# XVII. DISTRIBUTION OF THE NITROGENOUS CONSTITUENTS OF THE URINE ON LOW NITROGEN DIETS.

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During the course of experiments carried out in conjunction with Prof. C. J. Martin on ourselves, with the object of determining our minimum nitrogen requirements and the biological value of certain proteins, the opportunity was taken of investigating the distribution of the nitrogenous constituents in the urine when the total nitrogen output had reached a very low level.

In the particular experiments referred to in this paper, a diet consisting of carbohydrate and fat (corn starch, sucrose, lactose, honey, butter) together with a little lemon juice, inorganic salts and agar-agar was taken during seven days. The fuel value of this diet was equal to 44–52 calories per kilo body weight and the nitrogen content was about 0·3 g. A little tea and coffee was also taken but the nitrogen in these beverages was assumed to be "caffeine nitrogen" and to be excreted as such in the urine during the same 24 hours. It was therefore subtracted from the total nitrogen before calculating the percentage amounts of the other constituents. The above assumption is of course not strictly accurate, but in the one experiment (R.R.) the total amount of such nitrogen is very small, less than 0·1 g., so that any error thus introduced may be considered negligible.

The period on this low nitrogen diet was immediately followed by another of five days during which the same basal diet with the addition of a little milk was taken, the nitrogen intake being thus raised to about 3 g.

The total nitrogen in the urine and in all constituents of the diet was estimated by Kjeldahl's method, urea by van Slyke's urease method, ammonia by Folin's aeration method, amino-acids by formal titration after removal of the ammonia, creatinine by the method of Folin, and uric acid by that of Hopkins as modified by Folin and Schaffer.

The results are set out in Table I. In Table II the distribution of nitrogen on the days for which the total nitrogen output reached its lowest values has been compared with corresponding figures obtained by other investigators.

It will be seen that these observations are in complete agreement with Folin's [1905, 2] generalisations respecting the variation in the distribution of the urinary nitrogen. The creatinine nitrogen is practically constant and is

## Table 1.

Subject: C.J.M. Weight Nov. 28th—61·9 kilos; Dec. 5th—60·5 kilos

| Date 1920 Dec. | Day of exp. | Intake N g. | Volume of urine cc. Sp. gr. of urine | Total N g. | Total N less caffeine N g. | Urea N g. | Ammonia N g. | Amino-acid N g. | Creatinine N g. | Uric acid N g. | Undetermined N g. | In percentage of total N (less caffeine N) Urea | Ammonia | Urea + ammonia | Amino-acid | Creatinine | Uric acid | Undetermined |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4 | 6 | ·35 } ·29[1] } | 1421 1·014 | 2·69 | 2·40 | 1·27 | ·29 | ·05 | ·45 | ·07 | ·27 | 52·9 | 12·1 | 65·0 | 2·1 | 18·7 | 2·9 | 11·3 |
| 5 | 7 | ·33 } ·26[1] } | 908 1·020 | 2·39 | 2·13 | 1·08 | ·21 | ·05 | ·43 | ·07 | ·29 | 50·7 | 9·9 | 60·6 | 2·3 | 20·2 | 3·3 | 13·6 |
| 6[2] | 8 | 3·37 } ·25[1] } | 1708 1·011 | 2·67 | 2·42 | 1·24 | ·30 | ·11 | ·47 | ·02 | ·28 | 51·2 | 12·4 | 63·6 | 4·5 | 19·4 | ·8 | 11·5 |
| 7 | 9 | 3·36 } ·17[1] } | 1207 1·0165 | 2·74 | 2·57 | 1·39 | ·23 | ·08 | ·42 | ·06 | ·39 | 54·1 | 9·0 | 63·1 | 3·1 | 16·3 | 2·3 | 15·2 |
| 8 | 10 | 3·42 } ·29[1] } | 1060 1·020 | 3·30 | 3·01 | 1·91 | ·24 | ·06 | ·45 | ·06 | ·29 | 63·4 | 8·0 | 71·4 | 2·0 | 15·0 | 2·0 | 9·6 |
| 9 | 11 | 3·40 } ·34[1] } | 1128 1·0185 | 3·46 | 3·12 | 1·96 | ·28 | ·06 | ·44 | ·08 | ·30 | 62·8 | 9·0 | 71·8 | 1·9 | 14·1 | 2·6 | 9·6 |
| Subject: R.R. Weight Nov. 28th—58·6 kilos; Dec. 5th—57·7 kilos. | | | | | | | | | | | | | | | | | | |
| 3 | 5 | ·32 } ·09[1] } | 1886 1·007 | 2·08 | 1·99 | ·74 | ·35 | ·04 | ·50 | ·07 | ·29 | 37·2 | 17·6 | 54·8 | 2·1 | 25·1 | 3·5 | 14·5 |
| 4 | 6 | ·30 } ·07[1] } | 1703 1·010 | 2·24 | 2·17 | ·98 | ·27 | ·05 | ·50 | ·10 | ·27 | 45·2 | 12·4 | 57·6 | 2·3 | 23·0 | 4·6 | 12·4 |
| 5 | 7 | ·27 } ·06[1] } | 1547 1·009 | 2·07 | 2·01 | ·91 | ·25 | ·04 | ·47 | ·07 | ·27 | 45·3 | 12·4 | 57·7 | 2·0 | 23·3 | 3·5 | 13·4 |
| 6[2] | 8 | 2·98 } ·10[1] } | 1783 1·010 | 2·59 | 2·49 | 1·26 | ·31 | ·04 | ·50 | ·07 | ·31 | 50·6 | 12·5 | 63·1 | 1·6 | 20·1 | 2·8 | 12·4 |
| 7 | ·9 | 2·94 } ·09[1] } | 1991 1·011 | 3·04 | 2·95 | 1·71 | ·29 | ·04 | ·50 | ·03 | ·38 | 57·9 | 9·8 | 67·7 | 1·4 | 17·0 | 1·0 | 12·9 |
| 8 | 10 | 3·09 } ·16[1] } | 1403 1·012 | 3·38 | 3·22 | 2·06 | ·26 | ·04 | ·45 | ·05 | ·36 | 64·0 | 8·1 | 72·1 | 1·2 | 14·0 | 1·5 | 11·2 |
| 9 | 11 | 2·91 } ·15[1] } | 1134 1·014 | 3·01 | 2·86 | 1·69 | ·29 | ·04 | ·45 | ·09 | ·30 | 59·1 | 10·1 | 69·2 | 1·4 | 15·8 | 3·1 | 10·5 |
| 10 | 12 | 2·97 } ·18[1] } | 1260 1·015 | 3·01 | 2·83 | 1·89 | ·26 | ·03 | ·46 | ·02 | ·17 | 66·8 | 9·2 | 76·0 | 1·1 | 16·2 | ·7 | 6·0 |

[1] N from tea and coffee—taken as "caffeine N." [2] Milk diet began on Dec. 6.

## Table II.

| Observer | Subject | Body weight | Day of exp. | Intake N g. | Total N g. | Urea N g. | Ammonia N g. | Amino-acid N g. | Creatinine N g. | Uric acid N g. | Undetermined N g. | Percentages of total N Urea | Ammonia | Urea + Ammonia | Amino-acid | Creatinine | Uric acid | Undetermined |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Folin [1905, 1] | H.B.H. | 85·7 | 7 | 1 | 3·6 | 2·2 | ·42 | — | ·60 | ·09 | ·27 | 61·7 | 11·3 | 73·0 | — | 17·2 | 2·5 | 7·3 |
| ,, | E.S.A. | 55·7 | 7 | 1 | 2·8 | 1·7 | ·28 | — | ·41 | ·08 | ·32 | 60·7 | 10·0 | 70·7 | — | 14·0 | 3·0 | 11·6 |
| ,, | A.H. | 70·7 | 7 | 1 | 3·5 | 2·1 | ·27 | — | ·50 | ·14 | ·52 | 59·3 | 7·8 | 67·1 | — | 14·1 | 4·0 | 14·8 |
| Zeller [1914] | — | 67·9 | 17 | 1·04 | 2·88 | 1·42 | ·34 | ·22 | ·63 | ·15 | ·05 | 49·3 | 11·7 | 61·0 | 7·5 | 21·9 | 5·1 | 1·8 |
| Graham and Poulton [1912] | G.G. | 61·4 | 9 | ·91 | 2·25 | 1·047 | ·343 | — | ·598 | ·072 | ·19 | 46·54 | 15·25 | 61·79 | — | 26·58 | 3·2 | 8·44 |
| Robison | C.J.M. | 60·5 | 7 | ·33 } ·26[1] } | 2·13[2] | 1·08 | ·21 | ·05 | ·43 | ·07 | ·29 | 50·7 | 9·9 | 60·6 | 2·3 | 20·2 | 3·3 | 13·6 |
| ,, | R.R. | 57·8 | 5 | ·32 } ·09[1] } | 1·99[2] | ·74 | ·35 | ·04 | ·50 | ·07 | ·29 | 37·2 | 17·6 | 54·8 | 2·1 | 25·1 | 3·5 | 14·5 |
| ,, | R.R. | — | 7 | ·27 } ·06[1] } | 2·01[2] | ·91 | ·25 | ·04 | ·47 | ·07 | ·27 | 45·3 | 12·4 | 57·7 | 2·0 | 23·3 | 3·6 | 13·4 |

[1] N from tea and coffee—taken as "caffeine N." [2] Total urine N less "caffeine N."

equal to 7·3 mg. (C.J.M.) and 8·2 mg. (R.R.) per kilo body weight. These amounts like those of the other constituents are very similar to those found by Folin and others. The values for the total nitrogen are amongst the lowest on record and correspond with still further reductions in the percentage of urea nitrogen, this falling in one instance to 37 % of the total. The last figure was however accompanied by a somewhat high percentage of ammonia, but the sum of the urea and ammonia nitrogen was only 54·6 % of the whole amount. It would have been interesting to discover whether this sum (urea + ammonia) could have been further reduced by the ingestion of alkalies or whether any decrease in the ammonia nitrogen would have been accompanied by an increase in the urea.

The question as to whether any part of the urea nitrogen represents what Folin has termed the endogenous metabolism remains open.

I wish to express my indebtedness to Prof. C. J. Martin for his interest and help in this work.

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