THE EFFECT OF ENVIRONMENTAL TEMPERATURE ON THE BLOOD PROTEIN BOUND IODINE CONTENT OF THYROXINE MAINTAINED THYROIDECTOMIZED RATS

By

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In 1943 Dempsey & Astwood published their observations on the thyroid hormone production of normal rats at various environmental temperatures. They reached the conclusion that the amount of hormone produced by the thyroid increases with decreasing temperatures. As early as 1919 Stoland & Kimey had found that high doses of thyroid powder given to rats were more toxic when the animals were kept at 32°C., than when the room temperature was 18°C. These findings have been confirmed by Bodansky et al. (1936).

In order to investigate the disappearance rate of thyroid hormone from the bloodstream under various conditions of environmental temperature we studied the effect of changes in environmental temperature on the serum concentration of protein bound iodine of thyroidectomized rats; these were maintained on a daily dose of dl-thyroxine sufficient to prevent goiter with propylthiouracil treatment at 21°C.

METHODS

All animals used in this study were female rats of a great Wistar strain (weight 150–175 gm.). In order to prevent extra thyroidal thyroid hormone synthesis (Morton et al.,

1. This investigation was performed with the aid of the National Health Organization T. N. O., The Hague.
as far as possible, the animals were fed a low iodine diet as described by Leblond et al. (1952) for 10 days prior to thyroidectomy and until necropsy. Thyroidectomies were performed as described by Ingle & Griffith. Completeness of thyroidectomies was controlled by making radioautograms to the thyroid region of the trachea with adhering tissues after a dose of 5 μc 131I had been given 24 hours prior to the dissection of the animals.

After the operation the animals were given 6 μg. dl thyroxine per day intraperitoneally. This dose had been found to be effective in preventing the thiouracil goiter at an environmental temperature of 21° C., when tested according to the method of Dempsey & Astwood (1943).

On the 5th day, immediately after the injection of thyroxine, the animals were put in groups of 6-9 at thermostatically controlled room temperatures of resp. 4, 21 and 32° C. After 24 hours the animals were killed by stunning and blood was taken from the abdominal aorta. Blood samples were analyzed for their P. B. I. content with the wet ashing method of Barker (1947).

The same studies were performed, using normal animals which were fed a commercially obtained diet, with an iodine content of 300 μg. I per kg.

RESULTS

In Table 1 the results are shown in thyroidectomized rats maintained with 6 μg. dl-thyroxine per day. A statistically significant lower blood protein bound iodine (P. B. I.) content was found in the animals kept at 4° C. as compared with the 32° C. and 21° C. groups.

Between the 32° and 21° groups no significant variation in blood P. B. I. was observed.

The data obtained in normal rats are summarized in Table 2. An almost significantly higher (0.02 < P < 0.05) blood P. B. I. was found in the rats kept at room temperature of 4° C.

Table 1.
Blood protein-bound iodine of thyroxine maintained, thyroidectomized rats, kept at various environmental temperatures for 24 hours.

<table>
<thead>
<tr>
<th>Group</th>
<th>No. animals</th>
<th>Environmental temperature</th>
<th>Serum P. B. I. (μg./100 ml. ± s. e.)</th>
<th>Statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>18</td>
<td>32°</td>
<td>5.4 ± 0.38</td>
<td>△ I-II t = 0.95 p = &gt;0.3</td>
</tr>
<tr>
<td>II</td>
<td>18</td>
<td>21°</td>
<td>4.9 ± 0.38</td>
<td>△ I-III t = 4.8 p = &lt;0.001</td>
</tr>
<tr>
<td>III</td>
<td>21</td>
<td>4°</td>
<td>3.1 ± 0.31</td>
<td>△ II-III t = 3.9 p = &lt;0.01</td>
</tr>
</tbody>
</table>
Table 2.
Blood protein bound iodine of normal rats, kept at various environmental temperatures for 24 hours.

<table>
<thead>
<tr>
<th>Group</th>
<th>No. animals</th>
<th>Environmental temperature</th>
<th>Serum P. B. I. (μg./100 ml. ± s. e.)</th>
<th>Statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>20</td>
<td>32°</td>
<td>3.6 ± 0.29</td>
<td>t = 2.29</td>
</tr>
<tr>
<td>II</td>
<td>15</td>
<td>4°</td>
<td>4.9 ± 0.51</td>
<td>ΔI-II 0.02 &lt; p &lt; 0.05</td>
</tr>
</tbody>
</table>

DISCUSSION

These data obtained in thyroidectomized rats indicate that the disappearance from the blood of thyroxine is stimulated when the environmental temperature is reduced. Thus they support the hypothesis that peripheral thyroxin consumption is increased at lower room temperatures. From other observations mentioned in the literature, additional evidence supporting this hypothesis can be obtained. For example Leblond & Eartly (1952) found an increased maintenance dose of thyroxine to be necessary at a lower room temperature, when the survival time of thyroidectomized rats on a low iodine regimen was used as test criterion.

From the results obtained in normal rats the conclusion seems to be justifiable that the thyroid hormone production is stimulated by low environmental temperatures to such an extent that the increased demand of the peripheral tissues can be met.

Our results seem to be in agreement with those obtained by Bondy et al. (1952) in similar experiments, but after administering higher doses of thyroxine to the animals.

SUMMARY

1. The effect of various environmental temperatures on the blood protein bound iodine (P. B. I.) content of the serum of thyroxine maintained thyroidectomized and of normal rats has been studied.
2. Thyroidectomized animals, kept at 4° C. and maintained on 6 μg. dl-thyroxine per day, had significantly lower P. B. I. blood levels than did animals kept at 21° or 32° C.
3. In normal rats an almost significant higher (0.02 < P < 0.05) P. B. I. level of the serum was found when the animals were kept at 4° C. as compared with the values obtained at a room temperature of 32° C.
REFERENCES