Short communication

Effect of thiocyanate ingestion through milk on thyroid hormone homeostasis in women

BY KISHORE K. BANERJEE1, P. MARIMUTHU1, PIYALI BHATTACHARYYA2
AND MALAY CHATTERJEE2*

1All India Institute of Hygiene and Public Health, 110 Chittaranjan Avenue, Calcutta 700 073, India
2Division of Biochemistry, Department of Pharmaceutical Technology, Jadavpur University, Calcutta, India

(Received 11 February 1997 – Revised 19 May 1997 – Accepted 26 May 1997)

A thyroid-hormonal evaluation of thirty-five women consuming commercially packed milk containing thiocyanate was carried out. The mean serum thiocyanate concentration, which was measured by the FeCl3 colour test, was significantly higher \((P < 0.01)\) than that of control subjects. Serum thyroxine (T4), triiodothyronine (T3) and thyroid-stimulating hormone (TSH) concentrations of exposed women were compared with those of thirty-five control subjects. Thiocyanate ingestion was associated with lower levels of T4 \((P < 0.01)\) and higher levels of TSH \((P < 0.01)\) compared with the control subjects. T3 was found to be higher in the women consuming thiocyanate-containing milk but the difference was not significant. The serum T4 level was found to be negatively correlated \((r - 0.359, P < 0.05)\) while the TSH level was positively correlated \((r 0.354, P < 0.05)\) with thiocyanate concentration in the exposed group. From this study, it appears that ingestion of milk with added thiocyanate impairs thyroid function.

Milk: Thiocyanate: Thyroid

It has been found that the lactoperoxidase–thiocyanate–hydrogen peroxide system (LP system) can be successfully used for retarding bacterial growth in raw milk (Kalra, 1981; Singh & Ranganathan, 1981). In this system, \(\text{H}_2\text{O}_2\) produces OSCN which acts as a bacteriostat (Babu & Shemoli Kar, 1992). The process of preservation by the LP system requires addition of thiocyanate to the milk. The prevalence of thiocyanate use for milk preservation in the range of 30–50 mg/l is practised in local dairies, despite its limited international use.

Thiocyanate, with the same molecular size as iodide, competitively inhibits I and tyrosine oxidation when present at high concentrations \((60–80 \mu\text{mol/l})\) and thus affects I metabolism by inhibiting the uptake of I by the thyroid gland, whereas at low concentration \((0.5–1.0 \mu\text{mol/l})\), it exerts a stimulatory effect on the coupling reaction by interacting with thyroid peroxidase \((\text{iodide peroxidase}; \text{EC} \ 1.11.1.8)\) (Geen, 1978).

In view of these facts, we were interested in assessing thyroid function in women who regularly consume commercially packed cows’ milk containing thiocyanate, by analysing and correlating the indicators of thyroid function to the serum thiocyanate level. Serum thyroxine (T4), triiodothyronine (T3) and thyroid-stimulating hormone (TSH) concentrations were used as the biochemical indices of thyroid function.

* For reprints.
METHODS

Thirty-five women who, for more than five consecutive years, had consumed 250 ml/d of a commercially packed cows’ milk available in Calcutta city, were designated as the thiocyanate-exposed group. Thirty-five non-exposed women, matched for age and dietary habits, who had consumed the same quantity of raw cows’ milk, were designated as the control group. All subjects were selected randomly from a population of similar socioeconomic status with a uniform dietary pattern who did not use tobacco products and had no prior history of thyroid disease.

Blood (5 ml) was collected from each subject. The sera were separated by centrifugation at 3000 rev./min for 10 min and stored at $-20^\circ$.

$T_3$ and $T_4$ estimations were performed by enzyme immunoassay, using the kit manufactured by UBI-Magiwel, (Mountain View, CA, USA; catalogue nos. HP-702 and HP-703), whereas TSH estimation was by radioimmunoassay using a kit from the Bhabha Atomic Research Centre (Bombay, India) (Bhandarka & Pillai, 1992). Thiocyanate was analysed by the FeCl$_3$ colorimetric test (George & Schenck, 1983). The cerous-arsenite reaction was adapted to the measurement of urinary I levels (Benotti et al. 1965). All the samples were assayed in the same run.

The normal ranges for $T_3$, $T_4$ and TSH provided by the manufacturers of the kits were 0.93–3.12 nmol/l, 110–270 nmol/l and 0.2–4.0 µU/ml respectively. While the normal level of serum thiocyanate is typically stated as 34–69 µmol/l (Pechacek et al. 1985), the level ranged from 80 to 100 µmol/l in non-smokers in another study (Banerjee & Marimuthu, 1994).

Pearson’s correlation coefficients and Student’s $t$ test were used for data analysis.

RESULTS

Measured urinary I level was found to be 115 (SE 8.5) µg/l in the exposed group which was almost identical to that of the control group (123 (SE 7.8) µg/l) and there was no statistically significant difference in urinary I concentration between these groups.

Significantly lower levels of serum $T_4$ ($P < 0.01$) and higher levels of TSH ($P < 0.01$) were observed in the thiocyanate-exposed group compared with the non-exposed control subjects. Serum $T_3$ level was found to be higher but the increase was statistically insignificant (Table 1).

In the exposed group a significant negative correlation was found between serum $T_4$ and thiocyanate concentrations ($r = -0.359, P < 0.05$) and a significant positive correlation was

<table>
<thead>
<tr>
<th>Study group</th>
<th>Thiocyanate-exposed women</th>
<th>Non-exposed controls</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SE</td>
</tr>
<tr>
<td>SCN (µmol/l)</td>
<td>230.0**</td>
<td>10.0</td>
</tr>
<tr>
<td>$T_4$ (nmol/l)</td>
<td>87.8**</td>
<td>6.6</td>
</tr>
<tr>
<td>$T_3$ (nmol/l)</td>
<td>2.39</td>
<td>0.32</td>
</tr>
<tr>
<td>TSH (µU/ml)</td>
<td>2.49**</td>
<td>0.20</td>
</tr>
</tbody>
</table>

** Mean values were significantly different from those for the control group, $P < 0.01$.  

https://www.cambridge.org/core/terms. 
https://doi.org/10.1079/BJN19970186
found between serum TSH and thiocyanate concentrations ($r = 0.354$, $P < 0.05$). No significant correlations of $T_3$, $T_4$ and TSH with thiocyanate concentrations were found in the control group. The observed values for all the indices were normally distributed.

**DISCUSSION**

The significantly higher serum thiocyanate concentration in the women consuming thiocyanate-containing milk is consistent with their presumed greater exposure than that of the control group. The average thiocyanate concentration in the milk was found to be 45 mg/l.

A number of carefully studied cases of goitre subsequent to thiocyanate therapy for hypertension have been reported, and in all of these cases the goitre decreased in size when the thiocyanate administration was terminated or following treatment with thyroid hormone. Substances such as cabbage, cyanide and thiocyanate salts have all been used successfully to produce goitres in animals, and experimental study of such goitres has shown that the thiocyanate radical is responsible for this effect through prevention of I uptake (Vogel et al. 1981).

Our findings of decreased levels of $T_4$ and increased levels of TSH in the women consuming thiocyanate through milk indicated that thiocyanate does inhibit I metabolism by the thyroid gland. The level of $T_3$, the metabolically more potent of the thyroid hormones, was found to be elevated but this was not statistically significant. One could well speculate that this reflects a compensatory increase in the efficacy of thyroid hormone synthesis.

Normally $T_3$ and $T_4$ influence TSH secretion through negative feedback regulation. Both $T_3$ and $T_4$ might have had an influence at the pituitary level and the slight excess of circulating $T_3$ as found in the present study could have shut down the release of TSH, whereas the lower level of $T_4$ might have caused an enhanced secretion of TSH. The higher level of TSH in the exposed group within the normal range could be the net result of two opposing effects, of which the effect of the lower level of $T_4$ was predominant.

Therefore, our findings suggest that ingestion of thiocyanate-containing milk inhibits $T_4$ synthesis. However, due to normal regulatory mechanisms circulating levels of $T_3$ and TSH are enhanced.

**REFERENCES**


© Nutrition Society 1997