CXVII. THE BIOCHEMISTRY AND PHYSIOLOGY OF GLUCURONIC ACID.

VII. A NOTE ON THE CONJUGATION OF BORNEOL IN MAN.

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(Received March 27th, 1936.)

IN two instances reported by Quick [1928] in which borneol was ingested by man, about 80 % was excreted conjugated with glucuronic acid within 10 hours of the administration of 2 g., whilst 69 % was similarly excreted within 6 hours after giving 3.5 g. In the dog Quick has observed 52 % excretion within an unspecified time. We have extended these experiments to a greater number of human cases, and have measured the excretion of conjugated borneol at various times between 6 and 12 hours after ingestion. In agreement with Quick we find that the maximum amount of borneol conjugated with glucuronic acid seems to be about 80 % of that ingested and that, in the normal human being, this limit is reached within 12 hours. Preliminary experiments on certain pathological cases seem to indicate that, where the liver is affected, there may be a marked delay in this conjugation process.

EXPERIMENTAL.

Twenty-four student volunteers of age range 15–25 years, and all free from albuminuria, were each given about 2 g. of borneol accurately weighed in gelatin capsules. All urines collected from the time of ingestion to the end of the experiment (*i.e.* 6–12 hours) were analysed for borneolglucuronic acid. A measured volume of the urine was acidified and extracted for 3 hours in a liquid extractor with ether. The ether was removed and its content of borneolglucuronic acid was hydrolysed with HCl. After neutralising, the glucuronic acid was determined by

Table I.

Subject	Urine vol. ml.	Time hours	% borneol conjugated with glucuronic acid	Subject	Urine vol. ml.	Time hours	% borneol conjugated with glucuronic acid
R. T. W.	910	20.5	78.7	W. G.	310	10	79.3
H. K.	505	12.5	77.5	W. L.	660	10	76.3
G. M. J.	390	12	77.5	W. T.	445	10	75.0
J. H.	345	11.5	78.9	V. M.	310	10	74.8
H. S.	305	11	78.1	J. P. S.	375	(10)?	73.6
A. G.	400	11	76.0	J. H.	630	8.5	70.9
R. G. D.	690	11	74.1	R. T. W.	242	8.5	68.0
R. T. W.	300	10.5	77.9	J. C. J.	360	7	60.5
C. D. C.	432	10.5	77.3	S. W. B.	350	6	58.6
L. P. W.	500	10.5	75.2	K. G. S.	270	6	58.0
L. B.	435	10.5	75.0	M. L.	330	6	57.7
H. M. R.	550	10.5	74.8	H. R.	550	6	57.5
R. T. W.	327	10.5	73.0	C. J. E.	550	6	50.6
J. P.	300	10	81.5				

the Benedict sugar method as modified by Quick [1925] for glucuronic acid.¹ The results are given in Tables I and II. None of the 24 subjects noted any ill-effects following the ingestion of borneol, but in a few cases a transitory dizziness was

Table II. *Individual case.*

Subject	Urine vol. ml.	Time hours	% borneol conjugated with glucuronic acid
R. T. W.	125	4.5	54
"	242	8.5	68
"	327	10.5	73
"	464	13.0	72

mentioned. The borneolglucuronic acid content of each sample of urine was determined as soon as possible after collection. Urines kept for 24 hours even in the refrigerator gave results lower than those obtained for the same urines when fresh.

SUMMARY.

Figures are given, obtained from 24 human subjects, showing the progress of the excretion of bornylglucuronide following the administration of borneol. The maximum amount conjugated and excreted as glucuronide is approximately 80 % of that administered and this maximum is attained in from 10 to 12 hours.

The expenses of this work were in part defrayed by a grant from the Medical Research Council. One of us (R. T. W.) is indebted to the Council for a whole-time assistance grant.

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¹ The Benedict reagent was standardised against hydrated borneolglucuronic acid (0.4163 g. required 11.10 ml. of 0.1052 *N* NaOH; calc. for $C_{16}H_{26}O_7$, $1\frac{1}{2}H_2O$, 11.14 ml.). With this specimen the ratio of the reducing powers of glucuronic acid to glucose was found to be 1.14. Quick [1924] found 1.105 (*cf.* Goebel and Babers [1933] for comparative reducing powers).