NITROGEN AND SULPHUR ELIMINATION IN 24 HOURS URINE BY ELDERLY INDIANS

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Summary: Urinary output of N\textsubscript{2} - urea, creatinine, uric acid, ammonia and organic and inorganic SO\textsubscript{3} were repeatedly examined in healthy vegetarian subjects in Bombay - 35 elderly and 2 young. Their routine diet examined for a week indicated an average intake of 56 g proteins (15 g animal) and excretion of about 8 g N\textsubscript{2}, 0.75 g of SO\textsubscript{3} both in young and old subjects. These are much lower than figures reported for Europeans taking protein rich diets.

Two elderly subjects supplemented their protein intake to 95 g/day (50 g animal) for 3 weeks. A progressive rise in the outputs of N\textsubscript{2} and SO\textsubscript{3} with increasing protein intakes was seen.

SO\textsubscript{3} estimation like that of N\textsubscript{2} (urea) is indicative of the protein consumption of a person, but the estimations of urea output per day being easier are to be preferred.

Key words: protein intake urinary N\textsubscript{2} and SO\textsubscript{3} output elderly Indians

INTRODUCTION

That the daily output of N\textsubscript{2} in urine of Indians is low, has been reported by several workers (2, 7, 8, 9). So also of Sulphur (2, 7, 9). The sources of these compounds are proteins which are consumed in low quantities in Indian diet. Their urinary elimination, therefore, is considerably lower when compared with that of Europeans who habitually consume a high meat rich diet.

Most of the observations in Indians have been in young subjects. An attempt was made therefore, to examine the daily output of Nitrogen and Sulphur in the urine of elderly Indian subjects in Bombay, on their usual diet and then on increased protein intake continued for some weeks.

MATERIALS AND METHODS

In the study, there were 2 young subjects av. age 29 years and 35 elderly men av. age 68.4 years, all in sound state of health after thorough clinical and laboratory tests and without any gastro-intestinal disorder.
<table>
<thead>
<tr>
<th>Investigator</th>
<th>Diet</th>
<th>Subject</th>
<th>Urea</th>
<th>Creatinine</th>
<th>Uric acid</th>
<th>Ammonia</th>
<th>Total $N_2$</th>
<th>Inorg. $SO_3$</th>
<th>Org. $SO_3$</th>
<th>Total $SO_3$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Folin (4)</td>
<td>Pr.</td>
<td>Young</td>
<td>14.7</td>
<td>0.58</td>
<td>0.18</td>
<td>0.49</td>
<td>16.8</td>
<td>3.27</td>
<td>0.37</td>
<td>3.64</td>
</tr>
<tr>
<td></td>
<td>Rich</td>
<td>Euro.</td>
<td>2.2</td>
<td>0.60</td>
<td>0.09</td>
<td>0.42</td>
<td>3.6</td>
<td>0.46</td>
<td>0.30</td>
<td>0.76</td>
</tr>
<tr>
<td>Bodansky (1)</td>
<td>Pr.</td>
<td>Young</td>
<td>20.45</td>
<td>0.64</td>
<td>0.30</td>
<td>0.82</td>
<td>23.28</td>
<td>2.82</td>
<td>0.36</td>
<td>3.18</td>
</tr>
<tr>
<td></td>
<td>Rich</td>
<td>Euro.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Poor</td>
<td>Euro.</td>
<td>2.9</td>
<td>0.52</td>
<td>0.11</td>
<td>0.17</td>
<td>4.2</td>
<td>0.64</td>
<td>0.11</td>
<td>0.75</td>
</tr>
<tr>
<td>Davidson (3)</td>
<td>Pr. there</td>
<td>Young</td>
<td>188 g</td>
<td>23.7</td>
<td>0.63</td>
<td></td>
<td>1.15</td>
<td>26.0</td>
<td></td>
<td>1.44</td>
</tr>
<tr>
<td></td>
<td>69 g</td>
<td>Young</td>
<td>8.5</td>
<td>0.63</td>
<td></td>
<td>0.53</td>
<td>10.2</td>
<td></td>
<td></td>
<td>0.60</td>
</tr>
<tr>
<td></td>
<td>39 g</td>
<td>Young</td>
<td>6.0</td>
<td>0.65</td>
<td></td>
<td>0.38</td>
<td>7.7</td>
<td></td>
<td></td>
<td>0.66</td>
</tr>
</tbody>
</table>

**EASTERN**

| Campbell (2)     | Mixed    | Young  | 6.2  | 0.41       | 0.12      | 0.58    | 7.7         | 0.73         | 0.15        | 0.88         |
| Ray and Ganguli (9) | Mixed | Young  | 2.1  | 0.51       | 0.23      |         | 4.83        | 0.65         | 0.10        | 0.75         |
| Pathak and Bhatt (7) | Veg.    | Young  | 5.21 |           |           |         | 6.23        | 1.03         | 0.09        | 1.12         |
| Pathak and Joshi (8) | Veg.    | Elderly| 5.25 | 0.39       | 0.19      | 0.32    | 6.15        |              |            |              |
| Present Series   | 56 g Veg.| Elderly| 5.88 | 0.40       | 0.14      | 0.26    | 7.69        | 0.69         | 0.07        | 0.76         |
Urine for 24 hrs was collected in plastic bottles kept in cool and dark place, with chloroform as preservative. Routine clinical laboratory tests on these 24 hrs collections were done for abnormal substances, total volume, Sp. gr., etc. Quantitative estimations were carried out for urea by hypobromite, uric acid by Brown's, Ammonia by aeration titration and creatinine by Bonsne's and Taussky method; and for inorganic and organic SO₃ by Folin's method with barium chloride as a precipitant.

Total N₂ was calculated by adding the results re. N₂ compounds - urea, uric acid, creatinine, ammonia and total SO₃ by adding inorganic and organic SO₃.

Most subjects collected 24 hrs specimens more than twice. Results of repeated examination were close to their former findings.

All subjects were vegetarians. Both young and elderly subjects took about 56 g proteins (15 g animal) averagely.

Two elderly subjects 60 and 66 yrs respectively, later on supplemented their diet with milk powder making their total daily intake of 95 g proteins, (50 g animal - milk protein) for over 3 weeks during which their output for 24 hrs was examined twice in a week.

RESULTS AND DISCUSSION

Total N₂ and SO₃ in 24 hrs.

<table>
<thead>
<tr>
<th>Subjects (No.)</th>
<th>No. of</th>
<th>Prot. in diet</th>
<th>Urea</th>
<th>Creatinine</th>
<th>Uric acid</th>
<th>Ammonia</th>
<th>Total N₂</th>
<th>Inorg. SO₃</th>
<th>Org. SO₃</th>
<th>Total SO₃</th>
</tr>
</thead>
<tbody>
<tr>
<td>Young (2)</td>
<td>14</td>
<td>56 g</td>
<td>7.77</td>
<td>0.27</td>
<td>0.21</td>
<td>0.26</td>
<td>8.52</td>
<td>0.67</td>
<td>0.080</td>
<td>0.75</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>±2.06</td>
<td>±0.05</td>
<td>±0.02</td>
<td>±0.09</td>
<td>±2.06</td>
<td>±0.16</td>
<td>±0.033</td>
<td>±0.14</td>
</tr>
<tr>
<td>Elderly (35)</td>
<td>75</td>
<td>56 g</td>
<td>5.88</td>
<td>0.40</td>
<td>0.14</td>
<td>0.26</td>
<td>7.69</td>
<td>0.69</td>
<td>0.072</td>
<td>0.76</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>±3.93</td>
<td>±0.13</td>
<td>±0.04</td>
<td>±0.22</td>
<td>±1.83</td>
<td>±0.21</td>
<td>±0.027</td>
<td>±0.24</td>
</tr>
<tr>
<td>Elderly (2)</td>
<td>11</td>
<td>95 g</td>
<td>11.47</td>
<td>0.34</td>
<td>0.15</td>
<td>0.38</td>
<td>12.43</td>
<td>0.96</td>
<td>0.127</td>
<td>1.09</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>±1.73</td>
<td>±0.08</td>
<td>±0.06</td>
<td>±0.15</td>
<td>±2.03</td>
<td>±0.27</td>
<td>±0.057</td>
<td>±0.30</td>
</tr>
</tbody>
</table>
That the elderly Indian subjects also pass low amounts of $N_2$ or $SO_3$ is seen in this inquiry. These amounts are almost equal to the quantities reported in Europeans kept on protein-poor diet (1,3,4).

While Europeans passed 15 to 23 g $N_2$ in their urine on their protein-rich diet, the Eastern people hardly eliminated 5-6 g of $N_2$ per day. Bulk of the $N_2$ came from urea, but $N_2$ excreted as uric acid, creatinine, ammonia was comparatively very small, only a fraction of the total $N_2$ being eliminated. Also with varying protein intakes these (uric acid, creatinine, ammonia) do not fluctuate as urea (Fig. 1).

![Graph showing total $N_2$ and $SO_3$ and urea, creatinine, uric acid, ammonia excreted in 24 hrs urine by elderly subjects on varied protein intakes.]

**Urea:**

Increasing amounts of urea were passed with higher protein intakes by the elderly subjects (Fig. 1). Averagely about 6 g urea $N_2$ was passed while taking 56 g protein food; while in the two elderly subjects taking 95 g proteins (50 g animal) excretion rose to 11.5 g/urea $N_2$/day.

The total $SO_3$ content also increased with larger protein consumption - from 0.75 to 1.09 g/day. It was also noted that with larger protein intakes, the increase in $N_2$ elimination shot higher than $SO_3$ output.

**Protein intake and $N_2$ and $SO_3$ in urine (Fig. 2):**

For easier comparison graphs of $N_2$ in g and $SO_3$ in tenth of g are drawn together.

**Effect of age:**

Daily elimination of $N_2$ and $SO_3$ in urine of the young and elderly subjects (Table II).
Fig. 2: N\textsubscript{2} in g, and SO\textsubscript{3} in 1/10g, passed in 24 hrs urine by elderly subjects on varying protein intakes. Amounts of N\textsubscript{2} and SO\textsubscript{3} excreted rise with intakes of proteins almost parallely.

Most of the previous reports have been on young subjects. Since the findings on young and upper age are very similar, it may be assumed that for corresponding protein intakes age does not appear to make material difference, if the subjects are in sound state of health.

Other nitrogenous substances:

Graph of protein intakes, and N\textsubscript{2} fractions other than urea (Fig. 3):

Fig. 3: Amount of N\textsubscript{2} of ammonia, creatinine, uric acid passed in 24 hrs. urine by elderly subjects on varying protein intakes. Excretion of these components appears to be unrelated and not rise in proportion of protein intakes.
Creatinine:

The elderly subjects excreted 0.40 ± 0.13 and the young 0.27 ± 0.05 g of creatinine N₂ per day. Creatinine index - creatinine in urine mg/body wt in kg for elderly on similar protein intakes was variable. Alterations in protein intake were in no constant relationship with output of creatinine. This index averagely was 21 in elderly and 13 in the young subjects, with 56 g proteins in their diet. In the two elderly while taking 95 g proteins, the creatinine index was found to be 14.

Uric acid:

The young excreted 0.21 ± 0.017 and the elderly 0.14 ± 0.04 g uric acid N₂ a day averagely. This item too, seemed unrelated to total protein intake (Fig. 2). This uric acid output in Indians is closer to the amounts reported for europeans, than is urea or total N₂ (Table I).

Ammonia:

Ammonia N₂ on their usual diet was 0.26 g averagely in both young and the elderly. Since the end products of Indian vegetarian diet are not so acid as with the high protein diet of the West; and since it is the kidneys that contribute ammonia to neutralize the acid end products.

Sulphur:

Excretion of sulphur is expressed in terms of SO₃. The SO₃ derived from dietary protein is metabolised to inorganic and organic forms in the liver and eliminated by kidneys. While a small part gets conjugated in the liver into ethereal forms, the bulk of sulphur is thrown out as inorganic.

The elderly on their usual diet excreted total SO₃ 0.76 ± 0.24 g/day and the young also 0.75 ± 0.14 g/day. The two elderly with high protein intake of 95 g (50 g animal) averagely excreted 1.09 ± 0.30 g SO₃/day (Table II).

Ratio between the SO₃ and N₂ in urine was about 1 : 11 in the present series. Though N₂ and SO₃ come from proteins consumed in food, the ratio of S:N does not correspond with variable amounts of proteins in diet. Some of the SO₃ may be derived from sources other than proteins. The efficiency with which the S or N containing compounds are absorbed, utilised and finally eliminated, is apt to alter the relationship of S and N in urine.
Wendt (10) obtained S:N ratio of 1:14 in urine and 1:11 when total urine and stools were considered. Ray and Ganguli (9) obtained a ratio 1:16.1 in Bengalee subjects on mixed diet. Pathak and Bhatt (7) in vegetarian Gujarati subjects reported ratio of 1:11. They did not find difference in excretion between the sexes. Davidson (3) on high protein diet obtained a ratio 1:12.5 and on low protein diet, 1:9.4.

Ratio between organic/inorganic SO₃ in urine:

Ray and Ganguli (9) noted a ratio of 1:6.5; Pathak and Bhatt (7) obtained 1:9 between organic = inorganic amounts of SO₃ excreted in the urine of their subjects.

In present series organic and inorganic forms of SO₃ were 0.072 : 0.69 g on ordinary diet and 0.13 : 0.96 g on high protein diet, giving a ratio of 1:9.8 on ordinary diet and 1:7.4 on high protein intakes. The ratio is thus changed with the quantity of protein consumed.

As calculated the amount of N₂ eliminated in urine was about 95% of the N₂ intake; while only about half (50%), of S taken in diet was noted to be thrown out. This may be due to all SO₃ taken being not absorbed and its elimination not so complete as of N₂.

Harrison (6) had stated “measurements of a day’s output in urine of total sulphur gives an approximate indication of the quantity of proteins that the subject is ingesting”. It is obvious that SO₃ output varies with protein intake of subjects (Fig. 3). Total N₂ in urine, particularly urea, is better indicative of the protein intakes. Moreover, estimations for SO₃ being not so simple and easy, the estimations of total urea eliminated in urine in 24 hrs are preferable.

REFERENCES