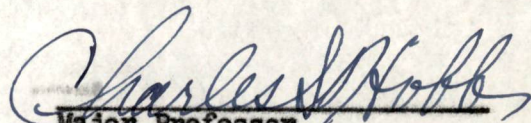


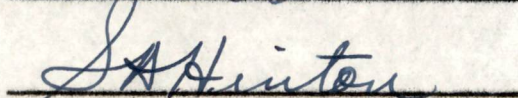
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To the Graduate Council:

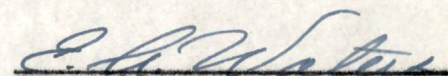
I am submitting herewith a thesis written by Everett Kincaid entitled "The Effects of Various Levels of Fluorides on the Feed Consumption of Cattle." I recommend that it be accepted for nine quarter hours of credit in partial fulfillment of the requirements for the degree of Master of Science, with a major in Animal Husbandry.


Major Professor

We have read this thesis
and recommend its acceptance:

Accepted for the Council:


Dean of the Graduate School

THE EFFECTS OF VARIOUS LEVELS OF FLUORIDES
ON FEED CONSUMPTION OF CATTLE

33

A THESIS

Submitted to
The Graduate Council
of
The University of Tennessee
in
Partial Fulfillment of the Requirements
for the degree of
Master of Science

by

Everett Kincaid

March 1953

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INTRODUCTION

The fluorine problem in livestock feeding is one of increasing importance. Untold damage has been caused by the detrimental effects of fluorine. The first problem arose through the feeding of a mineral supplement of raw rock phosphate containing from 3 to 4 per cent fluorine. The livestock fed high levels of raw rock phosphate showed a decrease in appetite, and the animals gradually became emaciated. The teeth of young animals fed the raw rock phosphate became mottled and pitted.

The same symptoms were observed in cattle eating vegetation grown in the vicinity of aluminum and phosphate industries. It was found that fluorine was given off from the manufacture of these materials and settled on the vegetation. This increased the fluorine problem considerably.

Research is being conducted at the Tennessee Experiment Station to determine at what levels fluorine becomes toxic and how long it takes the toxic condition to arise in cattle. This phase of the experiment was studied to determine the effects of fluorine on the feed consumption of cattle.

CHAPTER I

REVIEW OF LITERATURE

The poisonous effects of fluorine were recognized by Moissan in 1886. The first problem arose through the feeding of mineral mixtures containing rock phosphate which contains from 3 to 4 per cent fluorine. Cristiania and Guthici (4) in 1926 found that vegetation, in the vicinity of industrial plants processing aluminum, had absorbed sufficient fluorine from the air to cause fluorine toxicity to grazing cattle.

A considerable amount of study has been conducted concerning the effect of fluorine on man and animals. Most of these studies have been reviewed by Mitchell (15) and Rohms (20). In the studies to date there is very little data pertaining to the effects of fluorine on the feed consumption in cattle.

Reed and Huffman (18) of Michigan have shown that raw rock phosphate when fed as high as 1.5 per cent of the concentrate mixture was injurious to dairy cattle when fed for long periods of time. The animals which they used were placed on experiment at three months of age. From then until the time of the first lactation period, there was apparently no detrimental effect caused by feeding the raw rock phosphate at 1.5 per cent of the concentrate. When the concentrate allowance was increased to meet the requirements of the animal for milk production, the results were different. The heifers failed to consume a normal amount of roughage and later a portion of the concentrate allowance was not

consumed. The hair coats became roughened and later the animals were emaciated. Abnormal teeth developed which became so sensitive that warm water was necessary to get the animals to drink. Taylor (22) fed calcium fluosilicate at the rate of 1.5 per cent of the concentrate, and results were similar to those reported by Reed and Huffman.

Phillips, Hart and Bohstedt (17) fed raw rock phosphate at three different levels to dairy heifers. The first three lots received a basal ration plus special steam bone meal at the level of 2.5 per cent of the basal ration. Lot IV received the basal ration with 0.625 per cent of steam bone meal being replaced by raw rock phosphate. Lot V received the basal ration and 1.25 per cent of the steam bone meal was replaced by raw rock phosphate. Lot VI received the basal ration and all of the steam bone meal was replaced by the raw rock phosphate.

No differences were observed in the growth rates of the various groups up to calving. Subsequent to parturition lots 5 and 6 did not regain their weight loss, the feed consumption was significantly decreased and milk production was reduced 25 to 30 per cent. The birth weight of their calves was 12 per cent below that of the controls.

Phillips et. al. (17) (18) summarized their findings from the five-year experiment by reporting that the daily fluorine intake of 1 - 2 milligrams per kilogram of body weight did not materially retard growth; whereas intake in excess of 3 milligrams per kilogram of body weight throughout the growing period did retard growth. The critical margin of fluorine tolerance in dairy cattle appeared to be 2 - 3 milligrams per kilogram of body weight.

Elmslie (6) found that by feeding cows a constant level of raw rock phosphate, rather than varying it according to the concentrate fed, as was the procedure in the Wisconsin experiment, that the toxic level of fluorine for dairy cows lies between 1.5 to 3 milligrams of fluorine per kilogram of body weight.

Chang et. al. (3) reported that fluorine occurred in all normal tissues studied. The greatest quantity of fluorine was found to accompany calcium and phosphorus deposition. The bones and teeth contained large quantities of fluorine, while the active organs studied such as liver, kidney, heart muscle, etc. contained only trace quantities. The fluorine content of dried dentine and bone of normal cows was from 42 to 63 p.p.m.; that of similarly prepared liver, kidney, heart muscle, pancreas, thyroid, tendons, hair and hoof was less than 1 p.p.m.. The inclusion of 0.088 per cent fluorine in the form of raw rock phosphate in the diet of cows resulted in an increased storage (from 16 to 25 times normal) of the element in the bones and teeth. The fluorine content of the internal organs, tendons, and hair was doubled.

Pierce (16) reported that the fluorine content of the soft tissues increased when sheep were fed 22 and 52 p.p.m. fluorine as rock phosphate over a 3 year period. The accumulation may induce degenerative changes in the kidney, liver, adrenal glands, heart and central nervous system. He also stated that the reproductive organs are among the tissues less sensitive to fluorine.

Mitchell (15) in his review of work done on the fluorine problem in livestock feeding, stated that normal ivory color of the bones are

changed to a chalky white. The diameter of the cross-section of the long bones was increased due in part to enlargement of the bone marrow cavity but mainly to an increase in thickness of the bone substance. Exostoses of the mandible are frequent, occurring as isolated osteophytes or as a complete superficial covering of porous, white tissue. The bones of animals given toxic quantities of fluorine are, as a rule, much softer than normal, but due to extensive osseous proliferation the breaking strength of the whole bone may be increased. The incisors are pitted and eroded while the molars are broken and the uneven wear seriously interferes with mastication. The pulp cavities may be exposed.

Fluorides are recognized as potent protoplasmic poisons.

Phillips et. al. (18) reported the development of generalized systemic disturbances in dairy cattle following the ingestion of fluorides. The toxic levels of fluorine was supplied by the use of raw rock phosphate incorporated in the grain mixture.

Distinctive histopathologic alterations were noted in the liver, the suprarenal, the circulatory and the skeletal systems. The vascular walls were altered by extensive hyaline degeneration. Parenchymatous, fatty and amyloid degenerative changes were observed in the heart, liver and adrenal cortex. Pathognomonic renal anomalies were limited to cicartices which presumably were the result of cysts or abscesses. These changes were attributed to abnormal cellular respiration, intracellular accumulations of metabolic products and resultant anoxia or hypoxia.

They hypothesized that the altered function of the adrenal cortex was in itself sufficient to produce serious systemic dysharmony.

Skeletal manifestations of the fluorine intoxication syndrome were an increased rate of bone resorption in the endostial region and a concomitant extensive subperiosteal osteogenesis. The long bones, ribs and mandibles were primarily affected. The fundamental causes of this phenomena were not definitely stated. It was thought that medulary vascular stasis might be instrumental in the production of bone resorption.

Lawrenz et. al. (8) stated that fluorine present in the food is retained to a less extent in bones, teeth and soft tissue than equal quantities in the drinking water. This seems to be the result entirely of an impairment in absorption from the alimentary tract.

Phillips and Stare (18) reported a significant increase in vitamin C content in the actively metabolizing cells of the liver, kidney, thyroid, suprarenal cortex, and the anterior lobe of the hypophysis of cows ingesting toxic quantities of fluorides.

Inhibition of some phase of the aerobic respiration of cells probably occurs in chronic fluorine toxicosis. The increase in the vitamin C content of the certain tissues may be a compensatory mechanism developed by the animal in an attempt to maintain the oxidative processes. Total cellular respiration is lowered although the anaerobic phase is increased.

CHAPTER II

EXPERIMENTAL PROCEDURE

The cattle used in this experiment were grade Hereford heifers purchased as yearlings in Texas and Oklahoma in the winter and spring of 1948. These animals were not infected with communicable diseases. Prophylactic Brucella vaccine was administered to all animals. These animals were segregated into 11 lots of 3 animals each with the criteria of selection based on the source, type and weight.

Fluorine was added to the concentrate mixture in the form of sodium fluoride to increase the fluorine content to the desired levels in the total ration. The levels of fluorine added are given in Table I.

These animals were kept in the barn or on dry lot at all times and fed concentrates once daily. The concentrate consisted of a mixture of 3 parts of ground corn and 1 part cottonseed meal. Lespedeza or alfalfa hay averaging good in quality was fed all lots with the exception of 9 and 10 which received Blount 1 and Blount 2 hays, respectively. The latter was grown in the vicinity of an aluminum plant which emitted fluorine. Based on fluorine analysis Blount 2 hay was purchased to be the hay having the highest fluorine content of any hay that could be secured in the area near the plant. Blount 1 hay was purchased based on fluorine analyses to have a fluorine content about one half of Blount 2 hay. Periodically the cattle were weighed and their teeth examined for signs of the effect of fluorine. Also, colored photographs of teeth were taken periodically.

The fluorine content of the ration was adjusted every 28 days based on the feed consumption during the previous period. This was done to make sure the total concentrate consumed contained the amount of fluorine required for each particular level.

The total amount of fluorine fed includes the fluorine added as sodium fluoride plus that present in the control feeds. This would mean, for example, that lot 2 would actually be consuming approximately 10 p.p.m. fluorine added as sodium fluoride plus approximately 6 - 7 p.p.m. in the control ration. Thus, the ration contained 16 to 17 total p.p.m. of fluorine. This study was made to determine the effects of feeding various levels of fluorine on feed consumption in cattle. The data compiled herein covers the period from April 1948 to June 1952.

The concentrate feeding has been kept at a constant level of 4 pounds except during the first four months but the hay has been adjusted to the amount the heifers would consume from the beginning of the experiment up until the present writing.

In order to determine the average daily consumption of T.D.N. (Total Digestive Nutrients), an average value of 47.5% T.D.N. was used for the hay and 78% T.D.N. was used for the concentrate mixture. These values were based on a value of 47.5% T.D.N. in all analyses lespedeza hay and the average value of 78% T.D.N. for a mixture of 3 parts of number 3 corn and one part of 41% cottonseed meal.

These animals were fed once daily, allowed to remain in the barn for 12 hours and the remainder of the time kept on dry lot having access to water and salt ad libitum. Some variations were observed in the consumption of grain and hay during the first year of feeding. In the subsequent 4 year experimental period minimal differences in consumption of concentrates occurred among the various lots and individuals; however, some differences in consumption of roughage has been significant. Records have been kept on feed refusal and tables II, III, IV and V show the results of the effect of fluorine on feed consumption in cattle based on the T.D.N. of the ration.

Dates of calving have been recorded and tabulated along with the feed records. To arrive at the required T.D.N. for these animals, Morrison's "Feeds and Feeding" (14) was used as a basis, using the average T.D.N. requirement when the cows were not in milk and adding 1/3 pound of T.D.N. per pound of milk produced when the cows were lactating.

Arkansas Experiment Station (7) reported that they used a group of 57 Hereford cows to determine the average pounds of milk produced during lactation. They found an average of 6.5 pounds of milk was produced per day, therefore, this figure was used as the average milk production for this study.

To arrive at the T.D.N. requirement and consumption over a six-month-period, April and October of each year, were used as breaking dates. It was anticipated that the cows would be through calving by April and milking from April to October. Therefore, October to April was to be the dry period. Due to variations in breeding there has been an overlapping between these two periods.

TABLE I
TREATMENT OF ANIMALS BY LOTS

Lot No.	Fluorine added to concentrate above that in control ration	Fluorine in hay
1	0 P.P.M. (Control)	Control 6 P.P.M.
2	10 P.P.M.	Control
3	20 P.P.M.	Control
4	30 P.P.M.	Control
5	40 P.P.M.	Control
6	50 P.P.M.	Control
7	70 P.P.M.	Control
8	100 P.P.M.	Control
9	0 P.P.M.	Blount 1 (19 P.P.M.)
10	0 P.P.M.	Blount 2 (32 P.P.M.)
11	100 P.P.M. + Defluorophos	Control

TABLE II

THE AVERAGE T.D.N. CONSUMPTION COMPARED WITH
THE T.D.N. REQUIREMENTS

Lot Nos.	No. animals per lot	6-6-48 to 10-23-48			10-23-48 to 3-15-49		
		Av. weight of animals	Av. T.D.N. required*	Av. T.D.N. consumed	Av. weight of animals	Av. T.D.N. required*	Av. T.D.N. consumed
1	3	626	7.1	7.0	745	7.5	8.2
2	3	635	7.1	7.1	745	7.5	8.7
3	3	628	7.1	7.0	741	7.5	8.6
4	3	653	7.1	7.1	753	7.5	8.6
5	3	660	7.1	7.0	757	7.5	8.5
6	3	635	7.1	7.0	721	7.5	8.2
7	3	596	6.2	6.9	661	7.1	8.0
8	3	601	7.1	6.9	595	6.2	6.5
9	3	630	7.1	7.0	686	7.1	8.3
10	3	637	7.1	7.2	739	7.5	8.5
11	3	602	7.1	6.8	664	7.1	7.1

*Requirements taken from Morrison's "Feeds and Feeding," 21st Edition. For period when cows were nursing calves, Arkansas beef cow milk production figures were used with Morrison's standards for computing estimated T.D.N. requirements.

TABLE III

THE AVERAGE T.D.N. CONSUMPTION COMPARED WITH
THE T.D.N. REQUIREMENTS

3-15-49 to 10-25-49					10-25-49 to 4-11-50			
Lot Nos.	No. animals per lot	Av. weight of animals	Av. T.D.N. required*	Av. T.D.N. consumed	No. animals per lot	Av. weight of animals	Av. T.D.N. required*	Av. T.D.N. consumed
1	3	765	8.9	9.9	3	839	8.2	9.6
2	3	753	8.9	9.2	3	861	8.2	9.5
3	3	723	8.9	8.9	2	790	8.2	9.5
4	3	730	9.7	9.1	3	837	8.2	9.3
5	3	721	8.9	9.0	3	821	8.2	9.5
6	3	762	8.9	9.1	3	810	8.9	9.4
7	3	717	8.2	7.8	3	850	8.2	7.5
8	3	674	7.8	6.7	3	733	7.5	8.5
9	3	764	8.6	8.8	3	903	9.2	9.2
10	3	797	9.3	8.9	3	911	9.2	9.4
11	3	679	7.8	7.4	3	727	8.2	9.0

*Requirements taken from Morrison's "Feeds and Feeding,"
21st Edition. For period when cows were nursing calves, Arkansas beef
cow milk production figures were used with Morrison's standards for
computing estimated T.D.N. requirements.

TABLE IV
THE AVERAGE T.D.N. CONSUMPTION COMPARED WITH
THE T.D.N. REQUIREMENTS

		4-11-50 to 10-24-50			10-24-50 to 4-10-51		
Lot	No. animals Nbs. per lot	Av. weight of animals	Av. T.D.N. required*	Av. T.D.N. consumed	Av. weight of animals	Av. T.D.N. required*	Av. T.D.N. consumed
1	3	926	11.4	10.8	1072	10.1	12.1
2	3	872	10.4	10.6	1009	10.9	11.9
3	2	924	10.3	10.5	1042	10.1	10.9
4	3	878	10.4	10.6	1025	10.1	11.8
5	3	914	10.0	10.5	1007	10.1	11.0
6	3	830	9.6	10.2	988	9.2	10.8
7	3	914	9.9	10.3	1007	10.1	10.6
8	3	827	8.2	7.8	869	8.2	9.4
9	3	930	10.3	10.3	1045	10.1	11.3
10	3	920	10.3	10.1	1069	10.1	11.4
11	3	838	9.9	9.8	929	9.2	9.8

*Requirements taken from Morrison's "Feeds and Feeding," 21st Edition. For period when cows were nursing calves, Arkansas beef cow milk production figures were used with Morrison's standards for computing estimated T.D.N. requirements.

TABLE V

THE AVERAGE T.D.N. CONSUMPTION COMPARED WITH
THE T.D.N. REQUIREMENTS

Lot Nos.	No. animals per lot	4-10-51 to 10-23-51			10-23-51 to 6-24-52		
		Av. weight of animals	Av. T.D.N. required*	Av. T.D.N. consumed	Av. weight of animals	Av. T.D.N. required*	Av. T.D.N. consumed
1	3	1092	12.3	12.4	1177	11.6	12.1
2	3	1033	11.5	12.5	1102	10.9	12.2
3	2	1025	11.2	12.6	1140	10.9	12.2
4	3	1049	12.5	12.6	1190	10.9	12.2
5	3	1032	11.5	11.5	1086	10.1	11.4
6	3	978	11.4	11.6	1054	10.1	11.1
7	3	1078	10.9	9.4	1140	10.9	9.5
8	3	970	9.2	9.9	934	9.2	8.8
9	3	989	11.4	12.4	1145	10.9	12.1
10	3	1051	11.2	12.1	1057	10.1	11.3
11	3	931	8.9	9.9	964	9.2	9.6

*Requirements taken from Morrison's "Feeds and Feeding," 21st Edition. For period when cows were nursing calves, Arkansas beef cow milk production figures were used with Morrison's standards for computing estimated T.D.N. requirements.

CHAPTER III

DISCUSSION OF RESULTS

The results of this experiment are summarized in Tables II, III, IV and V. These tables include the number of animals per lot, the average animal weights, the average T.D.N. consumed and the estimated average T.D.N. required.

A study of the period from 6-6-48 to 10-23-48, Table II, shows that there was a slight daily decrease in the average T.D.N. consumed by lot 7 (70 p.p.m.) 6.9 pounds; lot 8 (100 p.p.m.) 6.9 pounds; and lot 11 (100 p.p.m. plus defluorophos) 6.8 pounds. Lot 1, control group (6 - 7 p.p.m.) consumed 7.0 pounds.

The actual daily T.D.N. consumption during this period was essentially the same as the estimated T.D.N. requirements for all lots with the exception of lot 7 which consumed 0.7 lbs. T.D.N. in excess of the estimated requirements.

A comparison of the average daily T.D.N. consumed within lots for the period 10-23-48 to 3-15-49 shows the following: lot 7, 8.0 lbs.; lot 8, 6.5 lbs.; lot 11, 7.1 lbs.; lot 2, 8.7 lbs.; and lot 1, 8.2 lbs.

During the same period, the average weight gain or loss among the enumerated lots was: lot 1 (control), 119 lbs. gain; lot 7, 65 lbs. gain; and lot 11, 62 lbs. loss. There was no appreciable difference in the gain in weight and feed consumption of the other lots, as compared to the control group during this period.

The actual feed ingested by all lots was in excess of the estimated daily requirements except lot 11 which consumed the exact estimated quantity of nutrients. The intake of the remaining lots exceeded the estimated requirements as indicated: lots 1 and 6 (0.7 lb.); lots 5 and 7, (0.9 lb.); lot 10, (1.0 lb.); lots 3 and 4, (1.1 lb.); and, lots 2 and 9, (1.2 lb.).

A study of the period from 3-15-49 to 10-25-49, Table III, shows that there was a continued decrease in the average daily T.D.N. consumption in the following lots compared to the control group, Lot 1, 9.9 lbs.; lot 7, 7.8 lbs.; lot 8, 6.7 lbs. and, lot 11, 7.4 lbs.

During this period, the average individual gain in weight of lot 1 was 20 lbs.; that of lot 7 was 56 lbs.; that of lot 8, 79 lbs.; and, that of lot 11, 15 lbs. Small weight gains occurred in other lots.

In this period the T.D.N. intake exceeded the estimated requirements by small amounts in four lots. Lot 1 ingested 1.0 lb. more than the estimated quantity. The consumption of five lots was less than the estimated requirements (lots 7, 10 and 11, 0.4 lb.; lot 4, 0.6 lb.; and, lot 8, 1.1 lb.). Lot 3 ingested the estimated nutrient requirements.

The estimated average T.D.N. consumed during the period of 10-25-49 to 4-11-50 was: lot 1, 9.6 lbs.; lot 11, 9.0 lbs.; lot 8, 8.5 lbs.; and lot 7, 7.5 lbs. Animals in lots 7, 8 and 11 raised fewer calves than the cows in the other lots. Lot 7 did not consume the estimated nutritive requirements for maintenance, growth and lactation.

The average T.D.N. consumption of the other groups was similar to lot 1.

In the period 4-11-50 to 10-24-50 some variation was observed in the estimated T.D.N. consumption among the various lots. Lot 8 consumed 7.8 lbs.; lot 11, 9.8 lbs.; and the control lot 10.8 lbs. All lots gained in weight. No calves were born in this period.

The daily T.D.N. consumed exceeded the estimated requirements from 0.2 lbs. to 1.1 lbs. in 7 lots: lot 7, 0.4 lb.; lot 5, 0.5 lb.; lot 6, 0.6 lb.; and, lot 11, 1.1 lb. Lot 9 ingested the estimated requirement. The other lots consumed from 0.2 lb. to 0.6 lb. less than the estimated requirements (lot 8, 0.4 lb.; and lot 1, 0.6 lb.).

A study of the period 10-24-50 to 4-10-51, Table IV shows that lot 8 consumed 9.4 lbs. and lot 11, 9.8 lbs. No calves were born in this period. Some differences in feed consumption among other lots occurred. However, all lots consumed an excess of the estimated requirements.

A similar pattern occurred in the period 4-10-51 to 10-23-51 as shown in Table V. Lot 7, consumed 9.4 lbs.; lot 8, 9.9 lbs.; lot 11, 9.9 lbs.; and, lot 1 (the control group) 12.4 lbs. Only cows in lots 7 and 8 failed to produce calves. Animals in all lots gained in weight during this period. Lot 7 failed to consume the estimated requirements.

In the final period covered by this study, 10-23-51 to 6-24-52, the average T.D.N. consumption was: lot 7, 9.5 lbs.; lot 8, 8.8 lbs.; lot 11, 9.6 lbs.; lot 5, 11.4 lbs.; lot 6, 11.1 lbs.; and lot 1, 12.1 lbs. Lot 7 was the only lot that failed to consume the estimated requirements.

The average weight of the animals in each lot was essentially the same at the beginning of the experiment. A variation in the weight of animals within and among lots was evidenced during the experimental period. Animals in lots 7, 8 and 11 consistently consumed less T.D.N. than lot 1, the control group.

The reduction in feed consumption may presumably be directly attributable to fluorine ingestion. Before final interpretation of results can be made the influence of calving and other environmental conditions must be considered in relation to feed consumption, weight gain, final weights, and calving.

CHAPTER IV

SUMMARY AND CONCLUSION

This phase of the experiment was studied to determine the effect of different levels of fluorides on feed consumption in cattle. In order to compare the T.D.N. consumed with the estimated T.D.N. requirements in the ration, the following figures were used: 47.5% T.D.N. for the hay, 78% T.D.N. for the concentrate and 1/3 pound of T.D.N. per pound of milk produced. Milk production was estimated using the average figure of 6.5 pounds of milk during the lactation period.

The ration fed during this experiment consisted of 3 parts ground corn to 1 part cottonseed meal. Each cow was fed approximately 4 pounds of the above concentrate mixture. Lespedeza and alfalfa hay of medium to good quality was fed all lots with the exception of the two lots receiving Blount 1 and Blount 2 hay respectively.

Sodium fluoride was added to the concentrate of each lot to give the following total amounts on a total dry ration basis: lot 1, 0 p.p.m.; lot 2, 10 p.p.m.; lot 3, 20 p.p.m.; lot 4, 30 p.p.m.; lot 5, 40 p.p.m.; lot 6, 50 p.p.m.; lot 7, 70 p.p.m.; lot 8, 100 p.p.m.; and lot 11, 100 p.p.m. plus 21 parts defluorophos per 1 part sodium fluoride added. Lot 9, control concentrate, Blount 1 hay contained on the average 19 p.p.m. fluorine (range 19 - 63 p.p.m.); lot 10, control concentrate, Blount 2 hay contained 32 p.p.m. fluorine. It was found that the control ration of hay and grain contained from 6 - 7 p.p.m. fluorine.

To date, the effect of sodium fluoride on feed consumption of cattle must be studied further before definite conclusions are drawn. During the first 5 months that these animals were consuming this experimental ration, practically all lots consumed enough feed to gain small amounts in body weight. Using the estimated T.D.N. requirement figures practically all lots were slightly under the T.D.N. requirement figure.

During the following years there has been some variations in feed consumption with lots 7, 8 and 11 consuming less than the control group 1. Sodium fluoride, calving, environmental conditions, etc., either separately or synergistically, were operative. Further study is needed to determine the definite influence of fluorine ingestion.

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