.75 ±0.40[y]	10.23 ±0.67[x]	10.71 ±1.19[x]	9.67 ±0.37[y]	9.62 ±0.38[y]	9.55 ±0.79[y]	9.68 ±0.68[y]	10.08 ±0.63[x]

[xyz] Values in the same row bearing different letters are significantly different at $p \leq 0.05$ (per weight classification per month)

The results of the physicochemical analyses of the milk show that the physicochemical characteristics of the milk samples in the first month is highest and the lowest values are obtained in the fourth month.

Table 3. Summary of Pearson Chi-square coefficients on the physicochemical characteristics of human milk and maternal dietary intake indicators from month 1 to month 4.

Dietary intake factors	Selected physicochemical characteristics of breast milk			
	Total Carbohydrates (%)	Crude Fat (%)	Crude Protein (%)	pH
Nutrient index (%)	0.505	0.504	0.240	0.531
Carbohydrate (g)	0.335	0.551	0.591	0.441
Fats (g)	0.534	0.035*	0.389	0.026*

* $p < 0.05$

Results of Pearson Chi-square tests on the physicochemical characteristics of the milk samples collected against the dietary intake indicators from 1st month to 4th month postpartum show that the crude fat content of the human milk is associated with the fat intake of the participants. Maternal dietary fat intake was also associated with the pH values of the human milk samples.

Table 4. Summary of Pearson Chi-square coefficients between the physicochemical characteristics and microorganism content of the breast milk from month 1 to month 4.

Physicochemical characteristics	Selected microorganism content in breast milk			
	Total Plate Count (TPC)	Staphylococcus	Lactic acid bacteria	Bifidobacteria
Total Carbohydrates (%)	0.558	0.474	0.168	0.872
Total Protein (%)	0.173	0.112	0.176	0.264
Total Fat (%)	0.100	0.022*	0.082	0.124
pH	0.326	0.912	0.551	0.540

* $p < 0.05$

Table 4 summarizes the Pearson Chi-square coefficients between the physicochemical characteristics and selected cultivable microorganisms of the human milk samples collected. Results show that the total fat of the milk samples is associated with the count of Staphylococcus during the fourth month of lactation ($p<0.05$). This finding substantiates the result of the association of maternal fat intake with the total fat content in human milk. Indirectly, maternal fat intake is linked with the Staphylococcus count in human milk.

CONCLUSION

The results suggest that maternal diet can shape the physicochemical quality of human milk, which may indirectly influence microorganisms present in it.

FUTURE WORK

The study design used was two months less than the globally accepted recommendation of exclusive breastfeeding for six months. It is recommended that future studies examine human milk characteristics for six months to provide further evidence on the benefits of exclusive breastfeeding.

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