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## Chemical Study of Human Milk Report (1)

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### I. Introduction :

Reports of chemical study of human milk we can see in many journals. But the results of its analysis are very various and even offer opposite opinions.

Human milk seems mysterious for us. Therefore, we have commenced our investigation to solve the mystery in human milk. At first, before analysing the components of human milk, we had aimed at pH of human milk, which probably makes a base. But we found that the literature about pH of human milk are scarcer than is expected and the method of research is insufficient. So we have started on the measurement of pH.

Thinking of pH of human milk which should be secret from the mother's body, we have now relations with quality of human milk, bodily conditions of the mother, nutrition of the mother, growth of the baby, diarrhoea of the baby and its other healthy state. At present, our studies are not so sufficient, but we shall report on fluctuation of pH and the process of study which has been made up till today.

### II. Method of the Research :

1) The first research :—

From 13th July to 24th August 1954, in Aiiku Hospital in Tokyo, Sucking mothers who have visited the clinic of Aiiku Hospital, Case number 107, Age of mothers from 21 to 41 years old, Age of infants under 8 month old.

2) The second research :—

(Individual follow-up cases :)

From the end of September to the beginning of October. Each one during a week, at two sucking mothers, at each home, two or three times a day.

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- 3) Measuring instrument:—  
 “DG Type Class Electrode pH Measuring” made by Denkishiki Kagakukeiki Co.
- 4) Methods of milking:—  
 Rubing off clean the mamilla with cotton being wet with distilled water and placing directly on her breast a testglass tube which were sterilized in a dry-heat method, we have milked immediately.
- 5) Items of questionnaire are as follows:—  
 Age and marriage age  
 Frequency of conception  
 Delivery day  
 Days after the delivery.  
 Previous suckle time  
 Frequency of suckling per day  
 Suckle method  
 Mother’s bodily and mentally states  
 Foods which the mother took and its liking  
 Infant’s bodily state (growth, remarkable symptoms, diarrhoea or faecal condition.)

### III. Results

- 1) We can show the result in the distribution of frequency (Fig. 1). The average of pH is  $7.01 \pm 0.26$  (the highest 7.85 and the

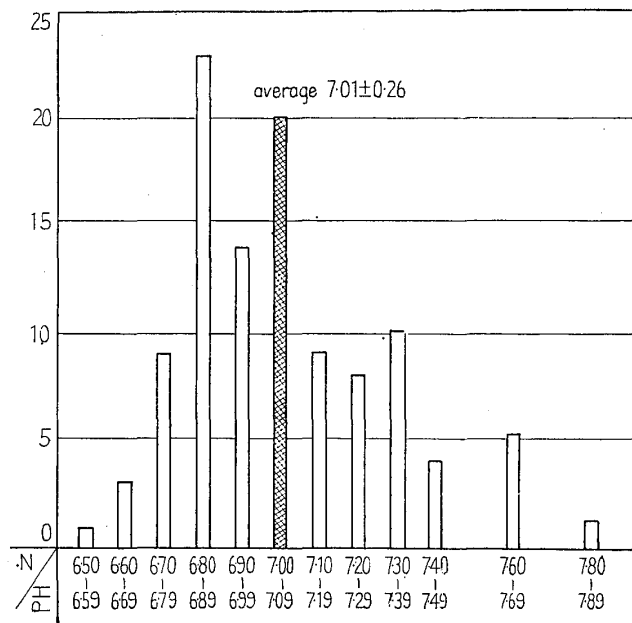


Fig. 1.  
 PH distribution chart of human milk

lowest 6.54) and it shows approximately the same value is com-

pared with the value which has reported in many literatures.\*

However, it was found that difference between the highest and lowest was very great. Then, we have made efforts to investigate its cause and added to examinations in regard to each items which are shown (Fig. 1.)

2)

- (1) In the measurement of pH before suckling and after suckling its average is as follows :

Before suckling      pH 7.16  
 After suckling        pH 7.13  
 $t=0.26 < 2.75$   
 $p=1\%$

We can not recognize any significant difference between both. It appeared, however, in some cases that the pH is high before suckling, low after suckling and in other cases it shows an inverse ratio and it shows vast difference as +0.61 -0.40.

Table 1. pHs before and after suckling

Case	before suckling	difference	after suckling	Case	before suckling	difference	after suckling
1	7.37	+0.40	6.97	9	1.81	-0.19	7.00
2	6.83	+0.15	6.68	10	7.06	+0.13	6.93
3	6.98	+0.01	6.97	11	7.61	+0.61	7.00
4	7.02	-0.30	7.32	12	7.40	+0.08	7.32
5	6.87	+0.12	6.75	13	7.26	-0.14	7.40
6	7.24	0	7.24	14	7.60	-0.01	7.61
7	6.76	-0.40	7.16	15	7.79	+0.15	7.64
8	6.74	-0.16	6.90	average	7.16		7.13

- (2) Average of human mother's milk which is milked from right and left almost simultaneously, is

Left      pH 7.11  
 Right     pH 7.07  
 $t=0.42 < 2.7$   
 $p=1\%$

and any significant difference between both is not recognized, but the case, which has difference as +0.81 -0.46 is found.

Table 2. pHs of milks from right and left breasts

Case	right	difference	left	Case	right	difference	left
1	6.84	+0.23	1.61	15	7.39	-0.07	7.46
2	7.67	+0.81	6.86	16	7.69	+0.29	7.40
3	6.87	-0.29	7.16	17	7.43	+0.03	7.40
4	6.86	+0.05	6.81	18	7.53	-0.08	7.61
5	6.83	-0.20	7.03	19	7.64	-0.17	7.81
6	6.82	0	6.82	20	6.76	+0.04	6.72
7	6.94	+0.08	6.86	21	6.87	-0.37	7.24
8	6.91	-0.07	6.98	22	6.75	+0.51	7.24
9	6.61	+0.07	6.54	23	6.84	-0.06	6.90
10	6.82	+0.10	6.72	24	7.16	+0.23	6.93
11	7.00	-0.46	7.46	25	6.86	-0.05	6.81
12	7.20	-0.18	7.38	26	6.76	-0.30	7.06
13	7.36	-0.30	7.66	average	7.07		7.11
14	7.49	+0.13	7.36				

(3) Eleven cases of 14 which was measured at intervals of 2 to 26 days showed low pH in the later days.

Infants of 4 cases of 11 cases, fell diarrhoea in spite of suckling mother having no bodily injury.

Therefore it is possible to expect some relation between pH ratio and "Diarrhoea symptomatica simplex", and so that, we are now increasing the case.

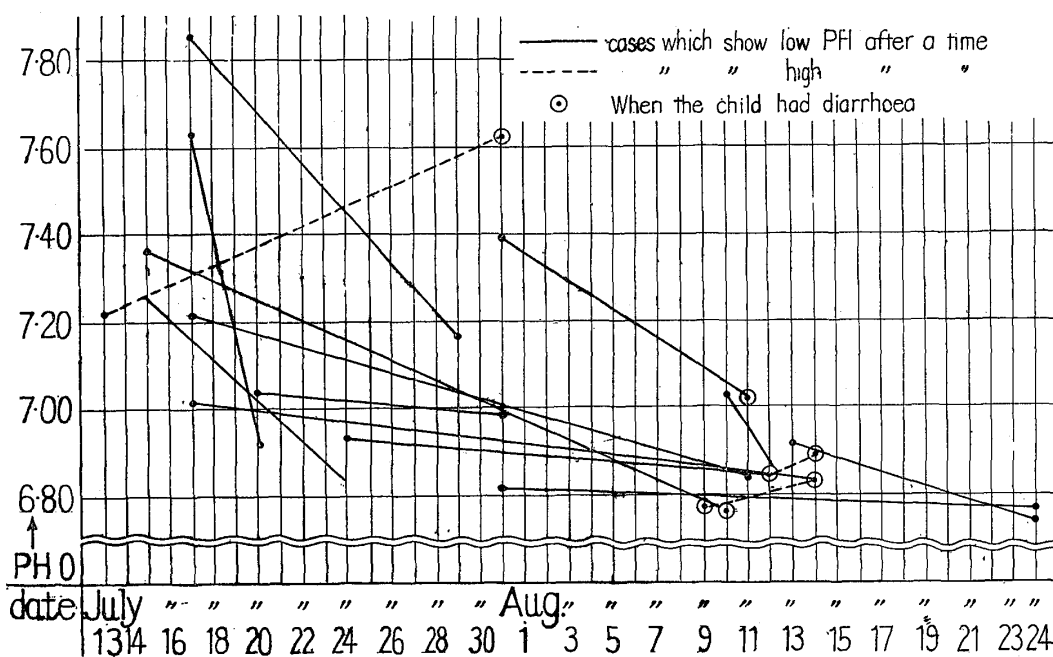
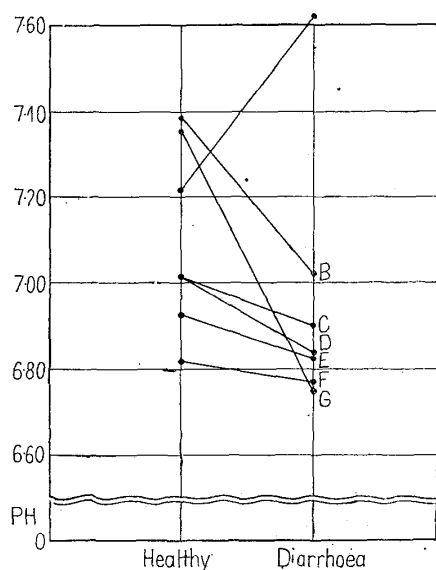


Fig. 2.

pH which were measured in enternal from 2 to 6 days

- (4) Besides, pH of human milk which feeds infants having diarrhoea, as compared with pH of human milk feeding infants who have good and healthy condition, 6 cases of 7 cases tend to be acid.



Human milk feeding infants who have Diarrhoea  
pH 6.94

Human milk feeding infants who have Health condition  
pH 7.10  
 $t=1.3 < 2.04$   
 $p=5\%$

Fig. 3. pH in comparison between diarrhoea and healthy condition of children

But the above difference is not remarkable enough. Therefore we must continue to investigate in on numerous cases.

- (5) It is not recognized any tendency between monthly age of infant and pH of mother's milk.

Table 3. Relation between monthly age of infants and pH

MONTHLY Age	PH															AVERAGE	CASES
	6.50 6.59	6.60 6.69	6.70 6.79	6.80 6.89	6.90 6.99	7.00 7.09	7.10 7.19	7.20 7.29	7.30 7.39	7.40 7.49	7.50 7.59	7.60 7.69	7.70 7.79	7.80 7.89			
0		•		••	••			••								6.97	7
1~2 under			••	•••	•	•	•		••			•		•		7.11	13
2~3			•	•••	•	•	•	•								7.09	10
3~4				•	•	••		•	•							7.05	7
4~5				•	••	••	••		•	•						7.11	9
5~6			••	•••	•••	•••	••	•	•	••						7.04	24
6~7			•	•••	•	•	•	•	••							7.03	11
7~8				•	•	•		•	•			••				7.17	9
8~9	•	••		•		•	•		•							6.98	7
9~10				••				•		•						7.11	4
10~11			•				•									6.98	2
11~12			•	••												6.83	3
12 MORE					•											6.92	1
CASES	1	3	9	23	14	20	9	8	10	4	0	5	0	1	7.07 107	107	

- (6) No significant tendency can be found between the age of suckling mother and pH of her milk.

Table 4. Relation between age of suckling mother and pH

AGE	PH	650	660	670	680	690	700	710	720	730	740	750	760	770	780	AVERAGE	CASES
		659	669	679	689	699	709	719	729	739	749	759	769	779	789		
FULL	21		•		•••	•			•				•			6.97	8
	22			•		•	•	•	•		•				•	7.17	8
	23							•	•	•						7.22	4
	24			•	•••	•	•••	•		•••			••			7.09	16
	25			••	•••	•••	•••	•		•			••			6.96	14
	26			••	••	•••	•••			••	••					7.04	16
	27				•	•	••	•			•					7.08	6
	28	•	•	•	•••		•••	•	•	•			•			7.02	15
	29			•	•	••										6.88	4
	30				•	•		•								6.99	3
	31		•	•	•		•		•							6.90	5
	33								•							7.21	1
	35						•		•	•						7.19	3
	36						•									7.03	1
	41				•								•			7.27	3
UNCERTAIN										•						7.33	
CASES		1	3	9	23	14	20	9	8	10	4	0	5	0	1	7.01	107

(7) It is not especially recognized any relation between infant growth state and pH of mother's milk.

Mother's milk which feeds good growth infants  
pH 7.03 ± 0.27

Mother's milk which feeds bad growth infants  
pH 7.05 ± 0.21

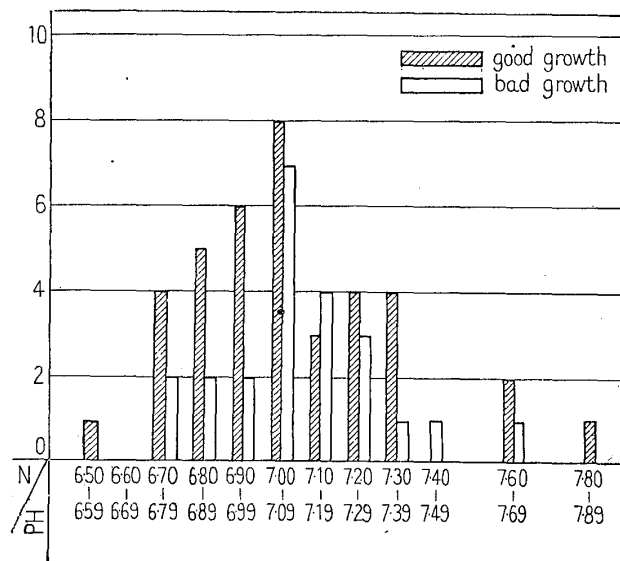


Fig. 4. Relation between growth state of children and pH

(8) It can not be recognized any significant difference between pH of the milk of the mother of the first delivery and

that of second or third delivery

Milk of the first delivery mother  $\text{pH } 7.03 \pm 0.27$

Milk of the second or third

delivery mother  $\text{pH } 6.94 \pm 0.21$

$m \ 1.9 < 3$

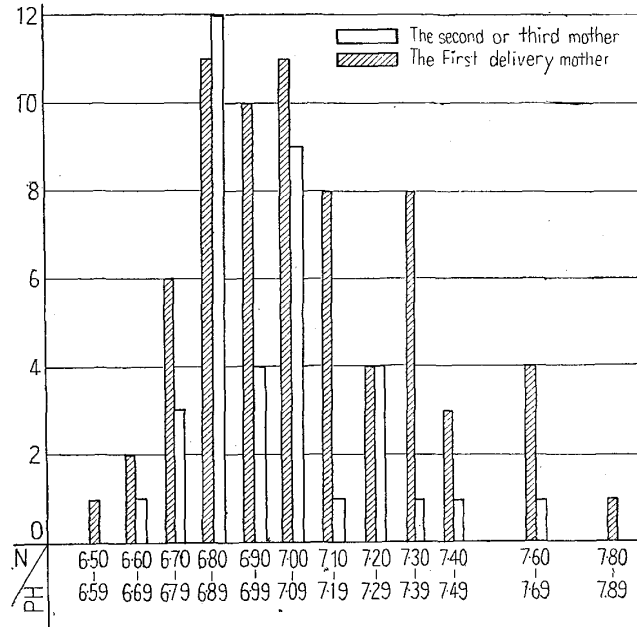


Fig. 5. Relation between delivery time and pH

(9) It is not recognized any significant relation between the nutritional method and pH.

Mother's milk only  $\text{pH } 7.07 \pm 0.30$

Mixing  $\text{pH } 7.01 \pm 0.24$

On weaning  $\text{pH } 6.96 \pm 0.23$

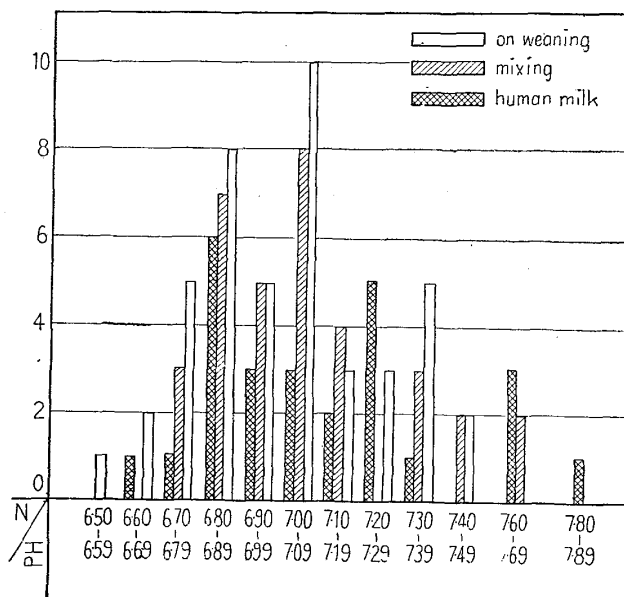


Fig. 6. Relation between the nutritional condition and pH

3)

(1) On timely variation of pH of human milk it is recognized that a little difference exists between the milk suckled in the morning and that suckled in the afternoon.

A.M. pH  $7.34 \pm 0.28$

P.M. pH  $7.12 \pm 0.24$

$m = 3.14 > 3$

$p = 1\%$

This table shows that mother's milk has the inclination to be acid in P.M. The result shall give us the good guidance on study in the futures.

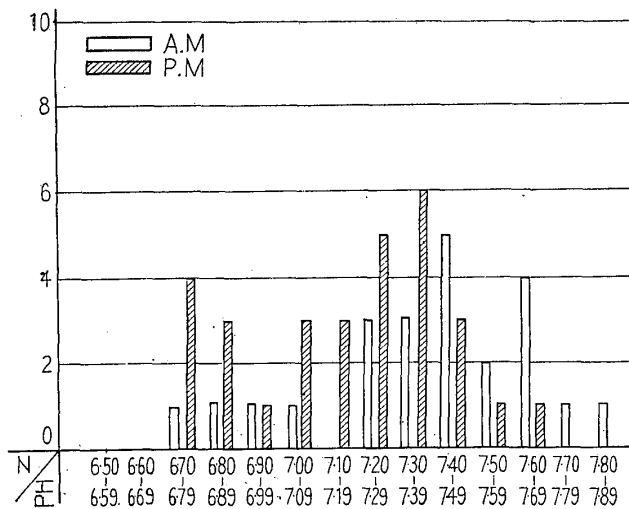


Fig. 7. pH in A.M. and P.M.

(2) In looking-up the sleeping hours of mothers with the ques-

Table 5. The sleeping hours of monther and pH

SLEEPING HOUR	PH	650	660	670	680	690	700	710	720	730	740	750	760	770	780	AVERAGE	CASES
		659	669	679	689	699	709	719	729	739	749	759	769	779	789		
		•			•											6.83	8
4~5		•	•	•		•	•			•						6.89	8
5				•	•••		•						•			6.97	8
5~6							•									7.02	1
5~7								•								7.14	1
5~9				•••	••	••	•		•	••	••					7.07	13
6		•	•	••	••	••	••	••	••				•			7.06	14
6~7																6.83	1
6~8				•	•••	•••	•••		•	••			••			7.08	23
7			•				•									7.07	4
7~8		•	•	•••	••	••	••	••	•	•	•		•			7.00	24
8~9									••							7.25	2
9				•	•			••		•					•	7.22	8
OTHER								•		•						7.23	2
TOTAL		1	3	9	23	14	20	9	8	10	4	0	5	0	1	7.01	107

tionaire method it is found that pH of mother's milk shows high ratio in the next day, when the mother feels fatigue or her sleep is insufficient.

- (3) It is not yet recognized that pH is the influenced by the food upon looking up the individual food- records during a week. Only, pH of milk in the next day that mothers took a fewer staple food and meat than usually, shows high ratio remarkably. (Fig. 8)

However, we must continue to investigate on numerous

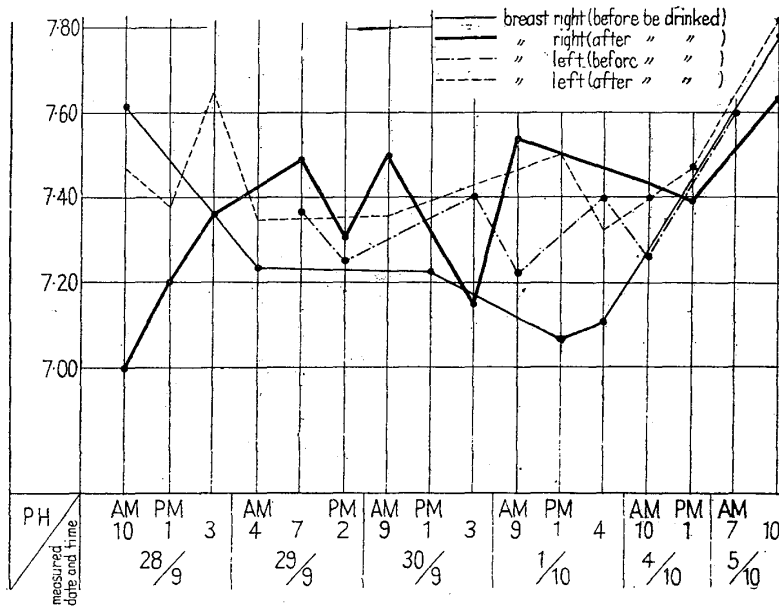


Fig. 8. Individual case (I)

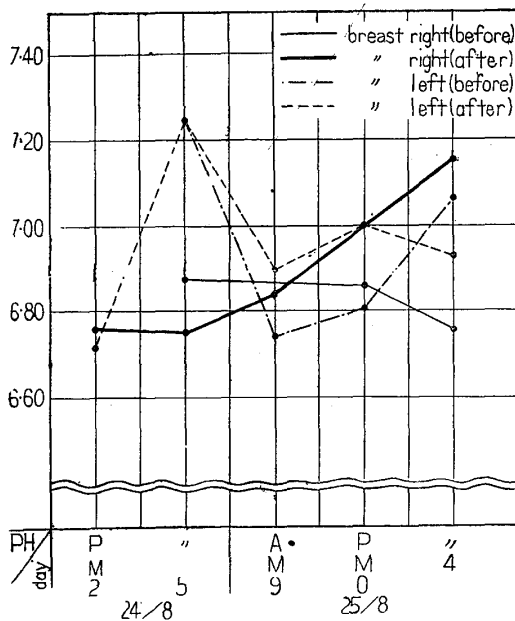


Fig. 9. Individual case (II)

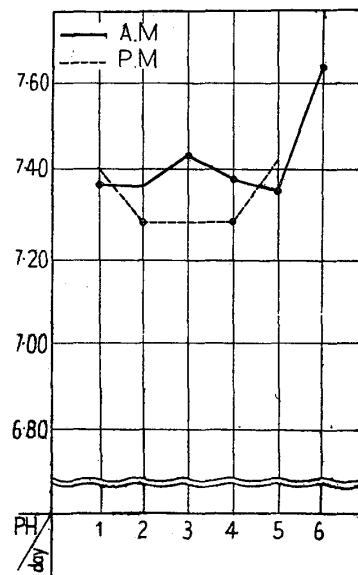


Fig. 10. Comparison between A.M. and P.M. (from Fig. 8)

cases.

- (4) In the examples of individual tracings as Figs. 8, 9 and 10. we could not see remarkable differences between milk of right breast and left through time progress.

But a little difference between before and after suckling is noticed.

### Summary.

As above mentioned, we have recognized that pH of human milk shows lower ratio in the afternoon than in the morning and has a tendency to be acid when the child is attacked by diarrhoea. But, we can not determine why the pH of human milk shows such a remarkable individual difference and does not show any regular tendency in the tracing examination.

At present time, we are studying the relation between pH and other factors through the analysis of human milk protein and other components.

### \*Literature

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