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To the Graduate Council:

I am submitting to you a thesis written by James Rex Allen, Jr. entitled "The Effect of Various Levels of Fluorine on the Digestibility of Feeds." I recommend that it be accepted for nine quarter hours credit in partial fulfillment of the requirements for the degree of Master of Science, with a major in Animal Husbandry.

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THE EFFECTS OF VARIOUS LEVELS OF FLUORINE ON THE DIGESTIBILITY OF FEEDS

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

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by
James Rex Allen, Jr.

June, 1951

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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 raw rock phosphate, containing from 3 to 4 percent fluorine, as a mineral supplement. The livestock fed raw rock phosphate at high levels of intake showed a decrease in appetite, and the animals gradually took on an emaciated look. The teeth of animals fed the rock phosphate become mottled and pitted.

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

Work is being done at the Tennessee Experiment Station to determine at what level fluorine becomes toxic and how long it takes the toxic condition to arise. This phase of the experiment was set up to determine the effects of fluorine on the digestibility of the ration.

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 percent fluorine. Cristiania and Guatier (12) in 1926 found that vegetation, in the vicinity of industrial plants processing aluminum, had absorbed sufficient fluorine from the air to cause fluorine toxicity in grazing cattle.

Reed and Huffman (28) of Michigan have shown that rock phosphate when fed as high as 1.5 percent of the concentrate was injurious to dairy cattle when fed for long periods of time. The animals were placed on experiment at three months of age. From then until the time of the first lactation period, there was apparently no marked detrimental effect caused by feeding the raw rock phosphate at 1.5 percent of the concentrate. When the concentrate allowance was increased to meet the requirements of the animal for milk production, the results were different. Their appetites were affected. The heifers failed to consume a normal amount of roughage and later a portion of the concentrate allowance was not consumed. Their coats became roughened and they looked emaciated. Abnormal teeth developed which became so sensitive that warm water was necessary to get the animals to drink. Taylor (30) fed calcium fluo-silicate at the rate of 1.5 percent of the concentrate, and results were similar to those reported by Reed and Huffman.

Phillips, Hart and Bohstedt (26) fed raw rock phosphate at three different levels. All lots received a basal ration plus special steam bone

meal at the level of 2.5 percent of the basal ration. Lot IV received the basal ration with 0.625 percent of steam bone meal being replaced by raw rock phosphate. Lot V received the basal ration and 1.25 percent of the steam bone meal being replaced by raw rock phosphate. Lot VI received the basal ration and all of the steam bone meal being replaced by raw rock phosphate.

Phillips et. al. (26) found that lots V and VI on the 1.25 and 2.50 percent rock phosphate respectively had a growth rate similar to the other lots up to the first lactation. Thereafter a decrease in body weight ocurred from which complete recovery did not take place. The 1.25 and 2.50 percent rock phosphate during lactation had a pronounced effect on the appetite. This drop in feed consumption, due to loss of appetite, caused a decreased milk production of 25 to 30 percent at the 2.5 percent rock phosphate level. The birth weight of calves on the 1.25 and 2.50 percent rock phosphate decreased 12 percent below the birth weights of the calves from the control animals.

Phillips et. al. (26) summarized their findings from the five year experiment by reporting fluorine intakes of 1-2 milligrams per kilogram of body weight did not materially retard growth. Should the intake level exceed 3 milligrams per kilogram of body weight throughout the growing period, growth is retarded. They state that the critical margin of fluorine tolerance in dairy cattle appears to be 2-3 milligrams per kilogram of body weight.

Elmslie (14) found by feeding cows a constant level of raw rock phosphate instead of 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. (11) report 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 such as the liver, kidney, heart muscle, and other tissues studied showed only small quantities of fluorine. The quantity of fluorine present in normal dentine and normal bone of cows was found to lie between 42 and 63 p.p.m. per 100 grams of dried tissue. The fluorine content of the liver, kidneys, heart muscles, pancreas, thyroid, tendons, hair and hoof was found to be less than 1 p.p.m. per 100 grams of dried normal tissue. Chang et. al. found that the inclusion of 0.088 percent fluorine given in concentrate mixture as raw rock phosphate resulted in an increased storage of fluorine in the bones and teeth. This amounted from 16 to 25 times that found in the normal osseous structure. The internal organs, tendons, and hair doubled in fluorine content when the concentrate mixture contained 0.088 percent fluorine.

Maynard (21) states that bones are the first organ effected by fluorine. After teeth and bones become saturated, the organs and soft tissues are effected.

Lawrenz et. al. (16) fed cryolite as a source of fluorine to rats. At an intake equivalent of 13 p.p.m. of food consumed, 96 percent of fluorine was deposited in the skeleton, and remaining 4 percent was equally divided between teeth and soft tissue.

Pierce (25) reports that the fluorine content of the soft tissues will also increase on 22 and 52 p.p.m. fluorine fed as rock phosphate to sheep over a three year period. These minute accumulations may induce degenerative changes in the kidneys, liver, adrenal gland, heart and central nervous system. He states that the reproductive organs are among the tissues less sensitive to fluorine.

Phillips et. al. (26) found that the teeth of cattle are effected by feeding rock phosphate. Levels of 0.044 and 0.088 percent fluorine in the concentrate caused excessive abrasion of the 2nd and 3rd molars over a 5 year period.

Mitchell (24), in his review of work done on the fluorine problem in livestock feeding, found that normal ivory color of the bones are changed to a chalky white. The diameter of the cross-section of the long bones increased due in part to enlargement of the bone marrow cavity but mainly to an increase in thickness of the bone substance. Exotosis of the long bone of the jaw is a common feature. These take the form of either isolated outgrowth or of a complete superficial covering of porous, white bones of high fluorine content. The bones of animals given fluorine are, as a rule, much softer than normal, but owing to overgrowth, the breaking strength of the whole bone may be increased. The teeth, particularly the incisors, become pitted and eroded. The molars become broken and the uneven wear seriously hinders mastication. In some cases the pulp cavities are exposed. These conditions were caused by feeding rock phosphate to cattle by Elmslie (14), Reed and Huffman (28),

and Phillips et. al. (26) for periods ranging from 3 to 6 years at levels of 0.052, 0.022 - 0.052 and 0.022 - 0.088 percent fluorine respectively as mentioned previously.

Phillips et. al. (26) state that the effects of fluorine upon dairy cattle resulted in generalized systemic disturbances at levels of 0.022, 0.044 and 0.088 percent fluorine fed as raw rock phosphate. They reported that evidence indicated that tissue oxygen want was manifested in fluorosis and may account for the observed systemic reactions to fluorine. The pathological histology of fluorosis with the chief deviation from normal being the overgrowth of hyaline particularly of the blood vessals, and milder forms of cellular degeneration indicate incomplete cellular metabolism. Such a condition is probably the result of insufficient cellular respiration where degenerative changes have taken place. The causes of the development of parenchymatous and fatty degeneration is thought to be an accumulation of cellular material which cannot be metabolized in the normal manner. Thus the pathological evidence suggests inhibition of oxygen supply in many of the actively metabolizing organs of the body. This pathological evidence is supported by actual oxygen uptake measurements upon the suprarenal cortex and a deminutive of cellular respiration occurs. The interference of the normal suprarenal metabolism may be sufficient by itself to materially reduce normal cellular activity throughout the body.

Lawrenz et al (17) state that doses of fluorine in the food is retained to a less extent in bones, teeth and soft tissue than equal doses of fluorine in the drinking water. Considering the total retention of fluorine

in the carcass, the impairment in absorption amounts to about 20 percent. This seems to be the result entirely of an impairment in absorption from the alimentary tract.

Studies by Phillips and Stare (27) showed that fluorine toxicosis influenced the distribution of vitamin C in the tissue. Actively metabolizing cells were found to contain large quantities of vitamin C per unit weight. The vitamin C present in the kidney, liver, suprarenal, and the anterior lobe of the hypophysis was increased in fluorine fed cows.

It would seem that the levels of fluorine intake cause a stimulation of the enzymatic system or systems responsible for ossecus metabolism. It is believed that this is the likely cause of the generalized exostosis and skeletal changes found in chronic fluorine toxicosis. On the other hand the reduction in the oxygen intake of the cortex of the suprarenal gland and changes in ascorbic acid in the various organs of the fluorine poisoned animal indicates an inhibition of the enzymatic processes of actively metabolizing tissue (27). Thus fluorine toxicity seems to exert its deleterious effects through bone, respiration and inhibitation or acceleration of the enzymatic systems of the body. Undoubtedly the affinity of fluorine for calcium with the formation of relatively insoluble calcium fluoride enters into the syndrome of chronic fluorosis. (26)

No work has been reported on the effects of various levels of fluorine on consumption and digestibility of feeds. Burroughs et. al. (3, 4, 5, 6,

7, 8, 9, 10) have shown that the addition of ash of alfalfa extract, autoclaved rumen liquid, and autoclaved water extract of manure increased cellulose digestion in the rumen. The addition of these materials are of greater value when poor quality roughages are fed. They state that definite amounts of protein in the feed are necessary for maximum rumen digestion of roughages (4).

Maynard (20) states that the quantitative relations involved in the microbiotic decomposition of carbohydrates vary according to the kinds and number of the microorganisms present in the rumen which in turn are under the influence of the character of the food. The addition of easily digestible carbohydrates such as starch, cane sugar, or molasses to the ration of cattle reduces the digestibility of the fiber and thus, lowers the nutritive value of the ration. This has been explained on the grounds that the bacteria attack the simpler carbohydrates by preference. This would lower the nutritive value of the entire carbohydrate portion of the ration, in that less crude fiber would be digested and more of the absorbable sugars would be lost as gases.

Digestibility may be limited by a lack of time for complete digestive action on less easily digestible substances or by a lack of complete absorption. (20). Such an effect is heightened by a rapid passage of the food through the small intestine. On the other hand, food may move so slowly through the intestine as to be excessively subject to wasteful fermentations. Lack of time for digestion or absorption may explain why, as the level of food intake increases above a certain value the digestibility of all nutrients

tends to decrease.

From the previous statements it would seem that various nutritive factors have effected the consumption and digestibility of feeds. This phase of the experiment was run to determine the effects, if any, of different levels of fluorine on digestibility of a ration.

CHAPTER II

EXPERIMENTAL PROCEDURE

The cattle used in this experiment were purchased as yearlings in Texas and Oklahoma in the spring of 1948. They were checked for brucellosis and T. B. and after brucellosis vaccination they were placed in 11 lots of 3 animals per lot. Assignment of individuals animals to the different lots was made on the basis of type, weight, and source. Fluorine was added to the concentrate in the form of sodium fluoride to increase the fluorine content to the desired levels in total ration. The levels of fluorine are as follows:

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. plus Defluorophos	Control

These animals were kept in barn or dry lot at all times and fed concentrate once daily. The concentrate consisted of 4 parts corn and 1 part cottonseed meal. Good quality lespedeza or alfalfa hay was fed all lots

except 9 and 10 which received Blount 1 and Blount 2 hays respectively. The latter was grown in the vicinity of an aluminum plant where fluorine was given off and settled on the vegetation. This hay was analyzed for its fluorine content, and from these results was placed in the Blount 1 or the Blount 2 group. The cattle were weighed and their teeth examined for signs of fluorosis once per month. Photographs were taken of the teeth every three months.

The fluorine content of the ration was adjusted every 28 days. This was done to make sure the total concentrate consumed contained the amount of fluorine desired for that level.

The total amount of fluorine fed includes the fluorine added as sodium fluoride plus that in the control feeds. For example, this would mean that lot 2 would actually be getting approximately 10 p.p.m. fluorine added as sodium fluoride plus 6 p.p.m. in the control ration.

The experiment to determine the effects of fluorine on consumption and digestibility of a ration was started January 19, 1951, and continued until March 20, 1951. The three trials ran during this period consisted of 12, 11, and 10 animals respectively per trial. They were brought into the metabolism barn and placed in the metabolism crates. The next 4 days consisted of an adjustment period in which the animals became accustomed to the new environment. The concentrate fed was kept at a constant level of 4 pounds, but the hay was adjusted to the amount each animal would consume. On the average there was a 3 to 4 pound drop in hay consumption from what

they had been eating previously.

This drop in feed consumption would in turn cause an increase in the amount of fluorine consumed inasmuch as the fluorine was added to the grain. As mentioned before, the fluorine in the feed is determined by the feed consumption of the previous month. This, as well as the fluorine in the normal feed would cause a deviation from levels prescribed.

The cows were weighed just before being brought into the metabolism barn and immediately after the trial. They were taken by truck 7 to 8 miles, after weighing, to the metabolism barn and a like distance before being weighed after the trial. The time between weights included the preliminary period as well as the actual trial. Attempts were made prior to this experiment to weigh the animals at the beginning of the trial, but this proved unsatisfactory. The cows would go off feed when taken out to be weighed and this would make a new preliminary period necessary (31). The loss or gain in weight was computed as a fraction of the total period (preliminary and actual trial). It would be assumed that cows having a preliminary period of 5 days and a trial of 10 days would have two-thirds of the weight lost or gained during the actual trial with one-third lost or gained during the preliminary period.

During the preliminary period of the first trial cow 47 from lot 3 was removed because she refused to eat. Cow 58 from lot 7 was removed due to a ruptured cyst on the neck. Cow 47 from lot 3 was brought in again for the second trial, but was removed because she failed to eat an adequate amount. The third trial had cow 49 from lot 5 taken out during the preliminary period

because she failed to eat.

Cows 58 and 21 from lot 7 were removed from the third trial on the fifth and eighth day respectively because blood and mucus appeared in the urine. These animals were removed because this abnormality effected the nitrogen content of the urine as determined by chemical analysis.

After the preliminary period, the animals were taped up in a manner described by Hobbs et al. (15). The tubes were observed for the next 12 to 24 hours to make sure no leaks developed, and that the harness was properly adjusted.

A pregnancy diagnosis was made on all the cows January 18, 1951, in order that the ones nearest parturition would be brought in for the first metabolism trial. Cows in early pregnancy and open cows were run last.

During the trial, the animals were fed their concentrate at 3 o'clock in the afternoon. They received their hay at 8 a.m. and 4 p.m. Two- thirds, by weight, of the hay was fed in the afternoon and one-third in the morning. The urine was weighed, the volume measured, and specific gravity taken each day. A ten percent sample of the urine, by volume, was taken once daily. The feces from each animal were weighed in the morning and afternoon. Three percent of the total weight of feces at each collection period was taken as a sample.

The urine and feces samples were kept under refrigeration at a temperature of 36° F. during the trial. One c.c. of toluene was added to each sample of urine at the beginning of the trial to act as a preservative.

An aliquot sample of the 10 day composite urine sample was taken for

analysis. A 900 gram sample was removed from the 10 day composite feces sample to be analyzed. The concentrate and hay not eaten by the animal was removed and weighed. Samples were taken from these weighbacks at the end of the 10 day trial.

The samples of hay and concentrate used, hay weighbacks and concentrate weighbacks, as well as the urine and feces samples were analyzed for calcium (1, 29), phosphorus (29, 11), fluorine (32, 22), moisture (1), fat (1), crude fiber (1), nitrogen free extract and nitrogen (1).

CHAPTER III

DISCUSSION OF RESULTS

In order to clarify the tables and figures these statements will hold true in all cases. They are as follows:

1. Sodium fluoride is added to the concentrate in sufficient quantity to bring the fluorine in the total feed intake in lots 2, 3, 4, 5, 6, 7, 8, and 11 to the amounts designated.

2. Lots 9 and 10 have fluorine present in the hay at levels of 19 and 32 p.p.m. fluorine respectively.

3. The levels of fluorine used in the figures and tables are the amounts added plus that found in normal hay and grain.

4. Lot 3 contained only one animal.

5. Lot 11, had 100 p.p.m. sodium fluoride added to the ration plus 21 parts defluorophos per 1 part sodium fluoride. The defluorophos brings the level of fluorine in lot 11 up to 109 p.p.m. fluorine in the ration.

6. The digestibility data for cow 24 lot 1, and cow 2 lot 7, was not used in their respective lot averages because the values ran very low in comparison with other animals in their lot and the lots of higher and lower fluorine intake levels. These low values were probably due to the high per cent dry matter in the feces and the correspondingly high per cent of nutrients present. Relatively low nutrient values would have been expected since the total feed consumption in relation to the rest of the experimental data was about the same.

7. In lot 7 the consumption and digestibility of each nutrient was calculated on the basis of two animals. The trial period was 5 days for cow 58 and 8 days for cow 21. The total nutrients consumed per day were obtained by dividing the total nutrients consumed for the 13 day period by the total number of days the animals were on trial. In determining the average digestibility of nutrients, the total grams of nutrients retained was divided by the total nutrients consumed. Explanation for the 5 and 8 day trial was given in the preceding chapter.

TABLE I

COMPARISON OF MORRISON'S REQUIREMENTS OF TOTAL DIGESTIBLE NUTRIENTS AND DIGESTIBLE PROTEIN TO THOSE OBTAINED IN THIS EXPERIMENT

Lot No.	Average Weight Per Lot	Morrison's Requirements D. P.	Morrison's Requirements T. D. N.	Amount Consumed D. P.	Amount Consumed T. D. N.
1	1005	.70-.80	7.5-10.5	1.77*	9.59*
2	928	.65-.70	6.9-9.7	1.71	9.54
3	1036	.70-.80	7.5-10.5	1.33	6.46
4	937	.65-.70	6.9-9.7	1.73	9.40
5	992	.65-.70	6.9-9.7	1.53	8.41
6	925	.65-.70	6.9-9.7	1.46	8.37
7	924	.65-.70	6.9-9.7	1.52*	7.50*
8	836	.65-.70	6.9-9.7	1.29	6.54
9	983	.65-.70	6.9-9.7	1.68	8.69
10	1012	.70-.80	7.5-10.5	1.34	7.96
11	864	.65-.70	6.9-9.7	1.31	7.26

* Average derived from Lot 1 and 7 by omitting animal 24 and 2 respectively. See page 15.

TABLE IIA

DRY MATTER OF CONCENTRATE AND HAY

Lot No.	Cow No.	Fluorine Fed p.p.m.	Dry Matter Hay (gms)	Dry Matter Conc.(gms)	Total Dry Matter Consumed (gms)
1	42	6	5428	1551	6979
	24	6	5901	1582	7483
	13	6	5327	1635	6962
			5552	1589	7141
2	46	16	5109	1559	6668
	16	16	5815	1550	7365
	11	16	5448	1625	7073
			5457	1578	7035
3	32	26	4404	1484	5888
			4404	1484	5888
4	48	36	5166	1552	6718
	31	36	4975	1490	6465
	30	36	5431	1638	7069
			5191	1560	6750
5	23	46	5105	1596	6701
	9	46	4349	1549	5898
			4727	1572	6300
6	50	56	4102	1300	5402
	1	56	4889	1534	6423
	6	56	4478	1532	6010
			4490	1455	5945

TABLE IIA

DRY MATTER OF CONCENTRATE AND HAY (CONTINUED)

Lot No.	Cow No.	Fluorine Fed p.p.m.	Dry Matter Hay (gms)	Dry Matter Conc.(gms)	Total Dry Matter Consumed (gms)
7	2	76	3814	1512	5326
	58	76	3850	1560	5410
	21	76	4572	1116	5688
			4079	1396	5475
8	61	106	4137	1073	5210
	28	106	3293	815	4108
	29	106	3338	1148	4486
			3589	1012	4601
9	27	16	4567	1596	6163
	63	16	4922	1553	6475
	26	16	5613	1582	7195
			5034	1577	6611
10	67	26	3945	736	4681
	20	26	5301	1342	6643
	19	26	4030	1635	5665
			4425	1238	5663
11	70	109	3972	1417	5389
	12	109	3772	1576	5348
	25	109	3281	1400	4681
			3675	1464	5139

TABLE IIB

RELATIONSHIP OF TOTAL CONCENTRATE CONSUMED TO TOTAL HAY CONSUMPTION PER DAY

Lot No.	Av. Wgt. Per Lot	Aver. Conc. Consumed Per Day (gms)	Aver. Hay Consumed Per Day (gms)	Total Amt. Consumed Per Day (gms)	% Conc. Consumed Per Day	Hay Consumed Per Day
1	1005	1777*	6218*	7995*	22.23*	77.70*
2	928	1780	6327	8107	21.95	78.04
3	1036	1707	5121	6828	25.00	75.00
4	937	1764	6042	7807	22.60	77.40
5	992	1792	5424	7216	24.83	75.17
6	925	1671	5230	6900	24.21	75.79
7	924	1396*	4948*	6344*	22.00*	77.99*
8	836	1068	4132	5199	20.53	79.47
9	983	1792	5740	7532	32.79	76.21
10	1012	1380	5025	6403	21.55	78.47
11	864	1630	4251	5881	27.72	72.28

* Average derived from Lot 1 and 7 by omitting animal 24 and 2 respectively. See page 15.

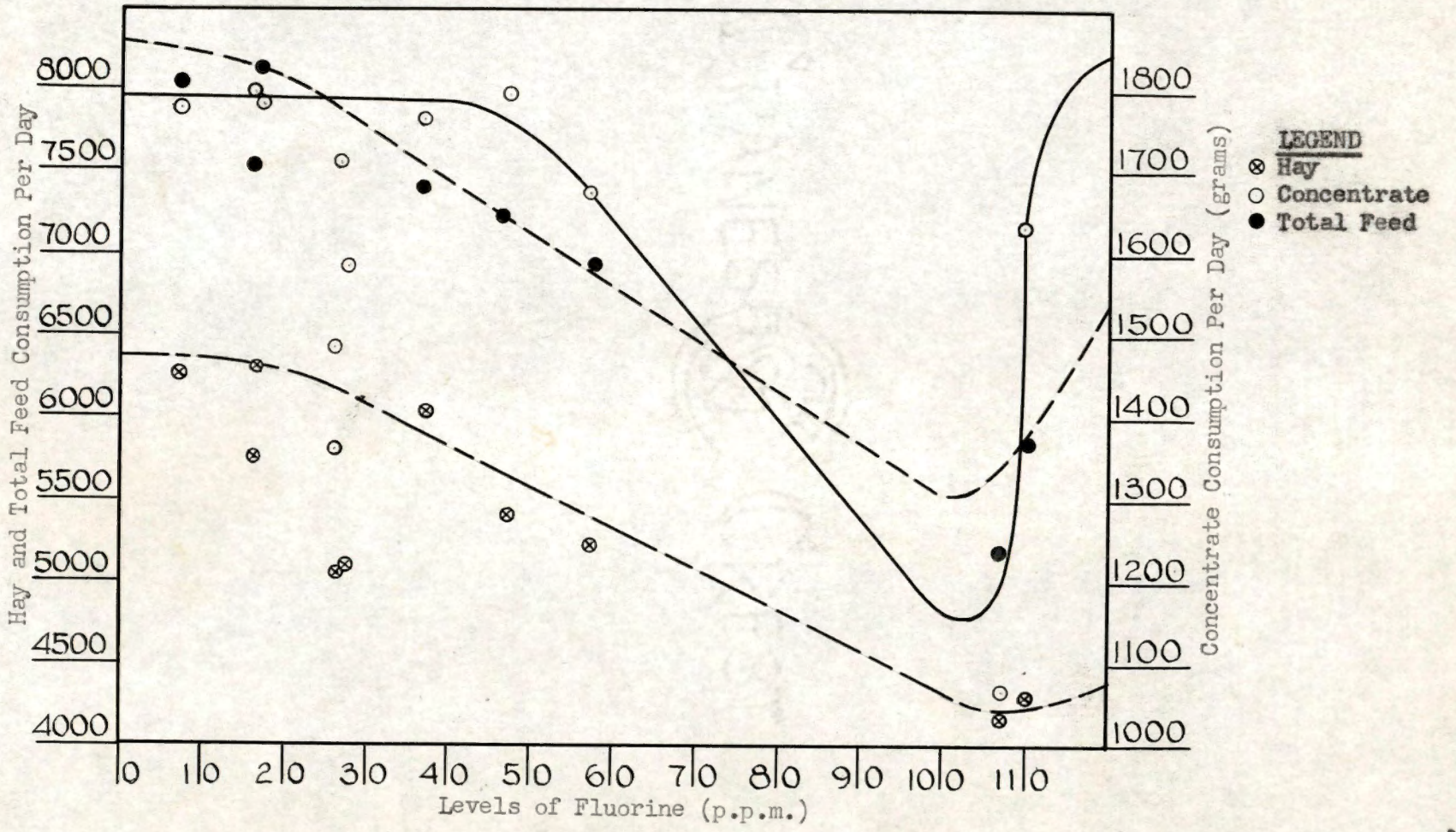


Figure 1

Relationship of Concentrate, Hay and Total Feed Consumed to the Levels of Fluorine Fed Per Day

TABLE III

TOTAL DIGESTIBLE NUTRIENTS

Lot No.	Cow No.	Fluorine Level Fed p.p.m.	Average Body wt/ Animal (lbs.)	T. D. N.	T. D. N./ cwt.
1	42	6	988	4206	425
	24	6	1080	2710	251
	13	6	948	4483	473
			1005	4344*	449*
2	46	16	867	4239	489
	16	16	967	4166	431
	11	16	950	4565	480
			928	4323	467
3	32	26	1036	2937	283
			1036	2937	283
4	48	36	913	4136	453
	31	36	921	4146	450
	30	36	977	4544	465
			937	4275	456
5	23	46	966	4203	435
	9	46	1019	3472	341
			992	3838	388
6	50	56	867	3557	410
	1	56	1026	4028	392
	6	56	882	3814	432
			925	3800	411

TABLE III

TOTAL DIGESTIBLE NUTRIENTS (CONTINUED)

Lot No.	Cow No.	Fluorine Level Fed p.p.m.	Average Body wt/ Animal (lbs.)	T. D. N.	T. D. N./ cwt.
7	2	76	890	2693	302
	58	76	880	3182	362
	21	76	1003	3614	360
			924	3398*	361*
8	61	106	735	3142	427
	28	106	867	2682	309
	29	106	907	3077	339
			836	2967	358
9	27	16	978	4026	412
	63	16	942	3581	380
	26	16	1028	4237	412
			983	3948	401
10	67	26	871	2868	329
	20	26	1119	3991	357
	19	26	1045	3997	382
			1012	3619	356
11	70	109	818	3444	421
	12	109	912	3266	358
	25	109	861	3166	368
			864	3292	382

*Averages derived from lot 1 and 7 by omitting animal 24 and 2 respectively.
See page 15.

TABLE IV

PROTEIN CONSUMPTION AND DIGESTIBILITY

Date of Trial	Lot No.	Cow No.	Fluorine Added p.p.m.	Total Nitrogen Intake in Hay Per day (gms)	Total Nitrogen Intake in Conc. Per day (gms)	Total Nitrogen Consumed Per day (gms)	Consumption of Protein Per day (gms)	Total Nitrogen In Feces Per day (gms)	Total Nitrogen Retained Per day (gms)	Digestibility of Nitrogen Per cent
1/26/51 2/4/51	1	42	0	128.4	45.2	173.6	1085	64.5	109.1	62.8
2/24/51 3/5/51	1	24	0	160.5	44.6	205.1	1281	119.9	85.2	41.5
3/11/51 3/21/51	1	13	0	146.9	53.3	200.2	1251	58.8	141.4	70.6
				145.3	47.7	186.9*	1168*	81.1	111.9	66.7*
1/26/51 2/4/51	2	46	10	115.6	50.3	165.9	1037	56.2	109.7	66.1
2/24/51 3/5/51	2	16	10	152.7	42.4	195.1	1219	68.8	126.3	64.8
3/11/51 3/21/51	2	11	10	149.1	50.4	199.5	1246	60.6	138.9	69.6
				139.1	47.7	186.8	1167	61.9	124.9	66.8
2/24/51 3/5/51	3	32	20	124.1	40.1	164.2	1026	67.0	97.2	59.2
				124.1	40.1	164.2	1026	67.0	97.2	59.2
1/26/51 2/4/51	4	48	30	126.4	47.2	173.6	1085	64.2	109.4	63.0
2/24/51 3/5/51	4	31	30	146.8	40.8	187.6	1172	61.3	126.3	67.3
3/11/51 3/21/51	4	30	30	148.9	51.3	200.2	1250	56.2	144.0	71.9
				140.7	46.4	187.1	1169	60.6	126.6	67.4
1/26/51 2/4/51	5	23	40	129.9	50.0	179.9	1124	66.1	113.8	63.2
2/24/51 3/3/51	5	9	40	123.0	42.3	165.3	1033	58.6	106.7	64.6
				126.4	46.2	172.6	1078	62.4	110.2	63.9

TABLE IV

PROTEIN CONSUMPTION AND DIGESTIBILITY
(CONTINUED)

Date of Trial	Lot No.	Cow No.	Fluorine Added p.p.m.	Total Nitrogen Intake in Hay Per day (gms)	Total Nitrogen Intake in Conc. Per day (gms)	Total Nitrogen Consumed Per day (gms)	Consumption of Protein Per day (gms)	Total Nitrogen In Feces Per day (gms)	Total Nitrogen Retained Per day (gms)	Digestibility of Nitrogen Per Cent
1/26/51 2/4/51	6	50	50	96.3	36.0	132.3	827	47.9	84.4	63.8
2/24/51 3/5/51	6	1	50	135.1	42.4	177.5	1109	56.2	121.3	68.3
2/24/51 3/5/51	6	6	50	126.1	42.1	168.3	1052	54.4	113.8	67.6
				119.2	40.2	159.4	996	52.8	106.5	66.6
2/24/51 3/5/51	7	2	70	104.5	41.1	145.6	910	69.1	76.5	52.6
3/11/51 3/15/51	7	58	70	105.0	48.7	153.7	961	44.1	109.6	71.3
3/11/51 3/18/51	7	21	70	126.1	33.5	159.6	998	44.4	115.2	72.2
				111.9	41.1	157.4*	983.8*	52.5	100.4	71.8*
1/26/51 2/4/51	8	61	100	105.1	34.9	140.0	875	49.2	90.8	64.8
3/11/51 3/21/51	8	28	100	96.8	24.7	121.5	759	30.9	90.6	74.6
3/11/51 3/21/51	8	29	100	94.0	37.0	131.0	819	32.6	96.4	75.2
				98.6	32.2	130.8	818	37.6	93.3	71.5

TABLE IV

PROTEIN CONSUMPTION AND DIGESTIBILITY
(CONTINUED)

Date of Trial	Lot No.	Cow No.	Fluorine Added p.p.m.	Total Nitrogen Intake in Hay Per day (gms)	Total Nitrogen Intake in Conc. Per day (gms)	Total Nitrogen Consumed Per day (gms)	Consumption of Protein Per day (gms)	Total Nitrogen In Feces Per day (gms)	Total Nitrogen Retained Per day (gms)	Digestibility of Nitrogen Per Cent
1/26/51 2/4/51	9	27	0	130.2	46.6	176.8	1105	58.0	118.8	67.2
1/26/51 2/5/51	9	63	0	146.9	45.3	192.2	1201	80.2	112.0	58.2
2/24/51 3/5/51	9	26	0	169.3	44.6	213.9	1337	81.2	132.7	62.0
				148.8	45.5	194.3	1214	73.1	121.2	62.5
1/26/51 2/4/51	10	67	0	104.1	21.2	125.3	783	47.9	77.4	61.7
2/24/51 3/5/51	10	20	0	137.9	38.1	176.0	1100	62.0	114.0	64.8
3/11/51 3/21/51	10	19	0	99.9	53.3	153.2	957	49.0	104.2	68.0
				114.0	37.5	151.5	947	53.0	98.5	64.8
1/26/51 2/4/51	11	70	100 ≠ def.	103.1	41.8	144.9	905	52.1	92.8	64.0
2/24/51 3/5/51	11	12	100 ≠ def.	104.2	42.2	146.4	915	48.6	97.8	66.8
3/11/51 3/21/51	11	25	100 ≠ def.	94.8	42.1	136.9	856	38.0	98.9	72.2
				100.7	42.0	142.7	892	46.2	96.5	67.7

*Averages derived from lot 1 and 7 by omitting animal 24 and 2 respectively.
See page 15.

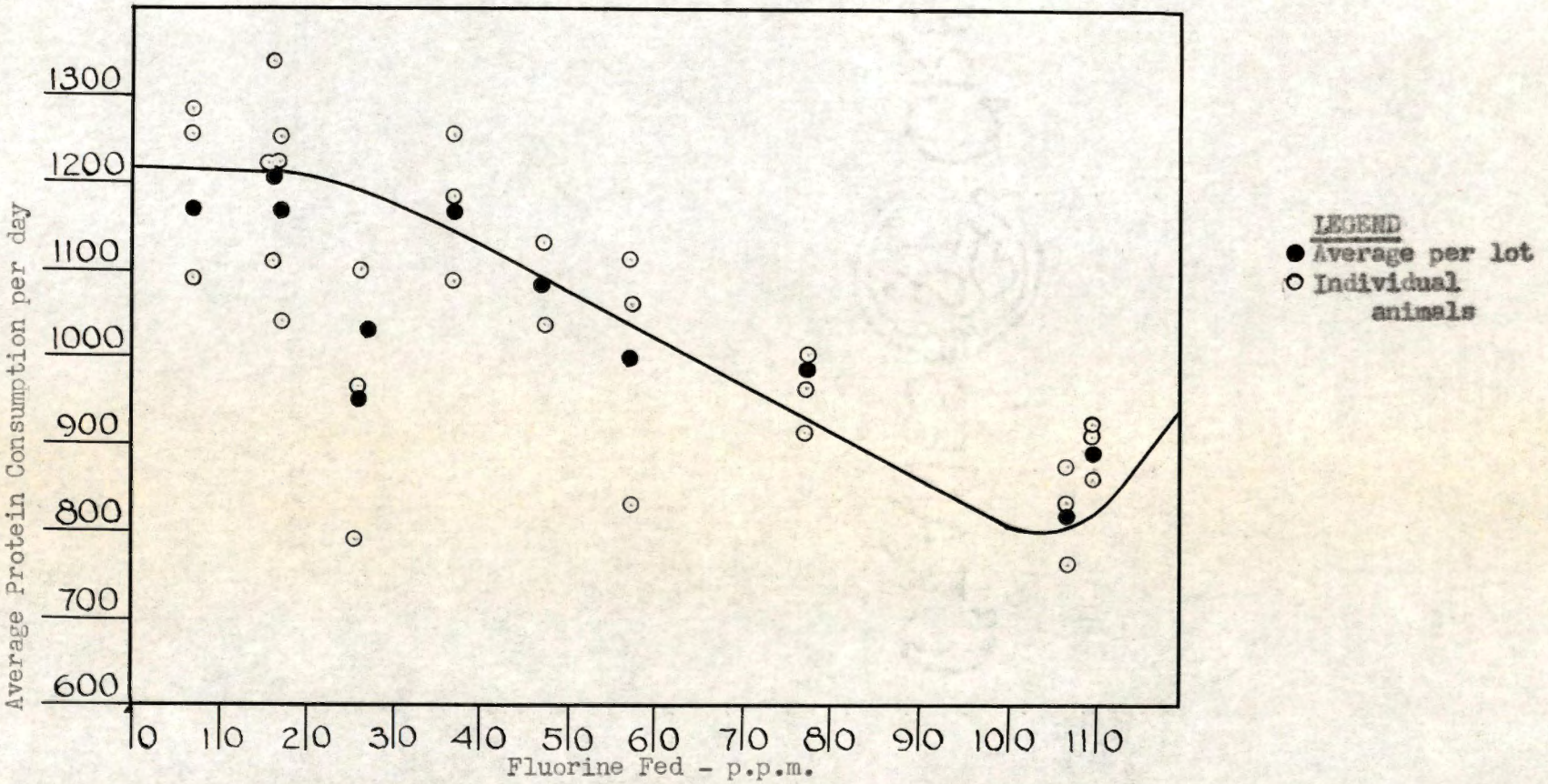


Figure 2
Average Consumption of Protein as Compared to Levels of Fluorine Fed

TABLE V

FAT CONSUMPTION AND DIGESTIBILITY

Date of Trial	Lot No.	Cow No.	Fluorine Added	Total Fat Intake in Hay Per day (gms)	Total Fat Intake in Concentrate Per day (gms)	Total Fat Consumed Per day (gms)	Total Fat in feces per day (gms)	Total Fat Retained per day (gms)	Digestibility of Fat per cent
1/26/51 2/4/51	1	42	0	88.3	83.2	171.5	74.8	96.7	56.4
2/24/51 3/5/51	1	24	0	103.5	87.0	190.5	165.0	25.5	13.3
3/11/51 3/21/51	1	13	0	109.1	95.7	204.8	77.1	127.7	62.3
				100.3	88.6	188.2*	105.6	83.3	59.4*
1/26/51 2/4/51	2	46	10	80.1	89.2	169.3	65.5	103.8	61.3
2/24/51 3/5/51	2	16	10	97.9	69.4	167.3	111.5	55.8	33.4
3/11/51 3/21/51	2	11	10	110.6	86.2	196.8	73.4	123.4	62.7
				96.2	81.6	177.8	83.5	94.3	52.5
2/24/51 3/5/51	3	32	20	82.7	81.7	164.4	116.1	48.3	29.4
				82.7	81.7	164.4	116.1	48.3	29.4
1/26/51 2/4/51	4	48	30	85.4	82.4	167.8	70.5	97.3	58.0
2/24/51 3/5/51	4	31	30	93.3	79.7	173.0	91.8	81.2	46.9
3/11/51 3/21/51	4	30	30	110.3	77.6	187.9	75.9	112.0	59.6
				96.3	79.9	176.2	79.4	96.8	54.8
1/26/51 2/4/51	5	23	40	90.1	82.4	172.5	73.0	99.5	57.7
2/24/51 3/5/51	5	9	40	78.8	88.3	167.1	91.7	75.4	45.1
				84.4	85.4	169.8	82.4	87.4	51.4

TABLE V

FAT CONSUMPTION AND DIGESTIBILITY (CONTINUED)

Date of Trial	Lot No.	Cow No.	Fluorine Added	Total Fat Intake in Hay Per day (gms)	Total Fat Intake in Concentrate Per day (gms)	Total Fat Consumed Per day (gms)	Total Fat in feces per day (gms)	Total Fat Retained per day (gms)	Digestibility of Fat per cent
1/26/51 2/4/51	6	50	50	65.7	71.9	137.6	54.8	82.8	60.2
2/24/51 3/5/51	6	1	50	85.8	81.4	167.2	88.1	79.1	47.3
2/24/51 3/5/51	6	6	50	80.8	80.9	161.7	79.7	82.0	50.7
				77.4	78.1	155.5	74.2	81.3	52.7
2/24/51 3/5/51	7	2	70	66.2	87.2	153.4	101.4	52.0	33.9
3/11/51 3/15/51	7	58	70	78.5	78.6	157.1	60.6	96.5	61.4
3/11/51 3/18/51	7	21	70	93.3	52.7	146.0	70.2	75.8	51.9
				79.3	72.8	150.2*	77.4	74.8	55.7*
1/26/51 2/4/51	8	61	100	71.6	61.9	133.5	59.9	73.6	55.1
3/11/51 3/21/51	8	28	100	68.8	44.5	113.3	51.8	61.5	54.3
3/11/51 3/21/51	8	29	100	69.8	62.4	132.2	50.6	81.6	61.7
				70.1	56.3	126.3	54.1	72.2	57.1

TABLE V

FAT CONSUMPTION AND DIGESTIBILITY (CONTINUED)

Date of Trial	Lot No.	Cow No.	Fluorine Added	Total Fat Intake in Hay Per day (gms)	Total Fat Intake in Concentrate Per day (gms)	Total Fat Consumed Per day (gms)	Total Fat in feces per day (gms)	Total Fat Retained per day (gms)	Digestibility of Fat per cent
1/26/51 2/4/51	9	27	Blount 1	129.6	85.3	214.9	79.9	135.0	62.8
1/26/51 2/4/51	9	63	Blount 1	143.5	83.3	226.8	87.3	139.5	61.5
2/24/51 3/5/51	9	26	Blount 1	119.4	87.0	206.4	118.3	88.1	42.7
				130.8	85.2	216.0	95.2	120.9	55.7
1/26/51 2/4/51	10	67	Blount 2	75.9	42.2	118.1	50.4	67.7	57.3
2/24/51 3/5/51	10	20	Blount 2	101.8	73.7	175.5	89.0	86.5	49.3
3/11/51 3/21/51	10	19	Blount 2	69.1	95.7	164.8	57.0	107.8	65.4
				82.3	70.5	152.8	65.5	87.3	57.3
1/26/51 2/4/51	11	70	100 ≠ def.	71.4	79.5	150.9	67.0	83.9	55.6
2/24/51 3/5/51	11	12	100 ≠ def.	66.1	83.9	150.0	71.7	78.3	52.2
3/11/51 3/21/51	11	25	100 ≠ def.	66.5	74.9	141.4	55.9	85.5	60.5
				68.0	79.4	147.4	64.9	82.6	56.1

*Averages derived from lot 1 and 7 by omitting animal 24 and 2 respectively.
See page 15.

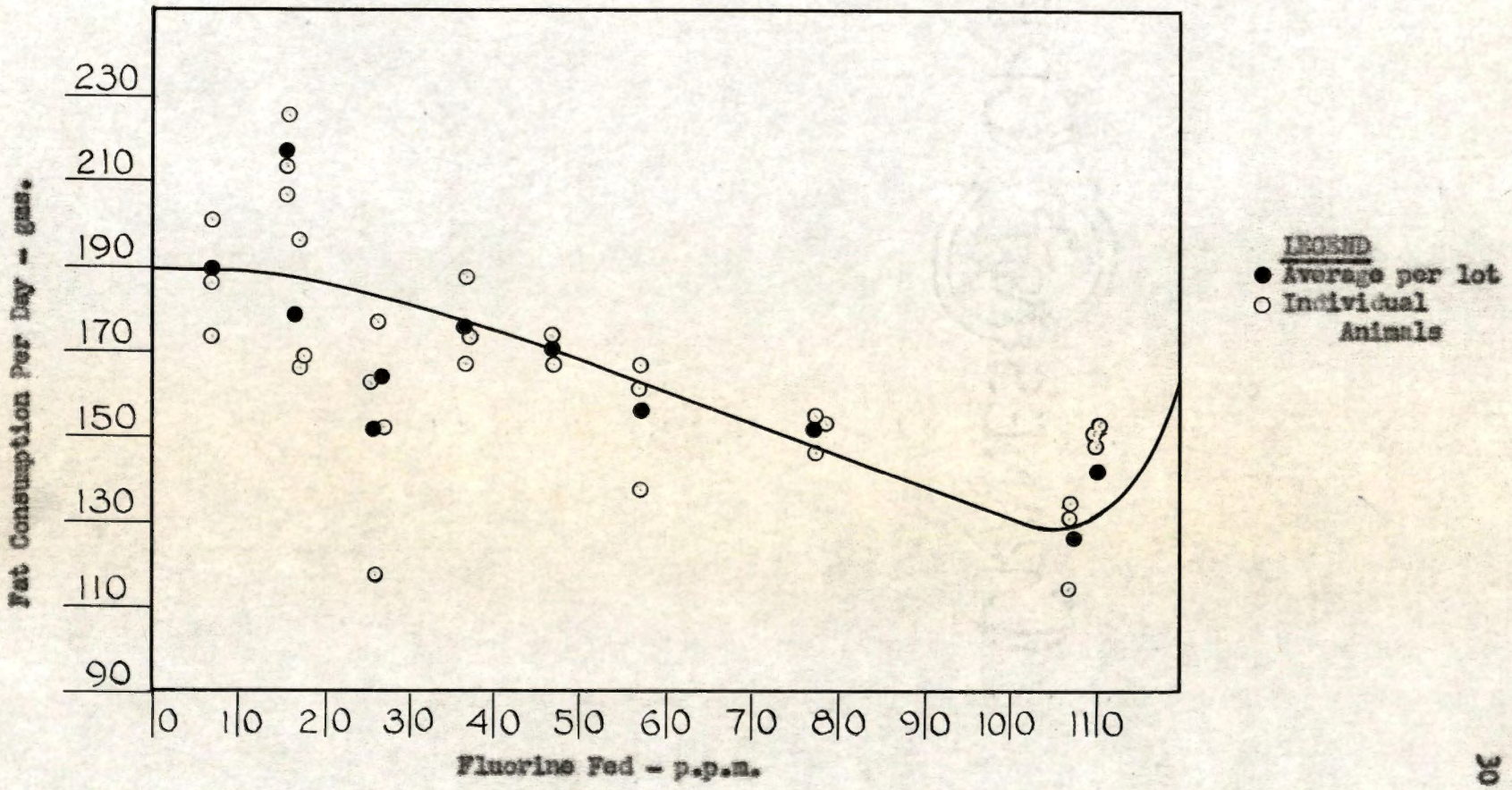


Figure 3

Average Fat Consumption Per Day as Compared to the Levels of Fluorine Fed

TABLE VI

CRUDE FIBER CONSUMPTION AND DIGESTIBILITY

Date of Trial	Lot No.	Cow No.	Fluorine Added	Total C. F. Intake in Hay per day (gms)	Total C. F. Intake in Concentrate per day (gms)	Total C. F. Consumed per day (gms)	Total C.F. in Feces per day (gms)	Total C.F. Retained per day (gms)	Digestibility of C. F. per cent
1/26/51 2/4/51	1	42	0	2084.5	62.0	2146.5	1094.0	1052.5	49.0
2/24/51 3/5/51	1	24	0	2002.0	55.6	2057.6	1773.5	284.1	13.8
3/11/51 3/21/51	1	13	0	1715.0	65.6	1780.6	964.8	815.8	45.8
				1933.8	61.1	1963.5*	1277.4	714.5	47.4*
1/26/51 2/4/51	2	46	10	2025.6	61.3	2086.9	960.9	1126.0	54.0
2/24/51 3/5/51	2	16	10	2051.2	53.5	2104.7	1211.7	893.0	42.4
3/11/51 3/21/51	2	11	10	1772.4	62.9	1835.3	1018.4	816.9	44.5
				1949.7	59.2	2009	1063.7	945.3	47.0
2/24/51 3/5/51	3	32	20	1459.1	49.0	1508.1	1153.2	354.9	23.5
				1459.1	49.0	1508.1	1153.2	354.9	23.5
1/26/51 2/4/51	4	48	30	1932.1	59.1	1991.2	1007.6	983.6	49.4
2/24/51 3/5/51	4	31	30	1568.8	51.0	1619.8	799.3	820.5	50.6
3/11/51 3/21/51	4	30	30	1764.9	65.1	1830.0	989.0	841.0	46.0
				1755.3	58.4	1813.7	932.0	881.7	48.7
1/26/51 2/4/51	5	23	40	1814.9	62.3	1877.2	887.1	990.1	52.7
2/24/51 3/5/51	5	9	40	1425.8	56.8	1482.6	901.9	580.7	39.2
				1620.4	59.6	1679.9	894.5	785.4	46.0

TABLE VI

CRUDE FIBER CONSUMPTION AND DIGESTIBILITY (CONTINUED)

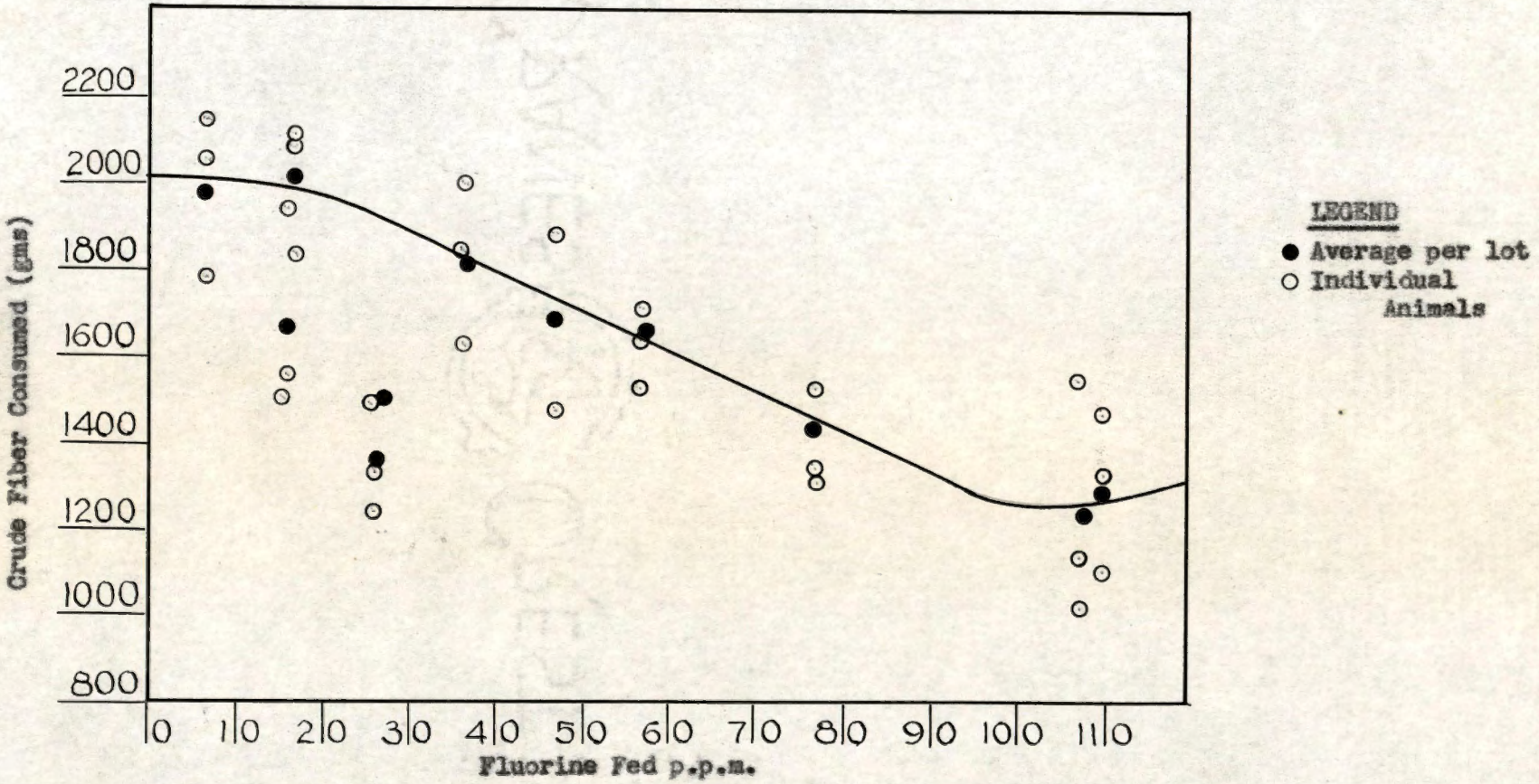
Date of Trial	Lot No.	Cow No.	Fluorine Added	Total C. F. Intake in Hay per day (gms)	Total C. F. Intake in Concentrate per day (gms)	Total C. F. Consumed per day (gms)	Total C.F. in Feces per day (gms)	Total C.F. Retained per day (gms)	Digestibility of C. F. per cent
1/26/51 2/4/51	6	50	50	1590.3	49.7	1640.0	662.8	977.2	59.6
2/24/51 3/5/51	6	1	50	1648.1	52.5	1700.6	829.4	871.2	51.2
2/24/51 3/5/51	6	6	50	1479.6	52.2	1531.8	788.3	743.5	48.5
				1572.7	51.5	1624.1	760.2	864.0	53.1
2/24/51 3/5/51	7	2	70	1294.9	52.3	1347.2	932.7	414.5	30.8
3/11/51 3/15/51	7	58	70	1245.2	67.3	1312.5	741.2	571.3	43.5
3/11/51 3/18/51	7	21	70	1469.7	46.8	1516.5	739.1	777.4	51.3
				1336.6	55.5	1438.1*	804.3	587.7	48.5*
1/26/51 2/4/51	8	61	100	1499.4	44.9	1544.3	785.4	758.9	49.14
3/11/51 3/21/51	8	28	100	989.5	28.9	1018.4	562.4	456.0	44.78
3/11/51 3/21/51	8	29	100	1077.4	47.9	1125.3	508.0	617.3	54.85
				1188.8	40.6	1229.3	618.6	610.7	49.6

TABLE VI

CRUDE FIBER CONSUMPTION AND DIGESTIBILITY (CONTINUED)

Date of Trial	Lot No.	Cow No.	Fluorine Added	Total C. F. Intake in Hay per day (gms)	Total C. F. Intake in Concentrate per day (gms)	Total C. F. Consumed per day (gms)	Total C.F. in Feces per day (gms)	Total C.F. Retained per day (gms)	Digestibility of C. F. per cent
1/26/51 2/4/51	9	27	0	1437.0	64.9	1501.9	707.9	794.0	52.9
1/26/51 2/4/51	9	63	0	1496.2	62.9	1559.1	1031.9	527.2	33.8
2/24/51 3/5/51	9	26	0	1868.8	55.6	1924.4	968.7	955.7	49.7
				1600.7	61.1	1661.8	902.8	759.0	45.4
1/26/51 2/4/51	10	67	0	1211.0	30.2	1241.2	525.3	715.9	57.7
2/24/51 3/5/51	10	20	0	1451.8	47.1	1498.9	1035.2	463.7	30.9
3/11/51 3/21/51	10	19	0	1283.5	65.6	1349.1	469.6	879.5	65.2
				1315.4	47.6	1363.1	676.7	686.4	51.3
1/26/51 2/4/51	11	70	100 ≠ def.	1405.4	55.2	1460.6	664.9	795.7	54.5
2/24/51 3/5/51	11	12	100 ≠ def.	1268.7	56.5	1325.3	750.2	575.1	43.4
3/11/51 3/21/51	11	25	100 ≠ def.	1066.5	36.6	1103.1	501.1	602.0	54.6
				1246.9	49.4	1296.3	638.7	657.6	50.8

* Averages derived from Lot 1 and 7 by omitting animal 24 and 2 respectively.
See page 15.



Average Crude Fiber Consumption Per Day as Compared to the Levels of Fluorine Fed

Figure 4

TABLE VII

NITROGEN FREE EXTRACT CONSUMPTION AND DIGESTIBILITY

Date of Trial	Lot No.	Cow No.	Fluorine Added	Total N.F.E. Intake in Hay per day (gms)	Total N.F.E. Intake in Concentrate per day (gms)	Total N.F.E. Consumed per day (gms)	Total N.F.E. in Feces per day (gms)	Total N.F.E. Retained per day (gms)	Digestibility of N.F.E. per cent
1/26/51 2/4/51	1	42	0	2061.2	1079.1	3140.3	885.9	2254.4	71.8
2/24/51 3/5/51	1	24	0	2350.2	1120.2	3470.4	1633.9	1836.6	52.9
3/11/51 3/21/51	1	13	0	2172.3	1089.9	3262.3	765.5	2496.7	76.5
				2194.6	1096.4	3201.3*	1095.1	2195.9	74.2*
1/26/51 2/4/51	2	46	10	1923.3	1045.5	2968.8	775.3	2193.5	73.9
2/24/51 3/5/51	2	16	10	2292.0	1124.0	3416.0	1058.1	2357.9	69.0
3/11/51 3/21/51	2	11	10	2212.2	1114.7	3326.9	724.8	2602.1	78.2
				2142.5	1094.7	3237.2	852.7	2384.5	73.7
2/24/51 3/5/51	3	32	20	1754.1	1069.4	2823.5	1865.3	958.2	66.1
				1754.1	1069.4	2823.5	1865.3	958.2	66.1
1/26/51 2/4/51	4	48	30	1974.4	1070.2	3044.6	795.3	2249.3	73.9
2/24/51 3/5/51	4	31	30	2005.8	1070.9	3076.7	723.6	2353.1	76.5
3/11/51 3/21/51	4	30	30	2204.9	1127.6	3332.5	781.5	2551.0	76.6
				2061.7	1089.6	3151.3	766.8	2384.4	75.6
1/26/51 2/4/51	5	23	40	1998.9	1089.7	3088.6	814.1	2274.5	73.6
2/24/51 3/5/51	5	9	40	1754.3	1100.5	2854.8	800.6	2054.2	72.0
				1876.6	1095.1	2971.2	807.35	2164.3	72.8

TABLE VII

NITROGEN FREE EXTRACT CONSUMPTION AND DIGESTIBILITY (CONTINUED)

Date of Trial	Lot No.	Cow No.	Fluorine Added	Total N.F.E. Intake in Hay per day (gms)	Total N.F.E. Intake in Concentrate per day (gms)	Total N.F.E. Consumed per day (gms)	Total N.F.E. in Feces per day (gms)	Total N.F.E. Retained per day (gms)	Digestibility of N.F.E. per cent
1/26/51									
2/4/51	6	50	50	1546.7	923.0	2469.7	603.2	1866.5	75.6
2/24/51									
3/5/51	6	1	50	1945.2	1098.0	3043.2	822.4	2220.8	73.0
2/24/51									
3/5/51	6	6	50	1789.1	1097.6	2886.7	712.3	2174.4	75.3
				1760.3	1039.5	2800.0	712.6	2087.2	74.6
2/24/51									
3/5/51	7	2	70	1513.6	1078.4	2592.0	909.0	1683.0	64.9
3/11/51									
3/15/51	7	58	70	1572.5	1062.7	2635.2	584.5	2050.7	77.8
3/11/51									
3/18/51	7	21	70	1865.0	782.5	2647.5	558.2	2089.3	78.9
				1650.4	974.5	2642.8*	683.9	1941.0	78.5*
1/26/51									
2/4/51	8	61	100	1593.7	717.2	2310.9	661.0	1649.9	71.4
3/11/51									
3/21/51	8	28	100	1357.6	578.3	1935.9	414.3	1521.6	78.6
3/11/51									
3/21/51	8	29	100	1339.8	777.3	2117.1	456.3	1660.8	78.4
				1430.4	6909.3	2121.3	510.5	1610.8	76.2

TABLE VII

NITROGEN FREE EXTRACT CONSUMPTION AND DIGESTIBILITY (CONTINUED)

Date of Trial	Lot No.	Cow Co.	Fluorine Added	Total N.F.E. Intake in Hay per day (gms)	Total N.F.E. Intake in Concentrate per day (gms)	Total N.F.E. Consumed per day (gms)	Total N.F.E. in Feces per day (gms)	Total N.F.E. Retained per day (gms)	Digestibility of N.F.E. per cent
1/26/51 2/4/51	9	27	0	1879.4	1108.8	2988.2	802.1	2186.1	73.2
1/26/51 2/5/51	9	63	0	2001.5	1079.5	3081.0	1040.6	2040.4	66.2
3/24/51 3/5/51	9	26	0	2139.7	1120.2	3259.9	1005.5	2254.4	69.2
				2006.9	1102.8	3109.7	949.4	2160.3	69.5
1/26/51 2/5/51	10	67	0	1676.9	522.7	2199.6	683.2	1516.4	68.9
2/24/51 3/5/51	10	20	0	2491.3	955.5	3446.8	827.6	2619.2	76.0
3/11/51 3/21/51	10	19	0	1782.9	1689.9	2872.8	648.9	2223.9	77.4
				1983.7	856.0	2839.7	719.9	2119.8	74.1
1/26/51 2/5/51	11	70	100 ≠ def.	1546.2	968.5	2514.7	635.5	1879.2	74.7
2/24/51 3/5/51	11	12	100 ≠ def.	1502.6	1111.1	2613.7	709.7	1904.0	72.8
3/11/51 3/21/51	11	25	100 ≠ def.	1289.9	965.7	2255.6	502.2	1753.4	77.7
				1446.2	1015.1	2461.3	615.8	1845.5	75.1

* Averages derived from Lot 1 and 7 by omitting animal 24 and 2 respectively.
See page 15.

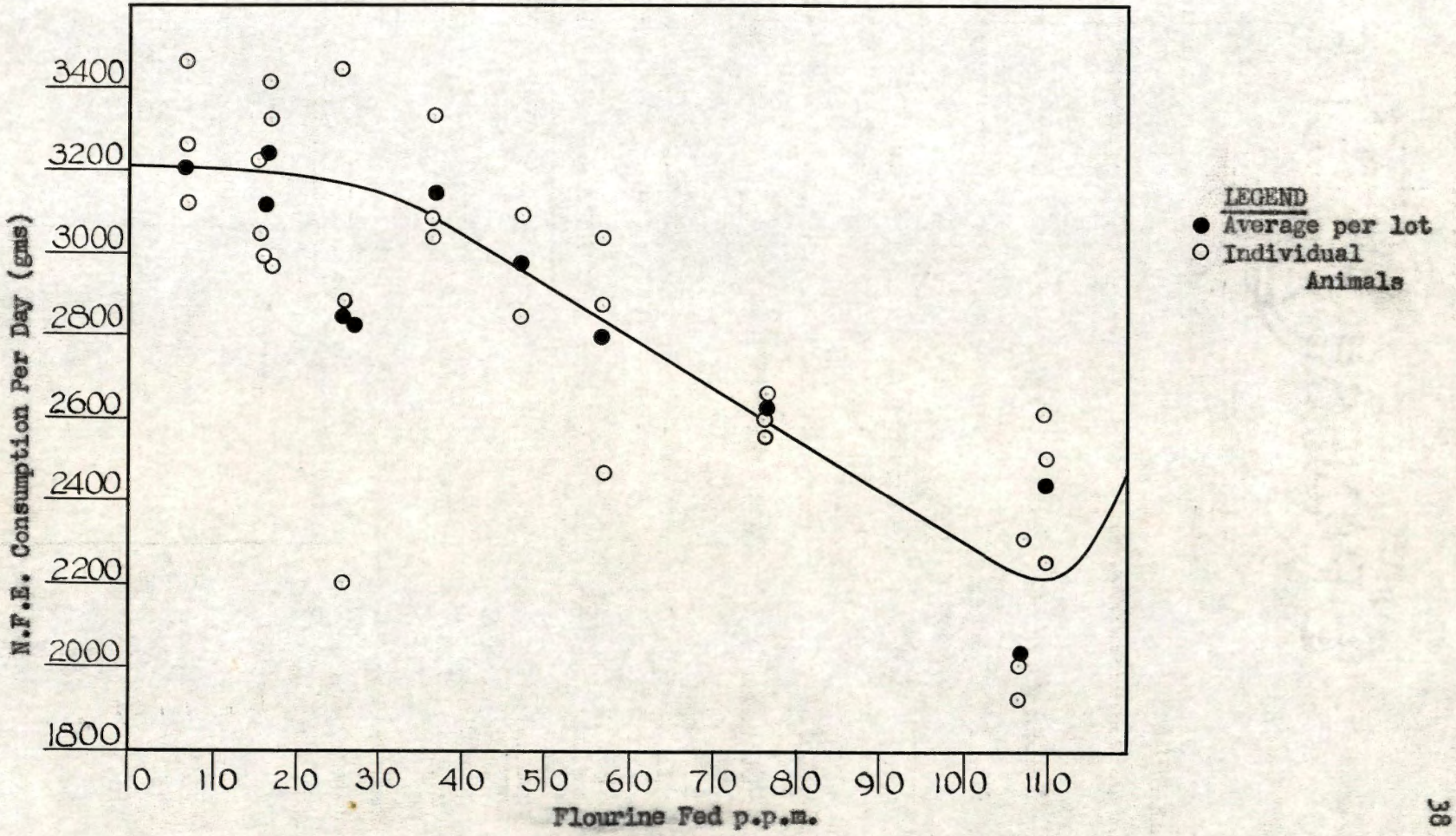


Figure 5

Average Nitrogen Free Extract Consumption Per Day as Compared to the Level of Fluorine Fed

TABLE VIII

AVERAGE DIGESTIBILITY OF NUTRIENTS

Lot No.	Fluorine Fed p.p.m.	% Digest Protein	% Digest. Fat	% Digest. Crude Fiber	% Digest. Nit. Free Ex.
1	6	66.7	59.4	47.4	74.2
2	16	66.8	52.5	47.0	73.7
3	26	59.2	29.4	23.5	66.1
4	36	67.4	54.8	48.7	75.6
5	46	63.9	51.4	46.0	72.8
6	56	66.6	52.7	53.1	74.6
7	76	71.8	55.7	48.5	78.5
8	106	71.5	57.1	49.6	76.2
9	16	62.5	55.7	45.4	69.5
10	26	64.8	57.3	51.3	74.1
11	109	67.7	56.1	50.8	75.1

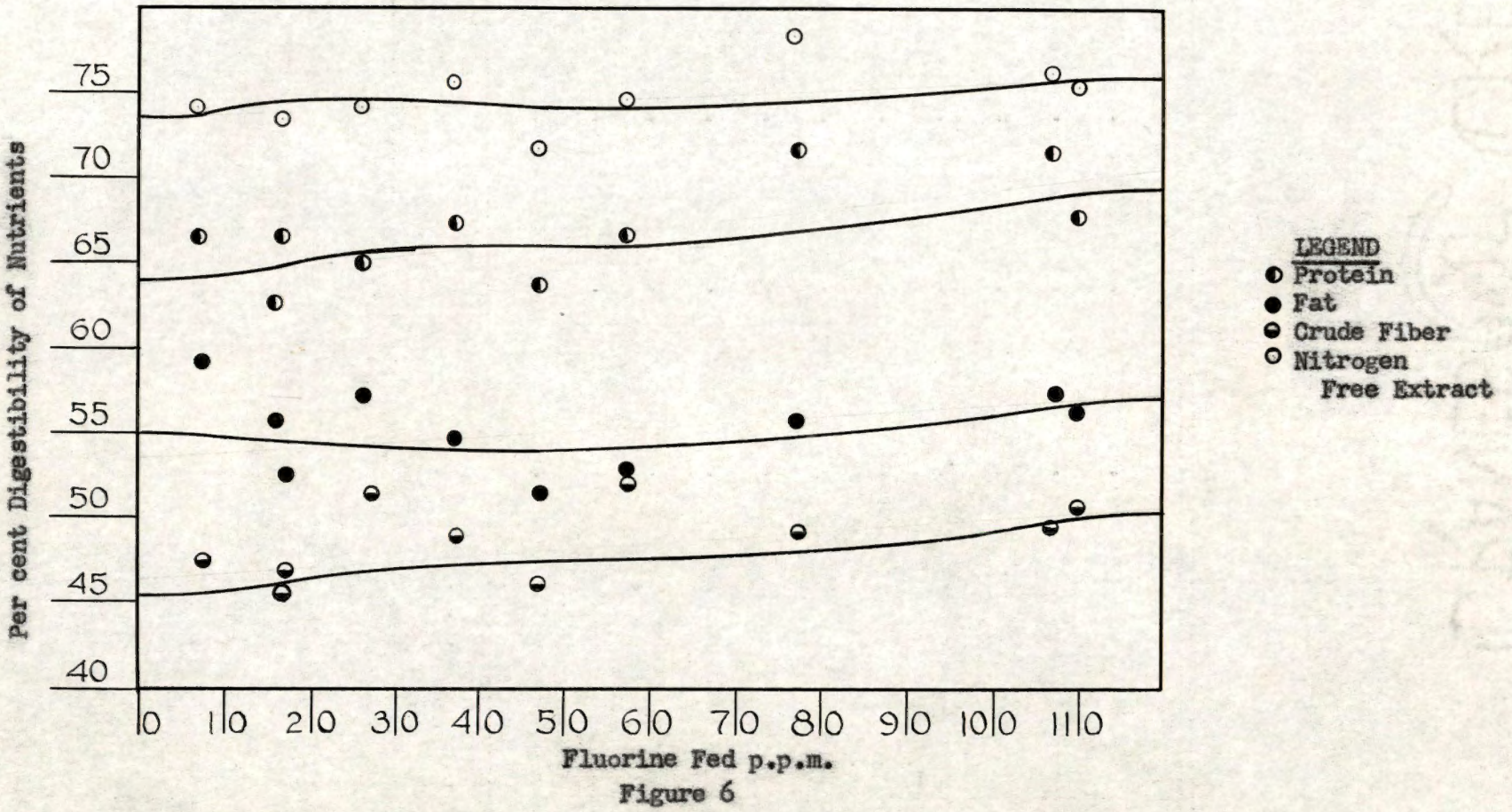


Figure 6

Average Digestibility of Nutrients as Compared to the Levels of Fluorine Fed

A. COMPARISON OF MORRISON'S REQUIREMENTS OF TOTAL DIGESTIBLE NUTRIENTS AND DIGESTIBLE PROTEIN TO THOSE OBTAINED IN THIS EXPERIMENT

Table I is a comparison between the requirements of digestible protein and total digestible nutrients as given by Morrison (23) and the amount actually digested by the animal. It will be noted that the digestible protein in all cases greatly exceeds the maximum given by Morrison. The total digestible nutrients fall within Morrison's range with the exception of lots 3 and 11.

B. THE RELATIONSHIP OF TOTAL FEED CONSUMPTION, DRY MATTER AND TOTAL DIGESTIBLE NUTRIENTS TO THE LEVELS OF FLUORINE FED

The feed consumption was fairly constant from the control level to lots receiving around 46 p.p.m. fluorine as shown in Table II A, and Figure 1. There was a drop in consumption from lot 5 receiving 46 p.p.m. fluorine in the ration to lot 8 receiving 106 p.p.m. fluorine. Lot 11, receiving 106 p.p.m. fluorine plus 21 parts defluorophos per one part sodium fluoride added to the ration, showed an increase in consumption of feed over lot 8 receiving 106 p.p.m. fluorine. A probable reason for increased consumption by lot 11 may be due to the addition of defluorophos.

The effects of various levels of fluorine on total digestible nutrients consumed per 100 pounds body weight showed a slight variation from the trend of total feed consumption. The consumption of total digestible nutrients consumed per 100 pounds of body weight was fairly constant up

to lot 5 receiving 46 p.p.m. fluorine fed. There was a gradual drop in total digestible nutrients per 100 pounds body weight from the lot receiving 46 p.p.m. fluorine to a low in lot 7 receiving the 76 p.p.m. fluorine level. Lot 8 receiving 106 p.p.m. fluorine in the ration was about in line with lot 7, and there was very little increase shown by lot 11.

The consumption of hay and grain holds fairly constant up to around 40 to 50 p.p.m. fluorine in the ration. From these levels there is a gradual decline in consumption of hay and grain as shown in Table IIB and Figure 1, with the drop being more apparent in the grain. Lot 8 receiving 106 p.p.m. fluorine in the ration had the lowest consumption. Lot 11 showed a marked rise in grain consumption over lot 8. There was little effect on hay consumption by the addition of defluorophos.

Data on consumption of individual nutrients as shown in Tables IV, V, VI, and VII as well as Figures 2, 3, 4, and 5 seem to substantuate the above pattern shown by the total feed consumption tables and figures. There were no appreciable difference in consumption of any one nutrient. Consumption of nutrients hold fairly constant from the control level to around 40 to 50 p.p.m. fluorine in the ration. From the 40 to 50 p.p.m. fluorine level there was a gradual drop until a low point was reached at the 76 and 106 p.p.m. fluorine level as shown by lots 7 and 8 respectively. Lot 11 showed a slight increase over lot 8 in the consumption of individual nutrients.

C. DIGESTIBILITY OF NUTRIENTS AS COMPARED TO THE LEVELS OF FLUORINE FED

The effect of fluorine upon the digestibility of individual nutrients seems to be rather similar as shown by Tables IV, V, VI, VII and Figure 6. The digestibility of one nutrient appears to be neither accelerated nor retarded by fluorine more than any other nutrient.

In this experiment it appears that the effect of increasing the level of fluorine above the control ration decreases feed consumption rather than effecting the digestibility of individual nutrients.

CHAPTER IV

SUMMARY AND CONCLUSION

The ration fed during this metabolism trial consisted of 4 parts corn to 1 part cottonseed meal. Each cow received 4 pounds of the above concentrate. Good quality lespedeza and alfalfa hay was fed all lots with the exception of the two lots receiving Blount 1 and Blount 2 hay.

Sodium fluoride was added to the concentrate of each lot in the following amounts: 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.; lot 9, no sodium fluoride added to the concentrate, but Blount 1 hay contains 19 p.p.m. fluorine; lot 10, no sodium fluoride in the concentrate, but Blount 2 hay contains 32 p.p.m. fluorine; lot 11, 100 p.p.m. sodium fluoride, plus 21 parts defluorophos per 1 part of sodium fluoride added to the ration. It was found that control hay and concentrate ration contained 6 p.p.m. fluorine.

Feed consumption of each individual nutrient followed the same general pattern. Consumption from the control level to lot 5 receiving 46 p.p.m. fluorine in the ration was similar. There was a drop in consumption from lot 5 to lot 8 receiving 106 p.p.m. in the ration. Consumption of concentrate was increased considerably by the addition of defluorophos to the ration, but no marked effect on hay consumption was apparent.

The effect of fluorine upon digestibility of individual nutrients

seems to be rather similar under conditions of this experiment. The digestibility of one nutrient appears to be neither accelerated nor retarded by fluorine more than any other nutrient.

In this experiment it appears that the effect of increasing the level of fluorine above the control level decreases feed consumption rather than effecting the digestibility of individual nutrients.

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