Uric Acid Content of Lactating Mothers' Urine and Arakawa's Reaction.

Part 1.

The Relation between Uric Acid Concentration of their Urine and Arakawa's Reaction of their Milk.

184th Report of the Peroxidase Reaction. (131st Human Milk Study.)

By

Michishiro Yamagishi.

(山岸 道四郎)

(From the Department of Pediatrics, Faculty of Medicine,
the Tohoku Imperial University, Sendai.

Director: Prof. A. Sato.)

(Received for publication, March 7, 1946)

Introduction.

Has vitamin B (B_1 is meant throughout the article) in human body any concern with uric acid excretion in urine? Concerning this question there are few conclusive opinions, so far as I know. Here I shall quote the results of some experiments performed concerning uric acid excretion of animals made experimentally B-avitaminotic, which pointed to a certain relationship between vitamin B and urinary uric acid content. In 1923 Adachi¹⁾ reported that dogs fed on B-avitaminotic diet had an increased excretion of uric acid in urine during their long-timed B-carence and its later period especially. In 1924 Collazo²⁾ observed that, when dogs were fed on B-avitaminotic diet, uric acid content of their urine increased during their long time of B-hunger, although it decreased during the last period before death. In the same year Kudrjawzewa³⁾ also recognized that rabbits fed on diet deficient in vitamin B had an increased excretion of uric acid in urine. Further, in 1928 Lawrow and Matzko⁴⁾ reported that hens had an increased uric acid output in urine when they were fed on polished rice, i.e. on B-avitaminotic food.

Additional remarks:—

Kakiuchi⁵⁾ cites in his book Simonnet's⁶⁾ reports that pigeons fed on B-avitaminotic diet had an increased excretion of uric acid in urine, but to my great regret I was unable to find such a report in Simonnet's original.

From these reports, it is probable that also in human beings there will

be a certain relation between vitamin B and urinary uric acid content. So I attempted to attack the problem from a new point of view: I investigated the relation between uric acid content of lactating mothers' urine and their Arakawa's reaction.*

In general, Arakawa's reaction of mothers' milk is directly related with the state of vitamin B supply in the body. In other words, mothers who secrete milk negative to Arakawa's reaction are generally in a state of vitamin B deficiency. This close relation has already been shown by a number of papers from our Laboratory, among which I may mention only a few references²⁻¹⁹⁾. The present paper is the outcome of my own investigation.

Materials and Method of Investigation.

1. Subjects of my investigation:—

Apparently healthy lactating mothers of breast-fed patients who visited our Dispensary during morning hours. I examined their milk with Arakawa's reagent in each case. Urine was obtained from these mothers for the estimation of uric acid content.

2. For the quantitative estimation of uric acid in urine I employed Pincussen's²⁰⁾ modification of Folin-Shaffer's method.

Principle of the method:—

Uric acid is precipitated from the urine as ammonium urate, and the amount in the precipitate is determined by titration with a standard potassium permanganate solution in the presence of acid. Phosphates and some organic matter are first precipitated by uranium acetate and ammonium sulfate.

Result of Investigation.

Urine samples were obtained from 328 cases during about 8 months (from the end of March up to the end of November 1941). In general, the uric acid content was subject to a considerable individual variation. If, I had assumed the apparently healthy lactating women in the present investigation to be really healthy, my result would have been summed up to the effect that the urinary uric acid was subject to a great individual

* Arakawa-positive may be used in two different senses. One of these is: Arakawa-positive in a biochemical sense. A sample of human milk is said to have become Arakawa-positive, when it becomes blue on the addition of Arakawa's reagent. Here it means that the sample is not negative to Arakawa's reaction. The other of these two senses is: Arakawa-positive in clinical sense. A sample of human milk is clinically Arakawa-positive only when it shows such a reaction as — or — in one minute of the addition of Arakawa's reagent. Another sample of human milk may be Arakawa-positive in the first described sense, but yet clinically negative.

fluctuation. But I observed the result, as above mentioned, from the viewpoint of Arakawa's reaction.

I classified, as Kimura²¹⁾ did in his report, all the cases into 4 groups according to the intensity of Arakawa's reaction of their milk, viz., the group of positive reaction, the group of better intermediate reaction, the group of worse intermediate reaction and the group of completely or almost completely negative reaction (Cf. Table I.).

In my investigation, there were 58 cases of the Positive

Group, 138 cases of the Better Intermediate Group, 91 cases of the Worse Intermediate Group and 41 cases of the Completely or Almost Completely Negative Group (Cf. Tables II, III, IV and V.

When I compared the average of the uric acid content of urine samples belonging to each group with one other, I found an interesting relation between the uric acid concentration of mothers' urine and the Arakawa reaction of their milk. As is seen from Table VI (Cf. Table VI), the uric acid concentration of Arakawa-positive mothers is on an average 40.24 mgrms. per 100 c.c., that of mothers with better intermediate

TABLE I.

The explanation for the classification of Arakawa's reaction, according to its intensity.

Group	Intensity of Arakawa's reaction expressed in signs	
	One side	the other side
Positive reaction*	(+++)'† (++)'†	{(+++)' (++)'}
Better intermediate reaction	(+++)'	{(±)' (-)'}
	(++)'	{(+)' (±)'}
	(++)'	(-)'
	(+)'	{(+)' (±)'}
Worse intermediate reaction	(+)'§ (±)'	(-)' (±)'
	(±)'	(±)5'
	(-)'	{(-)' (+)3' (-)' (+)3'}
Completely or almost completely negative reaction	(-)5'¶	(±)5'
	(-)5'	(-)5'

* Only this group is clinically positive.

† (+++)' or (++)' Arakawa's reaction is positive with the intensity (+++)' or (++)' in one minute.

§ (+)' (±)' or (-)' Arakawa's reaction is negative in the grade (+), (±), (-) in one minute.

¶ (±)5', (-)5' Arakawa's reaction is negative in the grade (±), (-) in 5 minutes.

Arakawa's reaction 50.60 mgrms. per 100 c.c., that of mothers with

TABLE II.

Uric acid content of urine of lactating mothers with Arakawa-positive milk.

Case No.	Date	Name	Age		Arakawa's reaction		U (mgrms. per 100 c.c.)
			M.* y.	Inf.* m.	Right	Left.	
1	31.III	S.K.	25	3	(+)'	(+)'	20.00
2	2.IV	S.N.	32	2	(+)'	(+)'	28.55
3	8. "	K.C.	32	5	(+)'	(#)'	32.60
4	18. "	S.K.	29	14	(+)'	(+)'	29.25
5	21. "	S.R.	23	3	(+)'	(+)'	22.00
6	1. V	I. I.	41	12	(+)'	(+)'	29.25
7	14. "	S.K.	26	9	(+)'	(+)'	17.25
8	17. "	S.T.	28	3	(+)'	(+)'	25.50
9	21. "	S. I.	34	6	(+)'	(+)'	42.00
10	27. "	S.K.	46	20	(#)'	(+)'	58.00
11	10.VI	Y.D.	29	12	(+)'	(+)'	31.50
12	11. "	A.T.	26	16	(+)'	(+)'	63.00
13	11. "	M.T.	22	3	(+)'	(+)'	71.25
14	13. "	T.S.	22	11	(+)'	(+)'	37.00
15	17. "	S.Z.	25	6	(#)'	(#)'	22.50
16	23. "	W.B.	38	5	(#)'	(+)'	16.50
17	26. "	H.W.	28	2	(#)'	(+)'	30.00
18	28. "	Y.D.	26	7	(+)'	(+)'	31.50
19	30. "	T.Y.	22	13	(+)'	(+)'	25.50
20	30. "	H.K.	20	13	(#)'	(#)'	30.00
21	3.VII	Y.M.	25	10	(+)'	(+)'	53.44
22	5. "	Y.M.	20	3	(#)'	(#)'	67.50
23	5. "	Y.D.	31	15	(+)'	(+)'	65.25
24	5. "	A.W.	24	10	(+)'	(#)'	18.75
25	8. "	Y.M.	24	2	(+)'	(+)'	43.50
26	9. "	S.T.	30	5	(#)'	(#)'	55.50
27	9. "	M.K.	31	13	(#)'	(#)'	45.75
28	14. "	N.W.	28	3	(#)'	(+)'	30.00
29	15. "	N.N.	19	8	(+)'	(#)'	36.75
30	15. "	S.M.	25	8	(+)'	(+)'	22.50
31	16. "	S.T.	30	1	(+)'	(#)'	28.50
32	28. "	S. J.	37	2	(+)'	(+)'	52.50
33	2.VIII	Y.D.	31	12	(+)'	(+)'	27.70
34	4. "	T.D.	37	6	(+)'	(+)'	31.50
35	7. "	M.T.	28	15	(+)'	(+)'	22.75
36	12. "	O.Y.	22	1	(+)'	(+)'	66.00

worse intermediate Arakawa's reaction 59.14 mgrms. per 100 c.c. and that of mothers with completely. or almost completely negative Arakawa's reaction 69.27 mgrms. per 100 c.c.

It will be seen that on an average the urine of Arakawa-positive mothers is the lowest in uric acid concentration, that the urine of mothers with completely or almost completely negative Arakawa's reaction is the highest, that the urines of mothers with intermediate Arakawa's reactions show intermediate values. It can thus be said that in general uric acid concentration of urine is lower in Arakawa-positive mothers than in Arakawa-negative ones.

The relation between the uric acid content in urine and Arakawa reaction will also be seen in the maximum and the minimum figures of the content (Cf. Table VI). The maximum content in the Positive, the Better Intermediate and the Worse Intermediate and the Completely (or Almost Completely) Negative groups is 71.25, 117.5, 119.25 and 136.5 mgrms. per 100 c.c. respectively, and the minimum content is 16.50, 15.0,* 27.0 and 34.0 mgrms. per 100 c.c. respectively. The figure (15.0) was slightly smaller than 16.50, but in the Worse Intermediate Group there were many more cases than in the Positive Group.

Comment.

In my investigation it is clear (Cf. Table VI) that uric acid concentration is the smallest (ca. 40 mgrms. %) in Arakawa-positive mothers and the largest (ca. 70 mgrms. %) in Arakawa-negative mothers, while in the cases of intermediate Arakawa's reactions the concentration shows intermediate values. And in these mothers of the Intermediate Groups, the concentration is smaller (ca. 50 mgrms. %) in the Better Intermediate Group than (ca. 60 mgrms. %) in the Worse Intermediate Group.

I do not discuss the origin of urinary uric acid in (Part I of) the present treatise, because I shall come upon this problem in Part 2 of it. At any rate, the remarkable difference of uric acid concentration among the different groups of lactating mothers with different Arakawa's reaction cannot be attributed to a difference of exogenous uric acid, because it is utterly inconceivable that that particular group of Arakawa-negative mothers, for instance, took much more food leading to uric acid excretion than the group of Arakawa-positive ones. Of course a lactating woman cannot have Arakawa's reaction at her disposal and does not know anything about her reaction until her milk is tested with Arakawa's reagent.

As related in the Introduc-

37	13. "	S. I.	39	13	(#)1'	(+)1'	43.75
38	14. "	Y.W.	39	8	(+)1'	(+)1'	55.00
39	15. "	H.M.	24	6	(+)1'	(+)1'	21.75
40	16. "	S.R.	22	6	(+)1'	(+)1'	43.50
41	18. "	N.I.	25	3	(+)1'	(#)1'	55.50
42	22. "	T.S.	30	9	(+)1'	(+)1'	25.50
43	22. "	T.W.	26	3	(#)1'	(#)1'	35.25
44	25. "	T. J.	25	14	(+)1'	(+)1'	57.00
45	28. "	W.B.	39	4	(#)1'	(+)1'	35.50
46	29. "	S.D.	28	9	(+)1'	(#)1'	35.25
47	30. "	S.W.	29	29	(+)1'	(+)1'	50.25
48	3.IX	M.M.	23	5	(+)1'	(+)1'	68.50
49	10. "	W.B.	26	7	(+)1'	(+)1'	38.25
50	11. "	M.G.	39	4	(+)1'	(+)1'	63.50
51	13. "	S.T.	29	16	(+)1'	(+)1'	52.50
52	15. "	S.R.	36	3	(+)1'	(+)1'	52.50
53	17. "	O.T.	32	6	(+)1'	(+)1'	27.75
54	22. "	Y.W.	32	9	(#)1'	(#)1'	27.75
55	22. "	N.N.	24	16	(+)1'	(+)1'	61.50
56	29. "	K.T.	33	3	(+)1'	(+)1'	29.25
57	6. X	A. I.	35	15	(+)1'	(+)1'	34.50
58	15. "	T.S.	30	4	(+)1'	(+)1'	36.75

* M.....Mother; y.....years; Inf.....Infant; m.....months.

TABLE III.

Uric acid content of urine of lactating mothers with milk of better intermediate Arakawa's reaction.

Case No.	Date	Name	Age		Arakawa reaction		U (mgrms. per 100 c.c.)
			M. ⁺ y.	Inf. ⁺ m.	Right	Left	
1	25.III	Y.D.	26	4	(+)1'	(+)1'	24.35
2	26. "	K.T.	25	2	(+)1'	(±)1'	40.00
3	27. "	H.K.	23	23	(+)1'	(±)1'	28.55
4	27. "	M.T.	30	12	(+)1'	(+)1'	20.00
5	27. "	W.B.	30	24	(+)1'	(+)1'	27.00
6	28. "	K.M.	26	14	(±)1'	(+)1'	61.00
7	28. "	S.K.	41	6	(+)1'	(+)1'	26.90
8	31. "	E.D.	35	5	(+)1'	(±)1'	23.80
9	2.IV	K.W.	42	6	(+)1'	(+)1'	30.30

TABLE III.
Continued.

Case No.	Date	Name	Age		Arakawa reaction		U (mgrms. per 100 c.c.)
			M. y.	Inf. m.	Right	Left	
10	7. IV	I. I.	34	2	(±)1'	(+)1'	29.05
11	7. "	O.M.	26	11	(±)1'	(+)1'	27.80
12	8. "	K.M.	39	7	(+)1'	(+)1'	41.65
13	8. "	S. I.	29	3	(+)1'	(+)1'	35.30
14	8. "	C.B.	29	13	(+)1'	(+)1'	40.00
15	14. "	T.D.	37	2	(+)1'	(+)1'	45.25
16	14. "	T.S.	31	7	(+)1'	(+)1'	35.25
17	22. "	T.D.	22	1	(+)1'	(±)1'	42.75
18	30. "	T.S.	39	7	(+)1'	(±)1'	34.50
19	2. V	K.M.	31	5	(+)1'	(+)1'	48.00
20	5. "	T.G.	25	15	(+)1'	(+)1'	20.25
21	5. "	W.B.	31	21	(+)1'	(+)1'	68.25
22	6. "	O.W.	26	18	(-)1'	(+)1'	73.50
23	7. "	A.W.	26	14	(+)1'	(+)1'	39.00
24	7. "	M.R.	25	3	(+)1'	(±)1'	67.50
25	7. "	Y.D.	29	4	(±)1'	(+)1'	42.95
26	12. "	S.K.	43	2	(+)1'	(+)1'	33.75
27	12. "	K.Y.	28	14	(+)1'	(+)1'	43.25
28	12. "	K.W.	29	10	(+)1'	(+)1'	57.00
29	15. "	T.T.	30	11	(±)1'	(+)1'	57.00
30	19. "	H.Y.	27	6	(+)1'	(+)1'	63.00
31	19. "	T.N.	33	7	(+)1'	(+)1'	60.75
32	20. "	N.T.	26	6	(+)1'	(+)1'	37.50
33	20. "	T.D.	28	7	(+)1'	(+)1'	49.50
34	23. "	M.W.	32	7	(±)1'	(+)1'	45.75
35	23. "	S.K.	33	5	(-)1'	(+)1'	45.00
36	23. "	H.N.	35	19	(+)1'	(+)1'	45.25
37	24. "	M.D.	28	20	(±)1'	(+)1'	31.50
38	29. "	N.M.	27	14	(-)1'	(+)1'	60.00
39	29. "	I.K.	26	19	(+)1'	(+)1'	38.00
40	29. "	B.B.	40	9	(±)1'	(+)1'	35.00
41	2. VI.	K.I.	27	3	(+)1'	(+)1'	22.00
42	9. "	S.J.	23	3	(+)1'	(+)1'	70.50
43	10. "	S.Z.	29	13	(+)1'	(±)1'	66.00
44	14. "	O.T.	22	18	(+)1'	(+)1'	109.87
45	14. "	T.M.	34	4	(+)1'	(±)1'	53.25
46	16. "	T.S.	22	7	(+)1'	(+)1'	24.75

tion, animal experimentation in literature shows the unanimous result that B-avitaminotic feeding leads to an augmentation of uric acid excretion. Now, lactating mothers with milk negative to Arakawa's reaction are in a state of avitaminosis-B. Their urine was, as has been shown in my investigation, of much higher uric acid content than that of Arakawa-positive mothers. So it may appear that the result of my investigation is in conformity with the result of animal experiment. But I cannot yet conclude to this effect; a further consideration is necessary.

The result of the animal experiments cited above concerns the whole day amount of uric acid excreted, while that of my own investigation is about the uric acid concentration alone of one urine specimen voided in the morning. As to the result of the whole day amount of the acid we have known nothing. But is it not probable in my cases that whole day urine was also of a higher uric acid content than in the group of Arakawa-negative mothers? Because in the group of Arakawa-positive mothers

$$\frac{40 \text{ mgrms.}}{100} \times 1000 \text{ (1000 . . . assumed amount of whole day urine in c.c.)}$$

and in the group of Arakawa-negative mothers

$$\frac{70 \text{ mgrms.}}{100} \times 1000 \text{ would represent}$$

an approximate amount of uric

acid excreted during 24 hours.

But this way of calculation is not correct, even if we assume that the uric acid concentration in each group remained constant during one whole day, because the amount of the whole day urine is not equal, but different according to different groups of Arakawa's reaction. Arakawa-negative mothers who are in a state of B-avitaminosis excrete, according to Umemura²²⁾ (Cf. 155th Report of the Peroxidase Reaction), a smaller amount of urine during 24 hours than Arakawa-positive ones; they suffer from abnormal water-retention, though not from manifest edema. He stated that Arakawa-positive mothers excrete about 1150 c.c. of urine, Arakawa-negative ones about 980 c.c. and mothers of intermediate reaction about 1090 c.c. respectively during 24 hours. So the calculation shall be like the following:—

In the group of Arakawa-positive mothers,—

$$\frac{40 \text{ mgrms.}}{100} \times 1150 = 0.46 \text{ mgrms.}$$

In the group of Arakawa-negative mothers,—

$$\frac{70 \text{ mgrms.}}{100} \times 989 = 9.69 \text{ mgrms.}$$

In the group of mothers with intermediate reaction,—

$$\frac{55 \text{ mgrms.}^\dagger}{100} \times 1090 = 0.60 \text{ mgrms.}$$

$$^\dagger 55 = \frac{50 + 60}{2}$$

If the calculation above mentioned is right, then mothers negative to Arakawa's reac-

47	19. "	S.Y.	34	11	(+)'	(+)'	28.50
48	25. "	I.R.	27	5	(±)'	(+)'	38.25
49	25. "	N.R.	28	11	(+)'	(±)'	68.25
50	27. "	A.B.	35	1	(±)'	(+)'	24.75
51	28. "	Y.C.	30	5	(+)'	(+)'	33.75
52	30. "	I.T.	28	4	(+)'	(±)'	58.50
53	30. "	I.T.	28	10	(±)'	(+)'	106.50
54	1.VII	K.N.	27	5	(+)'	(+)'	15.75
55	3. "	T.M.	38	11	(+)'	(+)'	106.50
56	4. "	M.M.	31	15	(+)'	(+)'	61.50
57	4. "	O.T.	28	12	(+)'	(+)'	45.75
58	5. "	T.N.	34	28	(+)'	(+)'	67.50
59	7. "	M.W.	26	5	(+)'	(+)'	49.50
60	8. "	S.J.	34	18	(+)'	(±)'	54.75
61	11. "	Y.C.	40	11	(+)'	(+)'	33.00
62	11. "	S.T.	32	13	(+)'	(+)'	66.50
63	11. "	O.N.	26	10	(+)'	(±)'	92.25
64	14. "	O.M.	23	4	(±)'	(+)'	54.75
65	14. "	M.M.	28	5	(+)'	(+)'	42.75
66	14. "	E.S.	24	2	(+)'	(±)'	26.25
67	15. "	K.N.	39	14	(+)'	(+)'	36.75
68	15. "	M.T.	25	6	(+)'	(±)'	85.50
69	16. "	K.T.	40	17	(+)'	(+)'	88.50
70	17. "	T.S.	27	3	(+)'	(+)'	37.50
71	17. "	U.R.	28	16	(±)'	(+)'	96.75
72	19. "	S.T.	25	7	(+)'	(+)'	86.25
73	22. "	N.I.	25	2	(+)'	(+)'	38.25
74	24.VII	I.O.	40	18	(+)'	(+)'	70.50
75	25. "	O.R.	21	2	(+)'	(+)'	60.00
76	25. "	A.W.	25	14	(+)'	(+)'	78.00
77	28. "	H.I.	30	9	(+)'	(+)'	30.75
78	28. "	T.S.	27	9	(+)'	(+)'	37.50
79	31. "	I.T.	28	19	(+)'	(+)'	68.25
80	31. "	H.M.	26	8	(+)'	(+)'	23.25
81	2.VIII	T.T.	33	4	(±)'	(+)'	15.00
82	2. "	N.T.	23	7	(+)'	(+)'	56.25
83	4. "	U.M.	27	6	(+)'	(-)'	48.00
84	5. "	N.N.	27	5	(+)'	(+)'	70.50
85	5. "	S.D.	21	12	(+)'	(+)'	58.50
86	6. "	T.N.	30	5	(+)'	(+)'	52.50
87	6. "	S.K.	38	3	(+)'	(±)'	117.50
88	6. "	S.J.	31	6	(+)'	(+)'	27.75
89	9. "	K.S.	26	13	(+)'	(+)'	74.25

TABLE III.
Continued.

Case No.	Date	Name	Age		Arakawa reaction		U (mgms. per 100 c.c.)
			M. y.	* Inf. m.	Right	Left	
90	9. "	M.K.	27	5	(#)I'	(±)I'	59.25
91	12. "	K.D.	32	3	(+)I'	(±)I'	66.75
92	15. "	N.C.	25	2	(±)I'	(+)I'	51.75
93	16. "	H.W.	28	12	(+)I'	(±)I'	57.00
94	18. "	G.K.	32	14	(+)I'	(+)I'	35.25
95	20. "	Y.K.	27	2	(+)I'	(+)I'	93.00
96	22. "	K.C.	25	5	(+)I'	(+)I'	43.50
97	23. "	O.B.	25	1	(+)I'	(+)I'	35.25
98	23. "	S.K.	30	9	(+)I'	(+)I'	41.25
99	25. "	S. J.	25	21	(+)I'	(+)I'	53.25
100	26.VIII	K.T.	30	14	(+)I'	(+)I'	80.25
101	30. "	I.T.	44	3	(+)I'	(+)I'	28.50
102	1.IX	S.K.	25	15	(±)I'	(+)I'	52.50
103	3. "	M.T.	22	6	(+)I'	(+)I'	57.00
104	5. "	M.T.	25	9	(+)I'	(+)I'	18.00
105	6. "	T.S.	34	16	(±)I'	(+)I'	21.00
106	8. "	H.Y.	26	13	(+)I'	(+)I'	81.75
107	16. "	K.T.	26	6	(+)I'	(+)I'	45.00
108	16. "	Y.D.	24	2	(+)I'	(+)I'	53.25
109	22. "	I.D.	29	5	(+)I'	(+)I'	85.25
110	24. "	I.W.	21	6	(+)I'	(±)I'	117.00
111	24. "	S.Z.	32	13	(+)I'	(+)I'	48.00
112	26. "	O.M.	34	16	(+)I'	(+)I'	43.50
113	26. "	O.G.	42	15	(+)I'	(+)I'	81.00
114	26. "	N. J.	29	5	(+)I'	(+)I'	43.50
115	27. "	N.S.	32	5	(+)I'	(+)I'	55.50
116	4. X	K.B.	38	4	(+)I'	(+)I'	58.50
117	8. "	A.R.	24	6	(+)I'	(±)I'	18.00
118	9. "	S.T.	28	14	(+)I'	(+)I'	53.25
119	9. "	M.M.	37	12	(+)I'	(+)I'	32.25
120	10. "	Y.M.	33	14	(+)I'	(±)I'	58.50
121	11. "	K.T.	31	17	(±)I'	(+)I'	78.00
122	13. "	S.T.	39	18	(+)I'	(±)I'	64.50
123	15. "	K.K.	42	4	(+)I'	(+)I'	48.00
124	15. "	H.K.	34	19	(+)I'	(±)I'	72.00
125	20. "	S.T.	26	2	(+)I'	(+)I'	27.75
126	23. X	S.R.	22	5	(+)I'	(+)I'	17.25

tion will excrete the largest amount of uric acid per day and Arakawa-positive mothers the least amount of it, while the mothers of intermediate reaction will excrete an intermediate amount of it. However, we cannot decide yet whether this conclusion is really right or not; we shall come upon this point in Part 2 of the present treatise.

Summary.

Animal experiments reported in literature show unanimously that animals fed on B-avitaminotic feeding excrete an augmented amount of uric acid. Human milk negative to Arakawa's reaction is generally a milk from a B-avitaminotic body. Then it will seem probable that lactating mothers with milk negative to Arakawa's reaction excrete a larger amount of uric acid per day than Arakawa-positive mothers.

In the present paper I have examined 328 lactating mothers of positive, negative and intermediate Arakawa's reactions. They were all apparently healthy. Urine voided at one time was used for the quantitative determination of uric acid. The result showed that uric acid was the most concentrated in the group of Arakawa-negative mothers and the least concentrated in the group of Arakawa-positive ones. In the groups of mothers with intermediate reactions, uric

acid content was of intermediate values.

As to the absolute amount of uric acid excreted per day, it will be reported in Part 2 of this treatise.

Remarks.

Arakawa-positive cases in strictly sense are those cases with such a reaction as in shown below or with a stronger reaction:

1' 2' 3' 4' 5'
++ ### ### ### ###

But the Arakawa-positive group comprised not only "Arakawa-positive" cases, but also "almost Arakawa-positive" cases. There were 16 of such cases among 58 belonging to the Arakawa-positive group. If I compile a table of these 16 cases, the result will be as is shown in Table VII (Cf. Table VII).

The uric acid content of these almost Arakawa-positive cases is 48.26 mgrms. % on an average, 71.25 mgrms. % in the maximum and 18.70 mgrms. % in the minimum. It will thus be seen that, though the number of cases are too small, the almost Arakawa-positive group comes on an average between the Arakawa-positive and the better intermediate group.

Conclusions.

Animal experimentation in literature shows us that B-avitaminotic feeding causes an augmented excretion of uric acid.

127	24. "	N.M.	27	20	(+)'	(+)'	34.50
128	28. "	T. I.	23	3	(+)'	(±)'	50.00
129	29. "	N.N.	24	14	(+)'	(+)'	63.00
130	4.XI	A. I.	23	4	(+)'	(±)'	25.50
131	11. "	E.D.	24	4	(+)'	(+)'	32.25
132	13. "	A.N.	43	25	(+)'	(+)'	30.75
133	13. "	Y. J.	29	3	(±)'	(+)'	27.00
134	17. "	S.T.	33	19	(±)'	(+)'	75.75
135	18. "	A.K.	24	6	(±)'	(+)'	50.00
136	20. "	O.W.	26	9	(±)'	(+)'	83.25
137	24. "	T.S.	29	4	(±)'	(+)'	27.75
138	26. "	D.M.	28	2	(+)'	(+)'	20.25

* Cf. Footnote of Table 2.

TABLE VI.

Uric acid content of urine of lactating mother's with milk of worse intermediate Arakawa's reaction.

Case No.	Date	Name	Age		Arakawa reaction		U (mgrms. per 100 c.c.)
			M. y.	Inf. m.	Right	Left	
1	27.III	O.R.	29	26	(±)'	(-)'	66.65
2	29. "	I. I.	34	2	(±)'	(±)'	27.27
3	2.IV	S. I.	30	1	(-)'	(-)'	52.60
4	2. "	S.T.	25	3	(-)'	(+)'	41.65
5	2. "	S.T.	23	3	(+)'	(±)'	53.30
6	7. "	M.W.	29	17	(-)'	(-)'	76.90
7	15. "	T.S.	35	3	(-)'	(±)'	75.25
8	17. "	M.M.	30	2	(-)'	(±)'	45.75
9	18. "	N.M.	25	2	(±)'	(-)'	52.65
10	21. "	H.K.	26	20	(±)'	(±)'	70.50
11	30. "	S.T.	23	10	(+)'	(-)'	81.75
12	1.V	I.T.	27	5	(±)'	(+)'	28.50
13	6. "	K.R.	42	15	(±)'	(±)'	95.25
14	8. "	N.M.	27	30	(+)'	(-)'	66.00
15	13. "	O.R.	28	5	(±)'	(±)'	37.50
16	14. "	S.R.	32	6	(+)'	(-)'	51.00
17	15. "	K.R.	35	1	(-)'	(-)'	90.00
18	16. "	I.G.	40	16	(±)'	(+)'	27.00
19	16. "	S.K.	25	4	(±)'	(+)'	33.75

TABLE IV.
Continued.

Case No.	Date	Name	Age		Arakawa reaction		U mgms. per 100 c.c.
			M.* y.	Inf.* m.	Right	Left	
20	17. "	S.W.	33	2	(-)'	(±)'	76.50
21	21. "	G.T.	26	3	(±)'	(±)'	53.25
22	24. "	H.R.	31	13	(±)'	(-)'	36.00
23	27. "	M.T.	26	2	(±)'	(-)'	28.50
24	27. "	S.Z.	34	16	(+)'	(-)'	50.25
25	30. "	O.R.	26	3	(+)'	(-)'	49.50
26	30. "	S.R.	24	1	(+)'	(-)'	42.00
27	30. "	K.W.	29	28	(+)'	(-)'	27.25
28	30. "	S.R.	39	4	(±)'	(±)'	48.00
29	2.VI	S.J.	35	8	(±)'	(-)'	81.75
30	2. "	T.N.	27	3	(±)'	(-)'	81.00
31	6. "	Y.K.	41	10	(-)'	(±)'	33.75
32	6. "	K.I.	34	2	(±)'	(±)'	38.25
33	9. "	H.S.	28	17	(±)'	(±)'	57.00
34	9. "	U.Y.	25	2	(±)'	(±)'	57.00
35	9. "	Y.M.	27	3	(-)'	{(-)' (+)'5'	35.00
36	10. "	O.D.	40	25	(-)'	(±)'	72.00
37	11. "	S.O.	28	29	(-)'	(±)'	53.25
38	14. "	K.B.	35	10	(±)'	(±)'	29.25
39	16. "	H.D.	26	5	(±)'	(±)'	46.50
40	16. "	H.N.	33	2	(±)'	(-)'	65.25
41	18. "	S.T.	36	9	(±)'	{(±)' (-)'	34.50
42	19. "	W.B.	30	8	(-)'	{(±)' (+)'5'	68.00
43	21. "	T.S.	34	2	(-)'	{(±)' (+)'5'	56.25
44	23. "	Y.W.	36	8	(±)'	(±)'	85.50
45	23. "	S.W.	29	5	(-)'	(+)'	32.25
46	25. "	O.R.	29	7	(-)'	(±)'	43.56
47	27. "	S.Z.	41	23	(-)'	(+)'	102.00
48	28. "	U.N.	24	3	(±)'	(±)'	84.75
49	30. "	U.I.	21	21	(±)'	(-)'	72.00
50	2.VII	T.R.	41	24	(-)'	{(±)' (+)'5'	70.50
51	7. "	S.T.	40	19	(+)'	(-)'	59.25
52	9. "	T.K.	34	21	(-)'	(+)'	117.50
53	10. "	O.R.	34	21	(±)'	(±)'	36.00
54	11. "	T.M.	28	2	(±)'	(±)'	60.00
55	14. "	S.N.	32	1	(±)'	(-)'	64.50
56	15. "	T.D.	32	19	(-)'	(+)'	85.50

Human milk negative to Arakawa's reaction is a milk from a B-avitaminotic body. In the present work, I have examined urine specimens of 328 mothers with milk of different Arakawa's reaction and come to the conclusion that uric acid content is the largest in Arakawa-negative mothers and the smallest in Arakawa-positive cases, while it shows an intermediate value in lactating mothers of intermediate Arakawa's reaction.

This work was carried out by a grant from the Foundation for Promotion of Scientific Research of the Education Department.

Prof. Akira Sato.

Literature.

- 1) A. Adachi, *Biochem. Ztsch.*, 1923, **143**, 412.
- 2) J. A. Collazo, *Biochem. Ztsch.*, 1924, **145**, 437.
- 3) A. Kudrjawazewa, *Biochem. Ztsch.*, 1924, **154**, 123.
- 4) B. A. Lawrow and S. N. Matzko, *Biochem. Ztsch.*, 1928, **198**, 148.
- 5) S. Kakiuchi, *Seikagaku-teiyo*, 1927 Tokyo, 845.
- 6) H. Simonnet, *Bull. Soc. Chim. Biol.*, 1921, **3**, 583.
- 7) T. Arakawa, *Tohoku J. Exp. Med.*, 1930, **16**, 83 and 118.
- 8) A. Sato, *Jikken Iho*, 1933, **19**, 1554.
- 10) T. Suzuki, *Tohoku J. Exp. Med.*, 1934, **23**, 23.
- 11) A. Takamatsu and A. Sato, *Tohoku J. Exp. Med.*, 1934, **23**, 506.
- 12) T. Kimura, *Tohoku J. Exp.*

Med., 1934, 23 , 494.	57	16. "	S.Z.	33	16	($\pm$)1'	($\pm$)1'	84.05
13) A. Takamatsu, Tohoku J. Exp. Med., 1935, 27 , 439.	58	4.VIII	U.D.	20	2	($\pm$)1'	($\pm$)1'	81.00
14) K. Asakura, Tohoku J. Exp. Med., 1932, 19 , 257.	59	6. "	K.R.	34	3	($\pm$)1'	($\pm$)1'	80.63
15) K. Asakura and H. Ohsako, Tohoku J. Exp. Med., 1933, 20 , 429.	60	7. "	M.K.	44	18	(-)1'	{(-)1' (+)5'	69.75
16) A. Takamatsu, Tohoku J. Exp. Med., 1934, 23 , 372.	61	8. "	M.R.	33	23	($\pm$)1'	(-)1'	63.00
17) M. Ishii, Tohoku J. Exp. Med., 1935, 27 , 532.	62	8. "	O.R.	28	8	(-)1'	(+)1'	59.25
18) T. Kurosawa, Tohoku J. Exp. Med., 1937, 31 , 106.	63	12. "	B.B.	30	3	($\pm$)1'	($\pm$)1'	78.00
19) K. Yoshino, Tohoku J. Exp. Med., 1937, 31 , 287.	64	14. "	S.K.	30	11	(-)1'	{(-)1' (+)5'	59.25
20) L. Pincussen, Mikromethodik. 4th edit., 1928 Leipzig, 66.	65	28. "	O.S.	29	14	($\pm$)1'	($\pm$)1'	45.00
21) S. Kimura, Tohoku J. Exp. Med., 1940, 39 , 90.	66	1.IX	S.K.	24	5	($\pm$)1'	($\pm$)1'	66.00
22) H. Umemura, Tohoku J. Exp. Med., 1942, 43 .	67	3. "	I.M.	29	2	(+)1'	(-)1'	39.00
	68	30. "	M.D.	27	2	($\pm$)1'	(-)1'	50.25
	69	6.X	Y.C.	26	2	(-)1'	{(-)1' (+)5'	52.50
	70	11. "	M.T.	26	2	(-)1'	($\pm$)1'	48.00
	71	15. "	K.R.	28	2	(-)1'	{(-)1' (+)5'	70.50
	72	16. "	M.M.	28	2	(-)1'	{(-)1' (+)5'	35.50
	73	22. "	N.T.	24	1	($\pm$)1'	($\pm$)1'	45.75
	74	28. "	K.T.	31	1	(-)1'	(+)1'	29.50
	75	28. "	O.R.	32	14	(-)1'	{(-)1' (+)5'	63.00
	76	29. "	S.D.	32	24	(-)1'	{(-)1' (+)5'	119.25
	77	30. "	M.Y.	34	12	(-)1'	($\pm$)1'	32.25
	78	30. "	S.T.	27	21	(-)1'	{(-)1' (+)5'	42.75
	79	30. "	K.T.	25	3	(-)1'	(-)1'	53.25
	80	4.XI	K.N.	39	25	(-)1'	{(-)1' (+)5'	93.00
	81	5. "	K.T.	33	16	($\pm$)1'	(-)1'	30.00
	82	6. "	N.M.	31	13	($\pm$)1'	($\pm$)1'	54.00
	83	11. "	A.W.	35	21	(-)1'	{(-)1' (+)5'	33.00
	84	12. "	T.S.	39	8	(-)1'	{(-)1' (+)5'	81.75
	85	12. "	S.T.	28	6	(+)1'	(-)1'	57.75
	86	15. "	E.D.	26	2	(-)1'	($\pm$)1'	48.00
	87	17. "	C.B.	33	7	(-)1'	{(-)1' (+)5'	39.00
	88	19. "	N.R.	28	9	(-)1'	(+)1'	48.00
	89	19. "	Y.M.	26	5	($\pm$)1'	($\pm$)1'	50.00
	90	25. "	E.D.	30	5	($\pm$)1'	($\pm$)1'	76.00
	91	25. "	M.D.	27	13	(-)1'	($\pm$)1'	117.75

* Cf. Footnote of Table 2.

TABLE V.

Uric acid content of urine of lactating mothers with milk of completely or almost completely negative Arakawa's reactions.

Case No.	Date	Name	Age		Arakawa reaction		U (mgrms. per 100 c.c.)
			M. y.	Inf. m.	Right	Left	
1	25.III	S.K.	32	5	(-)5'	(-)5'	55.55
2	27. "	Y.D.	25	7	(-)5'	(-)5'	58.80
3	2.IV	S.T.	25	1	(-)5'	(-)5'	63.55
4	7. "	T.M.	32	4	(-)5'	(-)5'	43.45
5	15. "	K.N.	30	2	(-)5'	(-)5'	85.70
6	16. "	T.S.	34	12	(-)5'	(-)5'	48.50
7	21. "	M.R.	29	2	(-)5'	(±)5'	70.50
8	21. "	I.S.	30	4	(-)5'	(-)5'	93.00
9	23. "	S.T.	34	16	(-)1'	(-)5'	70.50
10	26. "	N.C.	25	13	(±)5'	(-)5'	67.50
11	3.V	Y.D.	28	2	(-)5'	(±)5'	75.00
12	12. "	O.D.	22	6	(-)5'	(±)5'	60.75
13	15. "	A.N.	24	19	(-)5'	(±)5'	70.25
14	17. "	W.B.	38	9	(-)5'	(±)5'	55.50
15	22. "	S.I.	26	14	(-)5'	(-)5'	83.70
16	27. "	K.I.	29	2	(-)5'	(±)5'	84.00
17	7.VII	K.Y.	31	15	(-)5'	(±)5'	124.75
18	30. "	E.D.	35	2	(±)5'	(-)5'	90.75
19	6.VIII	O.N.	33	16	(-)5'	(±)5'	72.50
20	9. "	H.Y.	30	29	(-)5'	(-)5'	136.50
21	15.IX	T.I.	24	1	(-)5'	(-)5'	60.00
22	24. "	T.S.	30	14	(-)5'	(-)5'	109.50
23	25. "	T.S.	39	17	(-)5'	(±)1'	48.00
24	3.X	S.K.	27	12	(-)5'	(-)5'	36.75
25	8. "	M.R.	32	21	(-)5'	(-)5'	128.63
26	11. "	I.W.	32	1	(-)5'	(±)5'	72.00
27	13. "	T.S.	40	11	(-)5'	(±)5'	88.50
28	23. "	H.D.	25	10	(±)5'	(-)5'	97.50
29	25. "	S.K.	28	24	(-)5'	(±)5'	78.00
30	28. "	A.B.	32	14	(-)5'	(-)5'	59.25
31	31. "	A.B.	33	30	(-)5'	(-)5'	61.50
32	5.XI	K.M.	35	2	(-)5'	(±)5'	72.00
33 [†]	10. "	M.M.	30	38	(-)5'	(-)5'	18.00
34	14. "	T.S.	34	10	(-)5'	(-)5'	48.00
35	14. "	S.S.	31	7	(-)5'	(±)5'	87.38

36	15. "	A.B.	27	1	(±)5'	(-)5'	55.50
37	15. "	H.M.	31	2	(-)5'	(-)5'	47.25
38	15. "	E.D.	26	2	(-)5'	(-)5'	74.25
39	20. "	I. W.	32	1	(-)5'	(±)5'	48.00
40	21. "	S.T.	42	2	(-)5'	(±)5'	60.75
41	27. "	K.D.	27	2	(-)5'	(-)5'	64.50

* Cf. Footnote of Table 2.

† This case is quite exceptional, because it was a very late milk.

TABLE VI.

The relationship between the intensity of Arakawa's reaction, classified into 4 groups, and the uric acid content of urine of lactating mothers.

Group of Arakawa's reaction	Number of cases	U (mgrms. per 100 c.c.)		
		Maximum	Minimum	Average
Positive reaction	58	71.25	16.50	40.24
Better intermediate reaction	138	117.5	15.00	50.60
Worse intermediate reaction	91	119.25	27.00	59.14
Completely or almost completely negative reaction	40	136.5	34.00	69.27

TABLE VII.

The result in almost Arakawa-positive cases.

Case No.	Arakawa's reaction												U (mgrms. per 100 c.c.)
	Right						Left						
	0'	1'	2'	3'	4'	5'	0'	1'	2'	3'	4'	5'	
3	±	+	##	##	##	##	+	##	##	##	##	##	32.60
9	±	++	##	##	##	##	±	++	++	##	##	##	42.00
10	+	##	##	##	##	##	±	++	++	##	##	##	58.00
13	+	++	##	##	##	##	±	++	++	##	##	##	71.00
14	±	++	##	##	##	##	-	++	++	++	##	##	37.00
24	±	++	++	##	##	##	±	++	++	##	##	##	35.44
21	±	+	++	##	##	++	+	##	##	##	##	##	18.75

TABLE VII.
Continued.

Case No.	Arakawa's reaction												U (mgrms. per 100 c.c.)
	Right						Left						
	0'	1'	2'	3'	4'	5'	0'	1'	2'	3'	4'	5'	
29	+	+	+	+++	+++	+++	+	+++	+++	+++	+++	+++	36.75
36	+	+	+	+	+++	+++	+	+	+	+	+	+	66.00
37	+	+++	+++	+++	+++	+++	+	+	+	+	+	+++	43.75
44	-	+	+	+++	+++	+++	±	+	+	+++	+++	+++	57.90
48	±	+	+	+++	+++	+++	-	+	+	+	+	+	68.50
50	+	+	+	+	+	+	+	+	+++	+++	+++	+++	63.50
51	+	+	+	+	+	+	±	+	+	+++	+++	+++	52.50
57	-	+	+	+++	+++	+++	-	+	+	+++	+++	+++	34.50
58	+	+	+	+++	+++	+++	-	+	+	+++	+++	+++	36.75
	Average												48.26