CXXVII. DETERMINATION OF IODINE IN SHEEP THYROID

By JULIUS SIGURJONSSON

From the Physiological Laboratory, The University, Reykjavik

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In a recent paper [Sigurjonsson, 1938] I showed that in Iceland the human thyroid gland, being unusually small, is relatively very rich in iodine, containing on the average 0.834 mg. iodine per g. of fresh substance. This indicates a very high iodine intake. Now, whilst in regions where goitre is common and the "normal" thyroid is relatively large, the soil and water usually show low iodine contents, one cannot conversely deduce an exceptionally high iodine content of the soil from the prevalence of small and iodine-rich human thyroids, since the human being is not entirely dependent on food which derives its iodine from the soil. On the other hand, the thyroids of herbivorous animals such as the sheep, may serve as a fairly good indicator of the iodine content of the soil and water where they are grazed.

In this paper are reported the iodine contents of 33 sheep thyroids collected late in October 1937 at the slaughterhouse in Reykjavik. The sheep came from different districts of the south-western part of Iceland, where, during the summer months, they were grazed on the high areas.

The thyroid glands were carefully dissected from the adjacent connective tissue and fat and then weighed. A small piece was cut out and weighed for histological examination, and the rest minced, dried and pulverized. Then an aliquot, usually 0.2 g. of the dry powder, was taken for analysis.

One of the most delicate steps of the determination of iodine in organic matter is the ashing process. Even in the presence of sufficient alkali, the heat requires careful attention if no iodine is to be lost by volatilization. Ashing in an electric oven, where the temperature can be easily controlled, is therefore greatly to be preferred. Further, in wet ashing, frothing and sputtering may cause some trouble; I therefore used a pulverized mixture of Na_2CO_3 , K_2CO_3 and KNO_3 , recommended to me by the Zoophysiological Laboratory in Copenhagen [see also Kraus, 1915]. Thereafter I proceeded on much the same lines as in the method of Kendall as modified by Kelly & Husband [1924].

Reagents required:

Ashing powder: Na_2CO_3 , anhydrous, 353 g.;	Bromine.
K_2CO_3 , anhydrous, 460 g.; KNO_3 , 250 g.	Na_2SO_3 : <i>N</i> /100.
H_2SO_4 : 33 % (by volume).	KI.
Methyl orange.	Soluble starch: 1 %.
NaHSO_3 : 20 %.	KIO_3 : standard solution.

Outline of method. 0.2 g. of the powdered thyroid is mixed with 10 g. of the ashing powder in a nickel crucible, and covered with 5 g. of the powder. The crucible with cover is then placed in an electric oven and heated. As the ashing proceeds brownish fumes rise through the covering layer of the powder, which itself becomes dark brown. Towards the end of the ashing process, the brown colour completely disappears, and the white mass tends to retract from the

walls of the crucible. The KNO_3 greatly facilitates the ashing, which is completed in about $1\frac{1}{4}$ hr., at a final temperature about 400° (never exceeding 450°).

The crucible is then placed in a beaker with 100 ml. boiling water, and the melt dissolved. The solution which is perfectly clear and colourless, is transferred to an Erlenmeyer flask, the crucible with cover and the beaker are washed with distilled water, which is added to the solution and the volume made up to c. 400 ml. with distilled water. It is then neutralized with H_2SO_4 (methyl orange) and a few drops excess acid added. The liberated HNO_2 is eliminated by boiling 15–20 min. (controlled by KI-starch paper), 1 ml. NaHSO_3 is added and boiling continued 10 min. to expel SO_2 . Then freshly made bromine water is added to a distinct brown colour and the excess of bromine expelled by boiling c. 10 min. (controlled with KI-starch paper). Then after cooling 3 ml. of 10% KI are added and the liberated iodine titrated with $N/100 \text{ Na}_2\text{SO}_3$.

The ashing powder and other reagents must be tested for iodine content by a blank analysis.

In Table I are illustrated some results showing the accuracy of the method.

Table I

Amount of dry thyroid, No. 13 g.	Iodine added as KI mg.	Iodine recovered mg.	Error in %
—	0.100	0.108	+8.0
—	0.100	0.099	-1.0
—	0.200	0.193	-3.5
—	0.300	0.311	+3.7
—	0.400	0.394	-1.5
—	0.500	0.508	+1.6
0.2	—	0.595	—
0.2	—	0.616	—
0.2	—	0.618	—

Table II shows the iodine contents of the thyroids of lambs about 5 months old, and Table III that of the thyroids of sheep 17 months and older.

Table II*

Weight of thyroid in g.	I content in mg. per g. of		Total I content of thyroid
	Fresh weight	Dry weight	
1.85	0.945	3.365	1.748
1.97	0.844	2.963	1.663
1.62	1.058	3.545	1.714
1.37	1.421	4.847	1.947
1.17	1.112	3.693	1.302
1.87	1.061	3.598	1.984
1.23	0.988	3.990	1.215
1.75	0.963	3.672	1.685
1.58	1.138	3.746	1.798
1.54	1.038	3.323	1.598
1.21	1.072	3.418	1.296
1.58	1.725	5.926	2.625
1.40	0.960	3.524	1.344
1.42	0.990	3.820	1.406
1.40	1.519	4.709	2.126
1.88	1.222	4.423	2.297
Average 1.55	1.128	3.910	1.734

* It is to be noted that the figures of the fresh weight may be somewhat too low, as the glands were not collected until several hours after slaughtering, and may therefore have lost some weight during that time. This again will account for too high findings for the iodine content of the fresh substance, whereas the iodine content of the dry substance is not affected.

The histological picture of the lamb thyroids was fairly uniform, the acini small, 50–150 μ in diameter and smaller. In the thyroids of the older sheep, the acini showed more variation in size, and were on the whole larger, 100–300 μ being the predominating size, and some glands had a distinctly colloid character. In no case were there any signs of hyperplasia to be seen.

Table III*

Weight of thyroid in g.	I content in mg. per g. of		Total I content of thyroid in mg.
	Fresh weight	Dry weight	
3.07	1.543	5.291	4.737
3.07	1.334	4.815	4.095
1.62	1.224	4.466	1.983
3.35	0.878	3.048	2.941
2.15	1.179	3.831	2.534
2.33	1.274	4.127	2.968
2.82	0.902	3.175	2.541
3.37	0.932	3.143	3.143
2.62	1.856	6.032	4.862
3.30	1.354	4.360	4.468
2.30	0.714	2.646	1.642
3.00	1.160	3.513	3.480
4.60	0.731	2.392	3.363
3.90	1.576	4.762	6.146
3.45	1.186	3.820	4.092
4.40	1.091	3.492	4.800
3.80	1.629	5.476	6.190
Average 3.13	1.210	4.023	3.764

* See note to Table II.

DISCUSSION AND CONCLUSIONS

The number of thyroids here examined is indeed too small for far-reaching conclusions to be drawn, but as the results are fairly uniform and as the sizes of a great number of glands observed at the same time were apparently of the same order, I believe that the results will not differ much from the truth.

From Tables II and III it is seen that the relative iodine content of the lamb thyroid is practically the same as of the thyroid of the older sheep, and the average for the two groups taken together is 3.968 mg. per g. of dry substance, or 0.397%. This is very similar to the results of Martin [1912; 1913], who on two occasions found respectively 0.343 and 0.407% of iodine in the thyroids of sheep from the neighbourhood of Newcastle. This may be taken as an indication that the pastures in the two localities have iodine contents of somewhat the same order. In the tables of Martin no distinction is made between the thyroids of lambs and of older sheep, and therefore the sizes are not directly comparable, although it seems that here also there is a close relationship, as was to be expected from the relative iodine contents.

Marine & Lenhart [1909] found the iodine content of non-goitrous sheep thyroids in Ohio to be only 0.247% of the dry substance. In this district goitre was not infrequent, and the normal sheep thyroid was relatively large, the 19 glands examined ranging from 4.5 to 8.5 g. in weight. Also most other authors from different localities, as quoted by Orr & Leitch [1929], have found lower values for iodine content. It therefore seems that the pastures in the above-mentioned districts of Iceland and North England are among the richer in iodine.

While the iodine content of the soil in this particular district in Iceland may thus be assumed to be adequate to prevent endemic goitre in the human population, it does not seem to be high enough to be responsible alone for the above-mentioned smallness of the human thyroid, since the vegetables cultivated in this country only constitute a minor part of the food.

Other foodstuffs, particularly the iodine-rich fish, undoubtedly play a great role here. Further investigations are to be made on this point.

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