The results were presented at the 15th annual meeting of the American Electroencephalographic Society, Atlantic City, 9 June 1961. The drugs used were kindly supplied by Ciba Pharmaceutical Company, Montreal; Hoffman LaRoche Company, Montreal; Lilly Research Laboratories, Indianapolis; and Parke, Davis Company, Montreal.

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Effect of Dietary Nitrate on Thyroid Function

Abstract. Experimental results indicate that 0.31 and 0.92 percent dietary nitrate, when consumed by rats and sheep respectively, can affect the normal iodine metabolism of the thyroid gland. The dietary level of iodine appears to be highly important when nitrate is present in the diet.

It has been shown by Wyngaarden *et al.* (*1*) that several monovalent anions, including nitrate, when injected into the animal, can interfere with normal iodine metabolism of the thyroid gland. The effects of nitrate in natural feeds has concerned animal scientists in recent years (*2*). This report attempts to assess the effect of dietary nitrate on the normal functioning of the thyroid gland.

The method of Premachandra and Turner (*3*) was used to determine the goitrogenic effect of nitrate both qualitatively and quantitatively. Adult female rats weighing 200 to 300 g were kept under conditions of uniform temperature of 75°F. The animals were fed a finely ground corn-soybean oil meal diet calculated to contain 135 ppm iodine, for 1 week. Each rat was then injected with 3 μc of carrier-free I^{131}. A 24-hour external thyroid count was made on ether-anesthetized animals placed on a lead plate with the thyroid gland over a scintillation probe. Measurements were made with a scintillation counter connected to a rate meter. Nitrate was added to the ration as KNO_3 at concentrations of 0.5, 1.0, and 2.5 percent.

Table 1. Effect of dietary nitrate on serum total I^{131}, serum-protein-bound I^{131}, and blood NO_3 of sheep.

Activity (count/min per 100 ml serum)		Av. blood NO_3 (mg/100 ml)
Av. total serum I^{131}	Av. PBI^{131}	
Control (five sheep)		
93,170	83,510*	0.80
Treated with 1.5 percent KNO_3 (six sheep)		
59,580	53,950*	1.93

* Significantly different ($p < .01$).

The results, shown in Fig. 1, indicate that dietary KNO_3 at a level of 0.5 percent adversely affected the iodine uptake of the thyroid gland of the rat. This level of nitrate is not uncommon in some hays and ensilages (*4*). The higher levels of nitrate are more commonly found in hay, pasture, and ensilage that are grown either under conditions of unbalanced fertility or the onset of drought or other adverse conditions for plant growth.

Since the above-mentioned feeds are normally given to ruminants, sheep were fed a ration containing 1.5 percent KNO_3. This ration was composed of 58 percent corn cobs, 24 percent corn, 8 percent soybean oil meal, 7 percent molasses, 2 percent minerals, and 1 percent urea. The concentration of serum I^{131} fixed as protein-bound iodine 6 days after 100 μc I^{131} had been injected was used as the criterion (*5*) for normal thyroid function. Methemoglobin was determined and no difference was found between the control and experimental groups. The results in Table 1 indicate that some nitrate passed through the rumen unchanged and that this nitrate interfered with normal thyroid function.

Muhrer *et al.* (*2*) found symptoms of vitamin A deficiency in cattle that consumed nitrate. Garner *et al.* (*6*) showed increased depletion of vitamin A in rats fed nitrate. The function of the thyroid in the conversion of carotene to vitamin A is still debated. However, Johnson and Bauman (*7*) showed that a functioning thyroid gland is necessary for this conversion. In view of these facts, it is conceivable that the vitamin A deficiency is an indirect result of abnormal thyroid function induced by the nitrate.

From a practical view, it is fortunate that the interference of certain monovalent anions with normal iodine metabolism of the thyroid gland can be reversed by increasing the iodine concentration of the diet (*1*). This may help explain the extreme variability in nitrate effect reported by investigators located in different geographic areas. The dietary level of iodine is apparently important for evaluating a feed suspected of containing nitrate.

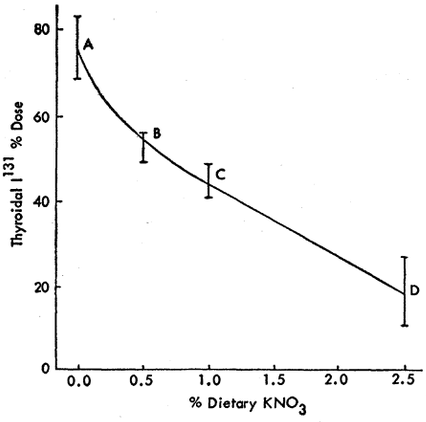

Fig. 1. The effect of dietary KNO_3 on thyroidal uptake of I^{131}. Vertical bars represent standard error of the mean. There were eight, six, six, and four rats in treatments *A*, *B*, *C*, and *D*, respectively. All treatments were significantly different from control *A*: *B*, $p < .05$; *C*, $p < .01$; *D*, $p < .01$.

This research indicates that dietary nitrate can adversely affect the normal functioning of the thyroid gland and suggests that some of the symptoms encountered in the field may be a result of impaired thyroid function of animals. On the basis of this work, we strongly recommend that animal rations suspected of containing nitrates be supplemented with adequate amounts of iodine and vitamin A (*8*).

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References and Notes

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