COMPARATIVE FEEDING TRIAL OF DRIED SUGAR BEET PULP VS SUGAR BEET PULP SILAGE FOR FATTENING YOUNG BULLS

by

Manuel A. Manuelian

A Thesis Submitted to the Faculty

of Agricultural Sciences in Partial Fulfillment

of the Requirements for the Degree of

MASTER OF SCIENCE IN AGRICULTURE

Major: Dairy Husbandry - Beef Production

Minor: Poultry Production

Approved:

Kurt Rollenstein
In Charge of Major Work

Franklin R Ampy

Nuhad J. Doghri

W. A. Dayell
Chairman, Graduate Committee

American University of Beirut

1965

COMPARATIVE FEEDING TRIAL FOR BULLS

MANUELIAN

ACKNOWLEDGEMENTS

The author wishes to extend his sincere thanks to Dr. Knud Rottensten for suggesting the subject, analysing the data and correcting the manuscript.

Many thanks are due to Dr. Samir Badawi for technical and practical assistance, and to Mr. Adel Asa'ad foreman at the Agricultural Research and Educational Center of the American University of Beirut for his assistance in managerial aspects of this work.

Sincere gratitude to Ferrosan, Copenhagen, for their generous supply of "Avimin Ido" the vitamin A preparations.

ABSTRACT

A comparative feeding experiment of dried sugar beet pulp and wet sugar beet pulp silage was conducted for fattening young bulls. The duration of the experiment was eight months from March 16 to November 15, 1964. In addition to the comparison of the two forms of sugar beet pulp, the effect of vitamin A injections was also studied.

The dried beet pulp group had a higher daily gain than the silage group, but the difference was not statistically significant. The beet pulp group also had the highest feed consumption, calculated as dry matter, but the silage group had the highest feed efficiency.

The feed consumption per lb. of gain increased with age. Based on a straight line regression,the dry matter intake per lb. of gain was 3.06 lbs. at the start of the experiment and 5.65 lbs. at the end.

The group which did not receive any vitamin injections in the early part of the experiment developed deficiency symptoms and their gains were significantly lower than those that received vitamin A from the beginning. After vitamin A injections were given to the "deficient group" their live weight gains were accelerated, so the difference in live weight gain at the end of the experiment was no longer statistically significant.

When equal price per kg. of dry matter in dry beet pulp and in silage and equal selling price per kg. of live weight was assumed, then the "profitableness" was slightly better for the silage than for the dried beet pulp group.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES AND GRAPHS

INTRODUCTION

The production of red meat in Lebanon is far short of the consumption. In calves from dairy herds which are not needed for replacement, there is a considerable potential for beef production. The main reason for not raising them in the past has been the unfavorable relationship between the feed cost and the price of the finished animals.

It is particularly roughage feeds which are expensive and scarce. It has been shown, however, that roughage is not as indispensible for young stock as it was thought earlier. If rations are prepared which will produce satisfactory gains economically, the prospect of producing beef at competitive cost would be much improved.

One of the cheapest animal feeds at present is sugar beet pulp. A sugar factory was established in the Beka'a in 1958, and since then, sugar beet production has been increasing at a fast rate. In 1958 it amounted to 3000 tons, in 1961 it was 24500 tons and 32000 tons in 1963, Worzella, W.W., et al. (1962), and Samman, M.A. (1964), and it seems likely that the production will keep on increasing in the near future. Approximately 60% of the beets is left as beet pulp after the sugar has been extracted. The dry matter of the fresh pulp, however, is only half or less than that of the beets, so it is only 25-30% of the dry matter in the beets which is left in the pulp.

The beet pulp can be fed fresh, but since it spoils quickly the feeding of fresh beet pulp is of very limited interest. The beet pulp can be stored in trench silos where it will undergo some fermentation. Such silage will keep for long periods without getting spoiled.

In the past ensiling of beet pulp has not been used, but the pulp has been dried. The drying is a very costly process but it has several advantages. Some of the other by-products from the sugar production, like molasses, can be added to the dry pulp. The dry pulp is easy to store and feed, the cost of transportation is reduced and losses of nutrients is almost eliminated.

With the prospect of increasing sugar beet production, it was of interest to investigate the feasability of using large amounts of beet pulp for the production of beef and to compare the value of the dried molasses beet pulp with ensiled beet pulp.

REVIEW OF LITERATURE

Sugar beet pulp has not been widely used for beef production as has other feedstuffs. Usually the dried form is used in concentrate mixtures, up to a maximum of 10 percent, and occasionally has it been fed in the form of silage. In both cases, as silage or as dried pulp, there has been some hay or straw added which is not the case in this experiment.

Charton, A.,(1954) has reported on disturbances in ruminants caused by beet pulp. In the fresh state or as silage, beet pulp has a high content of water and nitrogen free extract, and it is very low in protein, vitamins and minerals. It may cause severe disturbances of the digestive system in cattle, like diarrhea and bloat. It is generally considered safer when it is fed as dry pulp.

Kercher, C.J. and Bishop,D.V., (1963) have worked on the influence of all-concentrate feeding on the growth and carcass characteristics of beef cattle. In an experiment with 51 yearling Hereford steers, which were fed steam-rolled barley, steam-rolled oats, steam-rolled milo or beet pulp pellets as single grains in an all-concentrate feeding program, daily gains and feed consumption were measured. Dehydrated alfalfa pellets were fed as the supplement (12.5% of the ration). Relatively few cases of bloat or founder occurred and there were no death losses. Average daily gains and lbs. of feed per 1 lb. of gain were 2.9, 7.15; 3.0, 7.80; 3.1, 7.47; and 2.0, 9.91 for steers fed barley, oats, milo or beet pulp, respectively. The carcass yield (%) and carcass grade (9= ave. choice) were 60.9, 8.9; 57.4, 7.9; 62.6, 9.2; 60.8, 6.8 for barley, oats, milo and beet pulp fed steers, respectively. These differences were not statistically significant ($P<.05$).

The beet pulp fed steers had significantly lower levels of propionic acid and significantly higher levels of acetic acid in the rumen contents than the steers fed the other rations. Butyric acid levels were highest in steers fed barley followed by those fed oats, milo and beet pulp.

Several people have worked on fattening beef on all-concentrate ration, where some have used mainly barley, others have used some other cereal grain. Some have also studied the effect of different ratios of roughages and concentrates in different rations for cattle feeding.

Preston, T.R.,(1963) worked on beef production using 85% barley, and 15% supplement with 30% protein content. The barley was steam-rolled which made the high levels safer. Very satisfactory results in gain were obtained. Besides bloat, two other problems were observed: 1) Acidosis - caused by over eating of cereals, and 2) Kidney necrosis and liver abscess formation which may lead to complete condemnation of the liver and kidneys.

Richardson, D. and Smith, E.F.,(1961) have worked on the effect of roughage-concentrate ratio on gains, feed efficiency, digestion and carcass grades. Feeding trials with 91 heifers were conducted during three years with rations having roughage-concentrate ratios of: 1:1, 1:3, 1:5, and a changing ration in which the concentrates were increased every 28 days. Highest average gains was obtained with the 1:5 ratio and lowest with 1:1. Carcass grades and marbling score obtained with 1:3 and 1:5 ratios were not significantly different, but both produced higher carcass grade than 1:1 ratio.

PLAN OF EXPERIMENT

Pre-Experimental Period

Four months before starting the experiment, 125 tons of wet beet pulp was bought from the sugar factory and was ensiled in a trench silo without any concrete walls. It was left for fermentation until the start of the experiment.

Due to the shortage of bull calves at the AREC of the American University of Beirut, 20 Red Danish bull calves were bought from the Umitrade Farm. During the four months of pre-experimental period, the young bulls were fed milk to two months of age, and a concentrate starter ration and alfalfa hay ad libitum. From two months of age until the start of the experiment only concentrate and hay was fed.

Experimental Animals

To the 20 Red Danish bull calves bought from the Umitrade Farm, 4 Holstein-Friesian bull calves were added from the AREC herd making a total of 24 bull calves. The animals were paired according to age, and randomly assigned to group A and group B. The age, breed and weight of the bull calves at the start of the experiment are shown in Table 1.

Table 1. Age, breed and weight of the bull calves at the start of the experiment, (H.F.- Holstein-Friesian, R.D.- Red Danish).

GROUP A				GROUP B			
Calf No.	Breed	Age(days)	Weight(lbs)	Calf No.	Breed	Age(days)	Weight(lbs)
241	H.F.	133	222.0	243	R.D.	130	261.0
244	R.D.	128	237.0	245	"	124	265.0
246	"	119	285.0	247	"	116	217.0
248	"	115	235.0	249	"	113	224.0
250	"	112	182.0	251	"	110	187.0
253	"	110	216.0	254	"	109	234.0
256	"	108	157.0	257	"	108	216.0
258	"	107	247.0	259	"	107	238.0
252	"	102	210.0	242	H.F.	103	251.0
263	"	99	251.0	261	R.D.	101	198.0
265	"	96	175.0	266	"	95	171.0
268	H.F.	85	153.0	269	H.F.	76	175.0
Average		109.5	214.2	Average		107.7	219.7

Figure 1. The experimental bull calves at six months of age.

Housing

The two groups of experimental animals were housed in two separate pens, each with an approximate area of 30'x20'. The floors were concrete with one wooden manger (2'x8') and one automatic waterer in each pen. The pens were without roof until July 1st when zinc roofs were installed over half the area of each pen for protection from sun during summer and rain in winter.

Feeding Procedure

A. Concentrate feeding

Both groups were given equal but restricted amounts of concentrate. As the bull calves grew older the protein content of the concentrate was decreased and the amount fed increased.

Table 2 shows the ingredients of the concentrate mixture, and the level of protein at different periods of the experiment.

Table 2. The concentrate mixture

Ingredients	Price pl./kg.	% Crude protein	Percent in mixture 16/3-21/5	22/5-15/7	16/7-15/9	16/9-15/11
Barley	18.0	11.0	48	54	70	85
Wheat bran	15.0	16.0	30	24	20	10
Cottonseed meal	27.0	40.0	10	10	8	3
Linseed oil meal	25.0	30.0	10	10	--	--
Limestone (ground)	9.0	--	1	1	1	1
Salt	28.0	--	1	1	1	1
% Crude protein in mixture			17.0	16.8	14.8	12.0

The protein content of the concentrate, the amount fed per head per day and per month, and the total fed per month are shown in Table 3.

Table 3. Concentrate feeding schedule

Experimental period	% Crude protein	lbs/head/day	lbs/head/month	lbs/group/month
16/3 - 15/4	17.0	2.75	85.25	1023.0
16/4 - 15/5	17.0	3.25	97.50	1170.0
16/5 - 15/6	16.8	3.85	119.35	1432.0
16/6 - 15/7	16.8	4.75	142.50	1710.0
16/7 - 15/8	14.8	6.00	186.00	2232.0
16/8 - 15/9	14.8	7.50	232.50	2790.0
16/9 - 15/10	12.0	9.00	270.00	3240.0
16/10- 15/11	12.0	10.50	325.50	3906.0
Total			1458.60	17503.0

B. Sugar beet pulp silage feeding

By March 16th, when the experiment started, the wet beet pulp had been ensiled for four months and was ready for feeding. The bulls ate the silage reluctantly at the start, but after they got used to it, they ate it quite readily. The silage was fed to group A ad libitum. The amount consumed increased the first four to five months, but dropped down the last couple of months, probably due to heavier concentrate feeding. The actual consumption is shown in Table 4.

C. Dried molasses sugar beet pulp feeding

The dried pulp was bought from the sugar factory and was fed directly to the bulls in group B. The dried beet pulp was also fed ad libitum and

the amounts was adjusted so that the animals would clean up each day, leaving practically nothing for weigh back the next morning. They started consuming about 3.5 lbs. per head per day, at the begining and after one month about 4 lbs. per head per day. It gradually increased up to 6.3 lbs. per head per day after five months, and then it decreased slowly till the end of the experiment, as shown in Table 4.

Neither of the groups were fed any roughages.

Table 4. Beet pulp consumption per head per day, and per group per month.

Experimental period	GROUP A (on beet pulp silage)		GROUP B (on dried beet pulp)	
	lbs/group/mon.	lbs/head/day	lbs/group/mon.	lbs/head/day
16/3 - 15/4	8928.0	24.0	1280.0	3.44
16/4 - 15/5	10590.0	29.4	1463.0	4.06
16/5 - 15/6	9610.0	25.8	1422.0	3.82
16/6 - 15/7	10155.0	28.2	1880.0	5.22
16/7 - 15/8	12105.0	32.5	2090.0	5.62
16/8 - 15/9	11945.0	32.1	2333.0	6.27
16/9 - 15/10	8740.0	21.5	2145.0	5.96
16/10- 15/11	7600.0	20.4	1870.0	5.02
Total	79673.0		14483.0	
Ave./head/day		26.8		4.93

Weighings

The bull calves were weighed at the end of each experimental month.

Vitamin A Treatment

Since the experimental feed was practically devoid of vitamin A and carotene, vitamin A deficiency was anticipated after an unpredictable

length of time on the experimental feed. Hence it was decided to study the effect of vitamin A injection on seven of the bulls in each group leaving five for control. Half a million I. U. of vitamin A[1] suspended in 5 cc. water, was given intramuscularly at one month intervals, starting with the first injection after 56 days on the experiment. Soon after this time the control bulls slowed down in growth rate. They showed profuse lachrymation and eye inflamations, some actually turning blind and one showing convulsive fits. It seemed unlikely that the bulls could be carried through to the end of the experiment, and since it would not serve any useful purpose to further aggrevate the symptoms, the controls were also submitted to monthly injections of half a million units of vitamin A.

Three of the control bulls in the dry beet pulp group received their first injection 86 days after the start of the experiment. Three corresponding bulls in the silage group received the injections 115 days after, and the last two in each control group 122 days after the start of the experiment.

Carotene and Vitamin A Analysis of Blood Serum and Liver

About 80 cc of blood was drawn from Vena jugularis and left for serum separation. The analytical procedure outlined in Lumetron Reference Book for Clinical Tests pp. 598-599 was followed.

10 cc serum was thoroughly mixed with 10 cc of 95% ethyl alcohol and 30 cc of petroleum ether and kept overnight in the refrigerator. The next day 10 cc of the supernatant ether extract was transferred to a special Lumetron tube and the % transmission determined in the Lumetron colorimeter.

---

[1]The vitamin preparation was - Avimin Ido aquosum vet., donated by Ferrosan Blegdamsvej., Copenhagen, Denmark.

After this reading for carotene, the tube was placed in water bath at 40 -43°C. for the evaporation of the petroleum ether. The evaporation was enhanced by running a current of dry air into the tube. After all the ether was evaporated, lcc chloroform and 9 cc antimony trichloride was added, and the intensity of the blue color resulting from the reaction of the antimony trichloride with the vitamin A, was determined by reading the % transmission in the Lumetron colorimeter.

At the end of the experiment liver samples were taken from six bulls in each group, and analysis[1] of carotene and vitamin A was run. 3 -5 gm of liver tissue was ground in a mortar with 3 -5 times its weight of anhydrous sodium sulfate until it was completely dry. The dry powder was transfered quantitatively to a 250 cc volumetric flask and 100 cc peroxide-free anhydrous ethyl ether was added and shaken for two minutes. It was then set aside for a few hours and an aliquot of 10 cc of the ether layer was transfered into the Lumetron tube, and the % transmission was read for carotene. The following procedure for vitamin A determination was exactly like that of serum samples.

---

[1] The method given by Stanley, R. Ames, et al., Division of Eastman Kodak Co., Rochester, N.Y., Journal of Analytical Chemistry, 26:1378, August 1954, was used.

RESULTS AND DISCUSSION

Live Weight Gains

The individual monthly and daily gains for the silage group are shown in Table 5.

Table 5. Monthly and daily gains per bull (lbs.)

Seven early injected bulls with vitamin A

Bull number	16/3-15/4	16/4-15/5	16/5-15/6	16/6-15/7	16/7-15/8	16/8-15/9	16/9-15/10	16/10-15/11	Total	Ave. /day
241	52.0	54.0	89.0	97.0	121.0	98.0	52.0	73.0	636.0	2.60
246	67.0	43.0	103.0	74.0	94.0	64.0	68.0	86.0	599.0	2.44
250	35.0	10.0	64.0	54.0	68.0	67.0	15.0	66.0	379.0	1.55
256	43.0	45.0	35.0	30.0	70.0	75.0	51.0	76.0	425.0	1.73
252	42.0	54.0	64.0	65.0	112.0	48.0	95.0	66.0	546.0	2.23
263	46.0	70.0	43.0	45.0	95.0	85.0	60.0	65.0	509.0	2.08
268	32.0	40.0	30.0	50.0	65.0	72.0	77.0	79.0	445.0	1.82
Total	317.0	316.0	428.0	415.0	625.0	509.0	418.0	511.0	3539.0	14.45
Average /month	45.3	45.1	61.1**	59.3**	89.3	72.7	59.7	73.0	505.5	
Average /day	1.46	1.50	1.97	1.98	2.88	2.35	1.99	2.40		2.06

Five late injected bulls with vitamin A

244	48.0	55.0	38.0	47.0	90.0	76.0	76.0	75.0	505.0	2.06
248	65.0	50.0	35.0	-5.0	36.0	63.0	38.0	47.0	329.0	1.34
253	54.0	62.0	39.0	31.0	75.0	68.0	90.0	56.0	475.0	1.94
258	73.0	58.0	92.0	5.0	60.0	100.0	101.0	70.0	559.0	2.28
265	50.0	62.0	43.0	47.0	73.0	48.0	49.0	75.0	447.0	1.83
Total	290.0	287.0	247.0	125.0	334.0	355.0	354.0	323.0	2315.0	9.45
Average /month	58.0	57.4	49.4	25.0	66.8	71.0	70.4	64.6	463.0	
Average /day	1.87	1.91	1.60	0.83	2.15	2.29	2.34	2.08		1.89

** Significantly higher than the late injected bulls, at 1% level.

The individual monthly and daily gains for the dry beet pulp group are shown in Table 6.

Table 6: Monthly and daily gains per bull (lbs.)

Seven early injected bulls with vitamin A

Bull number	16/3-15/4	16/4-15/5	16/5-15/6	16/6-15/7	16/7-15/8	16/8-15/9	16/9-15/10	16/10-15/11	Total	Ave. /day
245	50.0	58.0	77.0	95.0	93.0	97.0	50.0	73.0	593.0	2.42
249	61.0	45.0	45.0	72.0	88.0	42.0	100.0	59.0	512.0	2.09
254	74.0	72.0	52.0	68.0	100.0	95.0	55.0	57.0	573.0	2.34
259	60.0	77.0	80.0	105.0	115.0	99.0	71.0	102.0	709.0	2.90
261	17.0	58.0	4.0	83.0	105.0	80.0	90.0	52.0	489.0	2.00
266	29.0	43.0	55.0	57.0	105.0	75.0	75.0	57.0	496.0	2.02
269	30.0	42.0	53.0	75.0	85.0	88.0	87.0	74.0	534.0	2.18
Total	321.0	395.0	366.0	555.0	691.0	576.0	528.0	474.0	3906.0	15.95
Average /month	46.0	56.4	52.3	79.3**	99.0	82.3	75.4	67.7	558.0	
Average /day	1.48	1.88	1.69	2.64	3.19	2.65	2.51	2.18		2.28

Five late injected bulls with vitamin A

243	59.0	32.0	38.0	10.0	68.0	80.0	76.0	81.0	444.0	1.81
247	58.0	60.0	-3.0	43.0	100.0	110.0	50.0	71.0	489.0	2.00
251	53.0	60.0	50.0	72.0	88.0	72.0	58.0	82.0	535.0	2.18
257	41.0	38.0	-8.0	13.0	52.0	76.0	97.0	62.0	371.0	1.51
242	77.0	47.0	65.0	60.0	95.0	103.0	82.0	61.0	590.0	2.41
Total	288.0	237.0	142.0	198.0	403.0	441.0	363.0	357.0	2429.0	9.91
Average /month	57.6	47.4	28.4	39.6	80.6	88.2	72.6	71.4	485.8	
Average /day	1.86	1.58	0.92	1.32	2.60	2.84	2.42	2.30		1.98

** Significantly higher than the late injected bulls, at 1% level.

The seven bulls in each group which received the first vitamin A injection on the 11th of May showed a fairly uniform gain. The other five which were intended as a control on the vitamin injection showed a drop after three months on the experiment and the drop was much more severe the following month. Since it was quite obvious that deficiency of vitamin A was the cause, and it seemed likely the bulls would succumb before the termination of the experiment, vitamin injections were given to numbers 244, 253 and 265 on the 9th of July, and to numbers 248 and 258 on the 17th of July, in the silage group. Gains within normal variation was resumed after the vitamin injections. The average daily gain per head for the whole period was 1.89 lbs. for the control group and 2.06 lbs. for the early injected group. This difference was not statistically significant as shown in Table 8.

In the dry beet pulp group the intended control bulls showed signs of vitamin A deficiency earlier than the silage fed bulls, as shown in Table 6. During the third month of the experiment two bulls hardly maintained their live weight. Vitamin injection was given to numbers 242 on the 7th of June, to 247 and 251 on the 10th of June, and to 243 and 257 on the 17th of July. Also in this group the bulls resumed normal growth soon after the vitamin treatment. The average daily gain per head for the whole period was 1.98 lbs. and 2.28 lbs. for the control group and the early injected group, respectively. This difference was not statistically significant, as shown in Table 8.

Gains of Silage Group vs Dry Beet Pulp Group

The average gain for the silage fed group for the whole period was 488.0 lbs. per head, as compared to 528.0 lbs. for the dry beet pulp group.

The difference of 40 lbs. was not statistically significant as shown in Table 7.

The daily average gain for the whole period was 1.99 lbs. for the silage group, as compared to 2.16 lbs. for the dry beet pulp group, which is not a statistically significant difference.

Table 7. Analysis of Variance of the gains of silage group and dry beet pulp group.

Source	Degrees of freedom	Sum of squares	Mean square	F ratio
Total	23	176723		
Between silage and dry beet pulp groups	1	9720	9720	1.28#
Within groups	22	167003	7591	

Not statistically significant.

Gains of 14 Early Injected vs 10 Late Injected Bulls

For six months of the experiment seven bulls in each group received monthly vitamin A injections. Five bulls in group B received injections only for five months, and five bulls in group A only for four months. After the injections these five bulls in each group tended to make up for the low gains during the deficiency period. At the termination of the experiment the average gain per bull was 532.0 lbs. for the early injected as compared to 474.5 lbs. for the late injected or the control group. This difference is likely to be real, but it is not statistically significant as shown in Table 8.

Table 8. Analysis of Variance of the gains for the whole experimental period of early and late injected bulls.

Source	Degrees of freedom	Sum of squares	Mean square	F ratio
Total	23	176723		
Between early and late injected groups	1	19191	19191	2.68#
Within groups	22	157532	7161	

Not statistically significant.

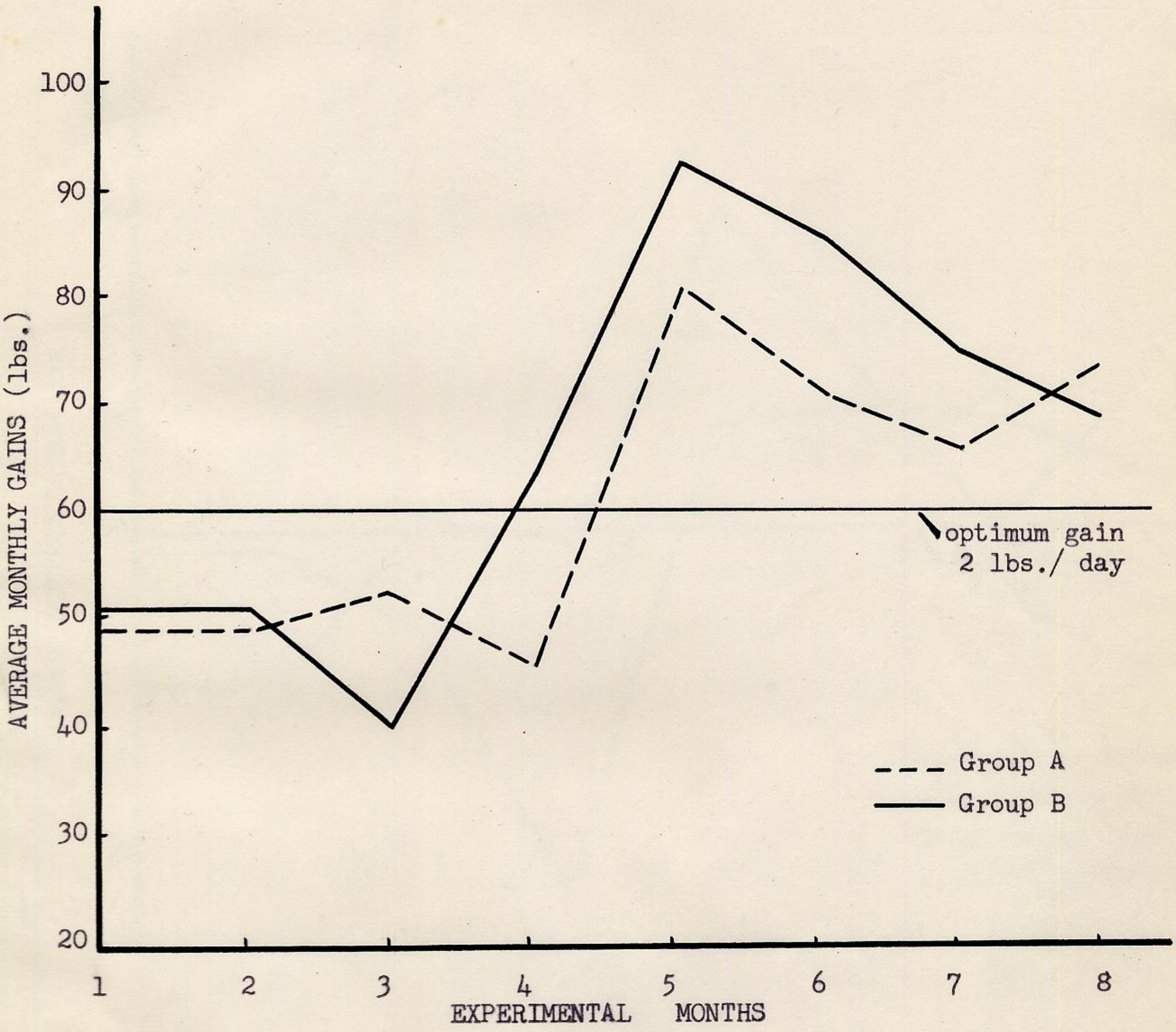
During the third and fourth experimental months, the average gain for the 14 early injected bulls was 126.0 lbs. as compared to 71.2 lbs. for the 10 late injected bulls. Statistical analysis showed that this difference was highly significant as shown in Table 9.

Table 9. Analysis of Variance of the gains during the third and fourth experimental months of early and late injected bulls.

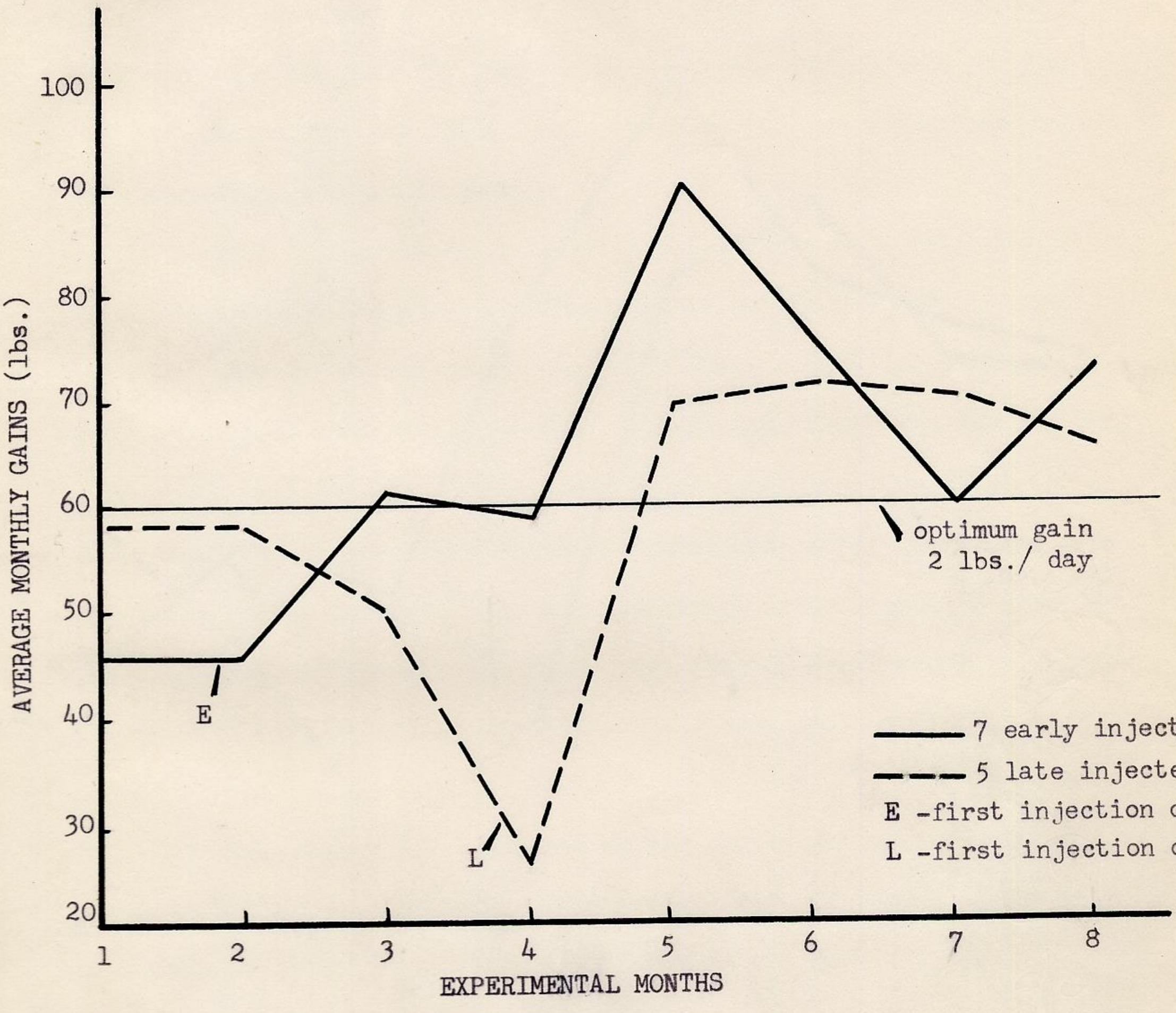
Source	Degrees of freedom	Sum of squares	Mean square	F ratio
Total	23	52785		
Between early and late injected groups	1	17517	17517	10.9**
Within groups	22	35268	1603	

** Statistically significant at 1 % level.

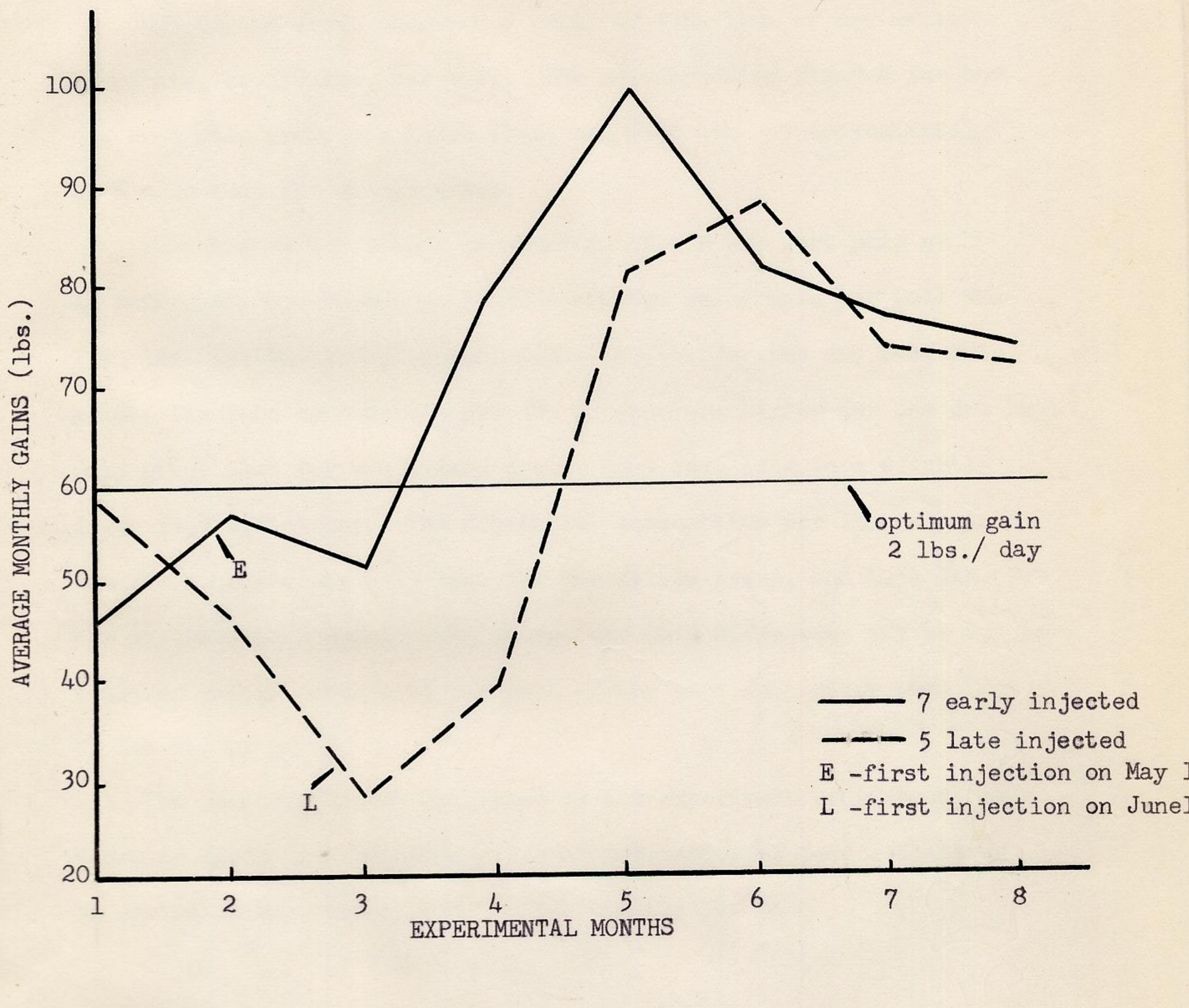
The live weight gains are also represented in graphs A, B and C.



GRAPH A - Average gains per month for 12 bulls in each group.



GRAPH B - Average gains per month for bulls in Group A.



GRAPH C - Average gains per month for bulls in Group B.

Feed Consumption and Feed Efficiency

The total monthly feed consumption expressed on dry-matter basis, and the total monthly gain in live weight is shown in Table 10.

The silage group consumed a total of 8764 lbs. of dry-matter in silage, or 730 lbs. per bull. The corresponding figures for the dry beet pulp group was 13036 lbs., and 1086 lbs. or approximately 49 % more than the silage group.

This higher dry-matter consumption of the dry beet pulp group is reflected in a higher gain. The average daily gain per bull was 1.99 lbs. for the silage group, and 2.16 lbs. for the dry beet pulp group, the feed consumption per lb. of gain was higher for the dry beet pulp group than for the silage group, thus resulting in a slightly lower feed efficiency. The dry-matter consumption per lb. of gain for the whole period was 4.19 lbs. for the silage group, and 4.54 lbs. for the dry beet pulp group. The reason for this difference may be due to a higher energy content of the gain of the beet pulp group than that of the silage group.

The feed efficiency decreased as the experiment progressed, as shown in Table 10. Assuming a linear regression of feed efficiency on months on experiment, the regression equation was:

$$\bar{Y} = 2.69 + 0.37X$$

where $\bar{Y}$ is the feed efficiency and X is the months on experiment, and 0.37 is the slope of the regression line or the average monthly increase in feed required per unit of gain.

The regression line is represented in graph D.

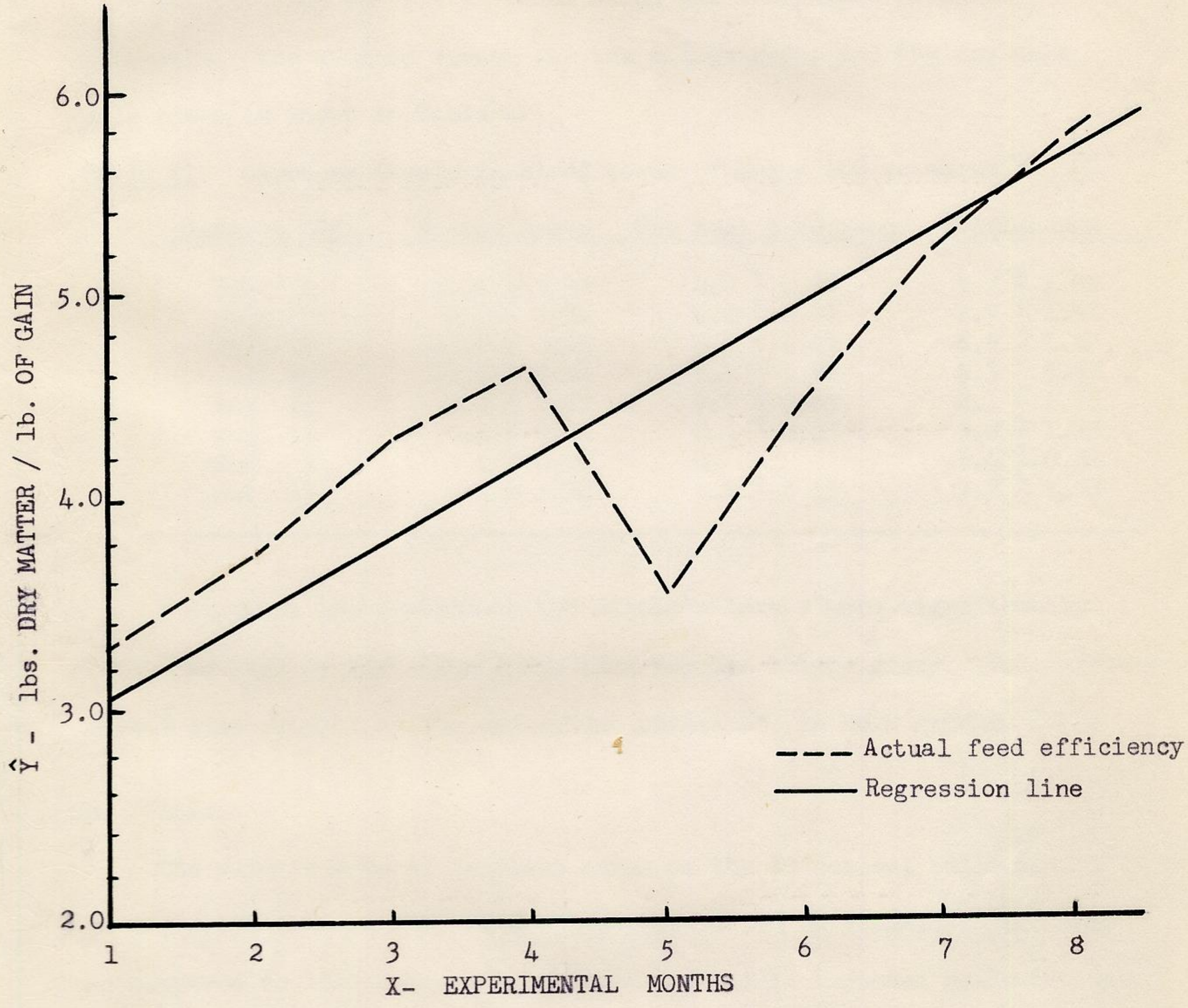
Table 10. Dry matter consumption, weight gains and feed efficiency (lbs.)

GROUP A (on silage)

Period	Concentrate (dry matter)		Silage (dry matter)		Total Dry matter		Total Gain		Dry matter /gain
	Total	Ave/day	Total	Ave/day	Total	Ave/day	Total	Ave/day	
1st month	921	2.48	982	2.64	1903	5.12	607	1.63	1 /3.14
2nd "	1053	2.93	1165	3.24	2218	6.17	603	1.68	1 /3.67
3rd "	1284	3.45	1057	2.84	2341	6.29	675	1.81	1 /3.47
4th "	1539	4.28	1117	3.10	2656	7.38	540	1.50	1 /4.92
5th "	2009	5.40	1332	3.58	3341	8.98	959	2.58	1 /3.50
6th "	2511	6.75	1314	3.53	3825	10.28	864	2.32	1 /4.43
7th "	2916	8.10	961	2.67	3877	10.77	772	2.14	1 /5.02
8th "	3515	9.45	836	2.25	4351	11.70	834	2.24	1 /5.22
Total	15748		8764		24512		5854		
Ave/head	1312		730		2043		488		
Ave/day/head		5.35		2.98		8.34		1.99	1 /4.19

GROUP B (on dry beet pulp)

	Concentrate		Dry beet pulp		Total D.M.		Total gain		D.M./gain
1st month	921	2.48	1152	3.10	2073	5.58	609	1.64	1 /3.40
2nd "	1053	2.93	1317	3.66	2370	6.59	632	1.67	1 /3.75
3rd "	1284	3.45	1280	3.44	2564	6.89	508	1.37	1 /5.05
4th "	1539	4.28	1692	4.70	3231	8.98	753	2.09	1 /4.30
5th "	2009	5.40	1881	5.06	3890	10.46	1094	2.94	1 /3.55
6th "	2511	6.75	2100	5.65	4611	12.40	1017	2.73	1 /4.53
7th "	2916	8.10	1931	5.36	4847	13.46	891	2.48	1 /5.44
8th "	3515	9.45	1683	4.52	5198	13.97	831	2.23	1 /6.25
Total	15748		13036		28784		6335		
Ave/head	1312		1086		2398		528		
Ave/day/head		5.35		4.44		9.79		2.15	1 /4.54



GRAPH D - Regression line for the average feed efficiency of both groups.

Carotene and Vitamin A Levels in Blood Serum

A. Carotene

The carotene content in blood serum was determined at monthly intervals. The average values for the silage group and the dry beet pulp group is shown in Table 11.

Table 11. Carotene levels in blood serum (mcg./ 100 cc serum).

Bleeding date	Silage group	Dry beet pulp group	Difference
May 13	14.4 ± 1.37	9.2 ± 1.38	5.2 ± 1.95
June 10	6.7 ± 1.31	4.0 ± 0.91	2.7 ± 1.61
June 16	16.0 ± 1.23	9.5 ± 1.41	6.5 ± 1.87
July 13	11.2 ± 2.92	6.9 ± 1.74	4.3 ± 3.38
Aug. 11	9.3 ± 1.55	7.2 ± 0.81	2.1 ± 1.75
Aug. 18	8.3 ± 0.99	2.5 ± 0.83	5.8 ± 1.23
Oct. 9	1.4 ± 0.81	0	1.4 ± 0.81
Oct. 27	5.4 ± 1.32	2.2 ± 1.13	3.2 ± 1.73

Throughout the experiment the carotene levels were significantly lower for the dry beet pulp group than for the silage group. The carotene levels also dropped as the experiment proceeded in both groups.

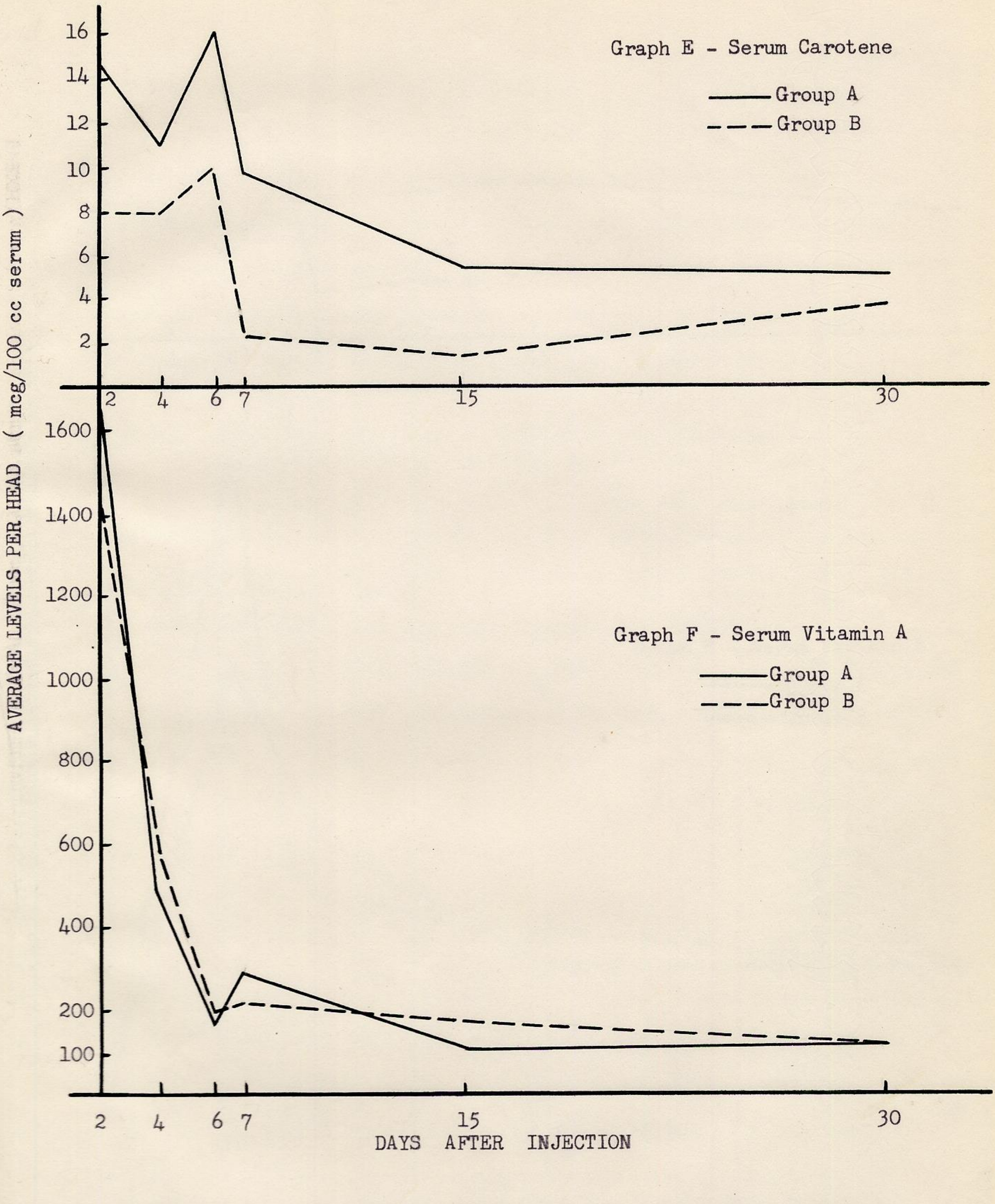
B. Vitamin A

The vitamin A level in blood serum of the 10 control bulls was 46 mcg./ 100 cc serum before they were subjected to vitamin injections as compared to 1527 mcg./ 100 cc serum for the 14 injected bulls two days after the vitamin injection. When the bleeding was done at different intervals after the injections the following months the values showed a rapid decrease with an increased interval between time of injection and time of bleeding as shown in Table 12.

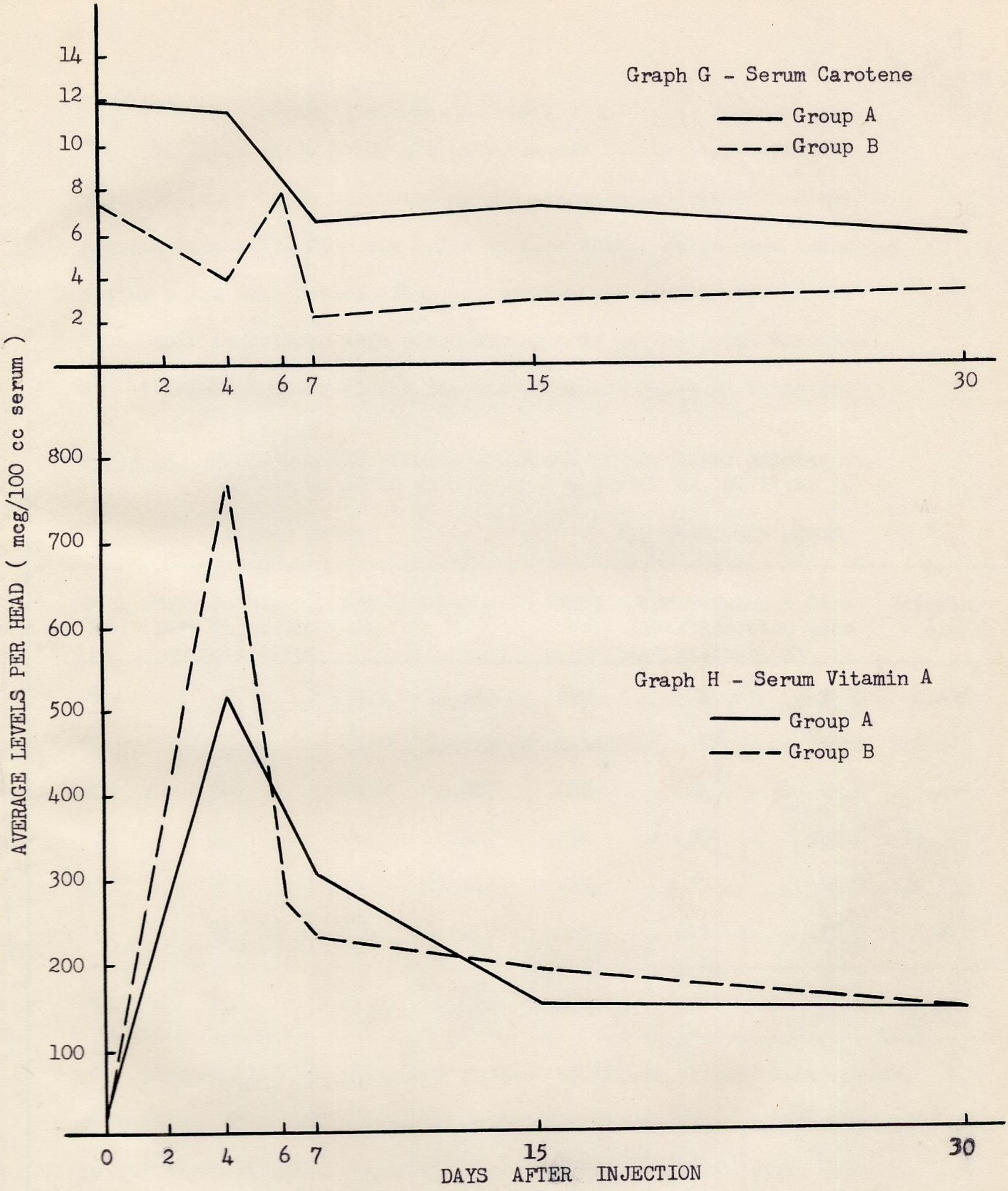
Table 12. Vitamin A levels in blood serum at different intervals between injection and bleeding.

Time interval between injection and bleeding (days after injection)	Months after first injection	Number of bulls	mcg./100cc serum
	GROUP A (on silage)		
0	0	10	50.8
2	0	7	1643.0
4	2	10	475.2
6-7	1-3	12	255.0
15	5	12	141.2
25-33	1-5	12	118.2
	GROUP B (on dry beet pulp)		
0	0	10	38.3
2	0	7	1412.7
4	2	10	644.2
6-7	1-3	12	221.0
15	5	12	168.0
25-33	1-5	12	119.5

The level of vitamin A in serum was quite similar in the two groups. The level of vitamin A dropped rapidly as the interval of injection and bleeding was prolonged. The vitamin A levels are also represented in graphs E, F, G and H.



GRAPHS E & F - Carotene and vitamin A levels of 7 early injected bulls in each group.



GRAPHS G & H - Carotene and vitamin A levels of 5 late injected bulls in each group.

Carotene and Vitamin A Content in Liver

The bulls which could not be butchered at the termination of the experiment were continued on the experimental ration. Liver samples were taken from six bulls in each group which were butchered during a six week period after the termination of the experiment. No vitamin injections were given during this period. The carotene and vitamin A content of the liver samples are shown in Table 13.

Table 13. Carotene and vitamin A content of the liver samples of six bulls in each group (mcg./100 gm. of liver).

Silage group				Dry beet pulp group			
Bull No.	Days between last injection and butchering	Carotene	Vitamin A	Bull No.	Days between last injection and butchering	Carotene	Vitamin A
246	6	335.2	12,583	259	6	84.0	4,513
241	9	75.0	11,823	245	9	56.4	10,615
258	22	222.0	4,707	242	22	97.6	6,995
263	30	130.0	9,397	254	30	122.0	11,261
252	37	53.5	11,912	249	37	65.0	10,216
244	47	159.4	10,673	261	47	118.0	7,309
Average		162.5	10,182	Average		90.5	8,485

The carotene and vitamin A content of livers of the silage group were higher than that of the dry beet pulp group, but the difference was not statistically significant. There was no relationship between the interval of last vitamin injection and the time of butchering and the carotene and vitamin A content.

Ralston, A.T., (1959) has worked on the relationship of liver and plasma carotenoid and vitamin A content in cattle. In 90 cows, he has found an average of 15,100 mcg of vitamin A /100 gm of fresh liver, and an average of 45 mcg of vitamin A /100 cc of plasma. As to carotemoids, he has found an average of 1,500 mcg/100 gm of fresh liver, and an average of 600 mcg/100 cc of plasma.

His results are somewhat different from those in this experiment, namely the carotenoid values being much higher both in plasma and in the liver, vitamin A in liver slightly higher, but vitamin A in plasma just equal to that of bulls which did not receive vitamin injection from the start. The higher carotenoid levels of the plasma is a reflection of the carotenoid content of the feed.

Cunha, T.A., (1964) concluded that blood plasma level of 10-16mcg./100 cc plasma indicated vitamin A deficiency and 30-50 mcg./100 cc an adequate intake. A liver content of 100-400 mcg./100 gm. also indicated deficiency. When deficient animals had the feed fortified with 20,000 I.U. of vitamin A daily, the rate of gain increased 10-20 % , the feed efficiency 8-10 %, the animals looked healthier and fewer livers were condemned.

Carcass Quality and Dressing Percentage

By visual inspection the carcasses of the dry beet pulp group was slightly fatter than those of the silage group, but otherwise there was no apparent difference between the carcasses of the two groups.

The dressing percentage is the weight of the carcass before cooling in percent of the live weight immediately before killing.

The carcass has the head removed between the first and the second cervical vertebra, and the legs at the carpal and tarsal joints. The testes and kidneys are left on the carcass. The carcass weight and grade of the six representative bulls of each group is shown in Table 14.

Table 14. Live weight, carcass weight (lbs.), dressing percentage and grade of six bulls in each group.

GROUP A

Bull number	Live weight	Carcass weight	Dressing %[1]	Grade
246	884.0	494.0	55.9	Good
241	865.0	488.0	56.4	Good
258	802.0	443.0	55.2	Good
263	777.0	472.5	60.8	Good +
252	818.0	503.5	61.6	Good +
244	810.0	475.0	58.6	Good
Average	826.0	479.4	58.1	

GROUP B

259	947.0	552.0	58.3	Good +
245	865.0	504.0	58.3	Good +
242	875.0	505.0	57.7	Good
254	873.0	538.0	61.6	Good +
249	828.0	446.0	54.0	Good -
261	733.0	427.0	58.3	Good
Average	854.0	495.4	58.0	

[1] The average dressing % of the silage group was 58.1 with a range of 55.2 -61.6, and of the dry beet pulp group 58.0 from 54.0 -61.6 .

Hazards of Feeding Roughage-Free Rations to Fattening Bulls

Slight diarrhea and a tendency to bloat was observed in both groups, but it was more pronounced in the silage group than in the dry pulp group. This tendency for bloating was presumably due to lack of roughage. The more pronounced bloat and diarrhea in the silage group might have been due to the high water content of the silage, which according to the report of Charton, A. (1954), is a factor associated with a tendency to bloat and diarrhea.

Profuse lachrymation and light sensitivity was observed early in the experiment. "Pink eye" or infectious keratitis was suspected and the bulls were treated with 3% silver nitrate and Pagenstecher's ointment which resulted in a temporary improvement. But later the eye troubles became more severe and after about three months on experiment three of the bulls in the dry beet pulp group, which were not treated with vitamin A, showed much more severe eye affections. The corneas became opaque and the bulls turned blind. One of them had staggering gait and a tendency to walk in circles, and sometimes "fainted" when handled. The bulls improved rapidly after administration of vitamin A. The early eye affections were apparently due to infections and it was later followed by more serious eye affections due to vitamin A deficiency.

The third hazard was the liver abscess formations which was observed in five of the bulls in the silage group, and none in the dry beet pulp group. Liver abscesses are often seen in intensive beef production on high cereal rations.

Several investigators have reported on liver abscess formations, and suggested different possibilities as to the cause of the abscesses.

Harris, A.H. (1962) and Fincher, M.G. (1956) have suggested that the cause for liver abscesses is due to high cereal feeding which should produce a low pH of the rumen and thus cause damage to the mucosa. So bacteria in the rumen are able to enter the portal blood. Harris has also reported that there is so far no means of controllingthis condition. The gross appearance of the affected livers varies considerably. In some cases there are discrete foci of necrosis up to 8 cm across, sometimes abscesses of similar size are scattered all over the liver. Bacteriological examination has demonstrated Corynebacterium pyogenes, Fusiformis spp., Bacillus necrophorus, Actinomyces necrophorus and Spherophorus necrophorus as causative bacteria.

Smith, H.A. and Jones, T.C. (1958) have reported that occasionally an animal dies of abscesses in liver after a few days of acute but vague digestive symptoms. Usually hepatic abscesses in heavily fattened cattle show no symptoms in the live animal.

It is evident from the previous discussion that the liver abscesses can not be attributed to any singlecause. In the present experiment specimens from two abscesses were cultured in nutrient broth and on agar plates without obtaining any bacterial growth.

Liver abscesses in the present experiment was observed only in the silage group where 5 out of 12 bulls were affected. The difference in the frequency in the two groups was statistically significant at 5% level.

There were no losses due to death in neither group during the whole experimental period.

Figure 2. Liver abscesses from one of the bulls in the silage group.

Economical Analysis

Cost of calves, milk, concentrate, beet pulp, labor and housing were added up, thus giving the total cost, which were subtracted from the selling price inorder to obtain the "profit" per bull. This economical analysis is shown in Tables 15 and 16.

Table 15. Feed prices used in estimation of "profitableness" and feed consumption per bull.

Item	Price (pl./kg.)	Total consumption (kg.)	Total cost
Milk	30	120	LL. 36.00
Concentrate (pre-experimental period)	22	100	" 22.00
Concentrate (experimental period)	20	597	" 119.40
Dried molasses beet pulp (dry matter)	15	494	" 74.10
Wet beet pulp (dry matter)	15	332	" 49.80

Table 16. Major cost items and "profitableness" per bull.

I t e m	Group A	Group B
Cost of calf	LL. 80.00	LL. 80.00
Feed cost (pre-experimental period)	" 58.00	" 58.00
Labor and housing (" " ")	" 7.00	" 7.00
Total initial cost per bull	" 145.00	" 145.00
Cost of concentrate (experimental period)	" 119.40	" 119.40
Cost of beet pulp (" ")	" 49.80	" 74.10
Labor and housing (" ")	" 25.00	" 25.00
TOTAL COST PER BULL	" 339.20	" 363.50
Value of bull at 150 pl./kg. live weight	" 479.00	" 510.00
"PROFIT" at 150 pl./kg. per bull	" 139.80	" 146.50
Value of bull at 160 pl./kg. live weight	" 512.00	" 544.00
"PROFIT" at 160 pl./kg. per bull	" 172.80	" 180.50

SUMMARY AND CONCLUSIONS

1. Fattening bulls were raised without roughages. Only a slight tendency of bloating was observed. Slight diarrhea was observed in both groups but it was more pronounced in the silage group.
2. On the experimental ration which was practically devoid of vitamin A, deficiency symptoms developed within two to three months.
3. Deficiency symptoms was prevented or relieved by monthly intramuscular injection of half a million I.U. of vitamin A in water suspension. The vitamin A storage level in the liver was high at the termination of the experiment. Vitamin and carotene determinations in blood and in liver indicated that beet pulp silage had some carotene.
4. The bulls in the silage group had an average daily gain of 1.99 lbs. as compared to 2.16 lbs. for the bulls on dry beet pulp.
5. The bulls consumed more dry-matter in the dry pulp group than in the silage group, but feed efficiency was slightly better in the silage group than in the dry pulp group.
6. There was no difference in the dressing percentage between the two groups, but the bulls in the dry pulp group appeared slightly fatter than those in the silage group.
7. Under the conditions of this experiment 5 out of 12 bulls in the silage group had liver abscesses, whereas no liver abscesses were found in the dry beet pulp group.

BIBLIOGRAPHY

1. Charton, A. 1954. Disturbances in ruminants caused by sugar beet pulp. (Translated summary). Rec. Med. Vet.

2. Cunha, T.A. 1964. More vitamin A for beef cattle. World Farming 6:8 - 26.

3. Fincher, M.G. 1956. Diseases of cattle. American Veterinary Publications, Inc. Evanston, Illinois.

4. Harris, A.H. 1962. Apparent hazards of high barley feeding to cattle. Vet. Rec. 74:1434.

5. Kercher, C.J. and Bishop, D.V. 1963. The influence of all-concentrate feeding on the growth and carcass characteristics of beef cattle. J. Animal Sci. 22:839.

6. _____ Vitamin A and carotene analysis in blood. Lumetron Reference Book for Clinical Tests. Photovolt Corp. 95 Madison Ave. New York 16, N.Y.

7. Preston, T.R. 1963. Barley beef production. Vet. Rec. 75:1399.

8. Ralston, A.T. 1959. Relationship of liver and plasma carotenoid and vitamin A in cattle. J. Animal Sci. 18:874 - 878.

9. Richardson, D. and Smith, E.F. 1961. Effect of roughage-concentrate ratio in cattle feeding rations, on gains, feed efficiency, digestion and carcass grades. J. Animal Sci. 20:316 - 318.

10. Samman, M.A. 1964. Sugar beet seed production. Thesis , Faculty of Agricultural Sciences, American University of Beirut.

11. Smith, H.A. and Jones, T.C. 1958. Veterinary pathology. Lea and Febiger, Philadelphia.

12. Worzella, W.W. et al. 1962. Cultural practices, varieties and fertilizers on sugar beet production in the Beka'a, Lebanon. Publication No. 16. Faculty of Agricultural Sciences, American University of Beirut.