PERFORMANCE OF RED DANISH AND HOLSTEIN-FRIESIAN BULL CALVES ON AN ALL-CONCENTRATE RATION

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AN ABSTRACT OF THE THESIS OF

Kazi Sazedul Huq for M.S. in Animal Nutrition

Title: Performance of Red Danish and Holstein-Friesian bull calves on an all-concentrate ration.

An all-concentrate ration containing dried molasses beet pulp, barley, cottonseed oil meal and wheat bran was fed to Red Danish and Holstein-Friesian bull calves in order to evaluate their potential for beef production. The experimental period extended from May 11, 1966 to April 18, 1967. The effect of intramuscular injections of vitamin A at monthly (0.5×10^6 I.U.) and bi-monthly (1×10^6 I.U.) intervals on animal performance and liver storage was also studied. Holstein-Friesian bulls had significantly higher average daily gain and slightly better feed efficiency than those of the Red Danish breed. There was no significant difference in growth rate due to the vitamin A treatments. The injection at bi-monthly intervals promoted good liver vitamin A storage, and resulted in higher levels for the Holstein-Friesian breed. Dressing percentage, rib-eye area, fat and lean percentage showed no major differences between the two breeds. Preliminary assessment of carcass quality showed Holstein-Friesian bulls to be superior to Red Danish bulls.

An analysis of cost and net return showed both breeds to be profitable with the Holstein-Friesian bulls giving a higher net return.

Health-wise, calves of both breeds showed no signs of ill-health or digestive disturbances which are usually encountered on high-concentrate rations.

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I. INTRODUCTION

Since the dawn of civilization meat has been a constituent of the human diet. Its organoleptic and chemical constitution has rendered it one of the highly sought foods available to our society. The per capita consumption of meat in most countries has steadily increased and paralleled the improvement in the standard of living.

Meat proteins have a high biological value. The body requirement for certain amino acids, of which at least eight are considered essential to life, are all available in meat. In addition, meat is rich in minerals with the exception of calcium, and in some vitamins. The completeness of meat as a food is therefore evident.

Meat production in Lebanon is still in its infancy. Yearly, large quantities of meat are imported to satisfy the local demand. Approximately 60 percent of the total meat supply in Lebanon is imported. In 1966 Lebanon imported 96529 head of cattle, 699166 sheep and 93844 goats, all of which were slaughtered for consumption (Ministry of Agriculture, Veterinary Service Report, 1966). The per capita consumption of beef and veal in Lebanon in 1966 was estimated at 7.48 kg (Badawi, 1967). Comparative figures for the U.S.A. and Argentina for 1960 were 41.4 and 61.4 kg, respectively.

For the past several years the local production of beef has been hindered by the high cost of feeds, particularly roughages and also the limited number of calves available for fattening. Recently however, the production of beef through the fattening of dairy calves and through the use of relatively inexpensive and locally available concentrates such as beet pulp and wheat bran has been found successful (Manuelian, 1965; Hanjra, 1966).

This study was designed to investigate the performance of Red Danish and Holstein-Friesian bull calves, both of which are found locally, on an all-concentrate ration based on dry beet pulp, wheat bran, barley and cottonseed oil meal. Since the ration was very low in carotene, the effect of vitamin A supplementation at monthly or bi-monthly intervals was also studied.

II. REVIEW OF LITERATURE

Considerable interest has developed recently in the feeding of all-concentrate rations to ruminants. This system of feeding however is not a new concept. McCandlish (1923) was unsuccessful in raising calves on rations devoid of roughage and concluded that fibrous materials are necessary in the diets of ruminants. Mead and Regan (1931) were able to secure satisfactory growth of calves to 19 months of age when cod liver oil and alfalfa ash were supplemented to a mixture of barley, oats, wheat bran and linseed meal. The authors stated that the failure to secure continued normal growth of calves in earlier work resulted from a deficiency of vitamin A alone, or in conjunction with an inadequate supply of certain minerals, and not from lack of roughage or bulk per se. Recent investigations have shown that the amount of crude fiber in cattle finishing rations may be reduced considerably with little or no adverse effects on animal performance. Cattle fed such rations have been reported to have a higher requirement for vitamin A than those fed conventional rations. Also, the supplementation of such rations with certain minerals has been advocated.

Several cereal grains and other feedstuffs, high in their energy content, have been tested in all-concentrate rations for beef production. All-concentrate rations based upon corn (Gordon and Erwin, 1960; Davis _et al_., 1963; Oltjen _et al_., 1965), milo (Durham _et al_., 1963; McCartor _et al_., 1964; Henrickson _et al_., 1965), barley (Geurin _et al_., 1959; Nicholson and Cunningham 1961; Preston, 1963), beet pulp (Sadovnikova, 1959; Kercher and Bishop, 1963; Manuelian, 1965; Hanjra, 1966) and wheat (Oltjen _et al_., 1966) have been successfully fed to fattening cattle. However, several undesirable effects have been reported to be associated with such a system of feeding. Preston (1963) observed bloat, acidosis, kidney necrosis and liver abscesses in some animals fed an all-concentrate ration based on barley. In this experiment which involved more than three hundred cattle, over half of the kidneys and approximately 30% of the livers were affected. Subsequent work (Preston _et al_., 1963) indicated the occurrence of bloat and death in five of fifteen cattle fed intensively on maize. Liver abscesses have also been reported by Harris (1962), Oltjen _et al_. (1966) and Hanjra (1966). The latter author reported bloat in two and liver abscesses in four of 22 cattle fed an all-concentrate ration containing 45% dried molasses beet pulp. Charton (1954) has reported diarrhea and bloat in animals fed beet pulp.

Geurin _et al_. (1959) reported no undesirable effects in cattle fed an all-concentrate ration based on barley when the method of processing was such as to preserve the existing roughage characteristics already present in the husk of this particular cereal. Barley was steamed prior to rolling it. Preston (1963) reported no incidence of deaths or bloat when barley rolled at 18% moisture was fed. Manuelian (1965) observed slight tendency to bloating with bulls fed dry beet pulp. However, no liver abscesses were observed. Durham _et al_. (1963) reported abscesses in 68% of livers of cattle fed a high-energy ration based on milo.

Several reports have indicated a lowering of ruminal pH when high-concentrate rations were fed (Fincher, 1956; Harris, 1962; Hogan, 1962; Nicholson _et al_., 1962; Griffiths, 1963 and Oltjen _et al_., 1966). The first two authors have suggested that high cereal feeding produces a low pH in the rumen which may result in mucosal damage and entrance of bacteria into the portal circulation. The use of buffers for controlling the lowering of the rumen pH has been advocated. Matrone _et al_. (1959) obtained improved growth in lambs when sodium and potassium bicarbonate were substituted for starch and a portion of the glucose in a purified diet. In a latter publication Wise _et al_. (1961) found no advantage from the addition of sodium and potassium acetate at a level of 5% of a basal diet containing ground shelled corn, urea and 2% cottonseed oil. The presence of acetate salts in the diet adversely affected growth performance and produced carcasses with less finish than the other diets. The authors ascribed the failure to obtain a response from added buffer salts to the presence of 1% urea in the basal diet. The authors concluded that calves are able to perform satisfactorily on all-concentrate rations for extended periods of time if the ration provides essential nutrients in adequate amounts and the buffering capacity of the rumen is adequate. Nicholson et al. (1962) observed a significant increase in feed intake and carcass weight when 3% sodium bicarbonate was added to an all-concentrate ration based on barley. The pH and buffering capacity of rumen fluid were lower when the control ration was fed. Preston et al. (1963) observed 33% mortality from bloat among cattle given a diet of ground maize and a protein supplement containing 2.5% fiber and 2.5% sodium bicarbonate.

Experiments comparing all-concentrate rations with part-roughage rations have been reported. Geurin et al. (1955) compared ear corn rations with the more conventional shelled corn and hay rations. The authors observed that hay was unnecessary with adequately supplemented ear corn rations and that the inclusion of hay decreased feed efficiency. Similar findings were reported by Wise et al. (1961) and Davis et al. (1963). The former authors reported that the addition of ground hay to a high-concentrate ration containing urea decreased feed efficiency and did not stimulate gains of cattle. Durham et al. (1963) compared an all-concentrate ration based on milo with a part-roughage ration containing corn silage. Cattle fed the all-concentrate ration performed significantly better than those fed the part-roughage ration with respect to gain (0.5 lb per day) and yield (3%). However, they had a substantially higher percentage of condemned livers (68% compared to 3% for control). Forbes et al. (1965) compared a concentrate-hay system, a high-barley concentrate hay system and a high-fat concentrate hay system for beef production. Mean daily live weight gains from 6 to 58 weeks were 1.84, 2.21 and 1.97 lb, respectively. When steers were slaughtered at 950 lb live weight the following dressing percentages were obtained, respectively: 52.7, 56.6 and 55.4. Steers fed the high-barley concentrate yielded better carcasses. McCroskey et al. (1960) studied the performance of cattle fed rations based on milo and varying in their concentrate to roughage ratios from 1:4 to 4:1. A higher daily gain (28%) and a better feed efficiency (25%) were obtained on the 20% roughage ration. Also observed was a decrease in daily intakes of feed with the higher concentrate levels. Similar findings were obtained by Richardson and Smith (1961) who studied the effect of roughage-concentrate ratios on gain, feed efficiency, digestion and carcass grade. Highest average gain was obtained with a 1:5 ratio and lowest with a 1:1 ratio. Carcass grade and marbling score obtained with 1:3 and 1:5 ratios were not significantly different. Both gave superior results to a 1:1 ratio.

Experiments comparing various cereals for use in all-concentrate rations have been reported. Preston (1963) compared the performance of beef animals fed a ration consisting of 85% rolled barley and 15% of a supplement containing 30% protein and calves receiving a conventional ration based on roughage. The age of slaughter was reduced from 418 to 365 days and there were improvements in daily weight gain from 970 to 1260 gm, in feed efficiency from 25.6% to 30% and in carcass score from 58% to 61% on the rolled barley ration. Preston _et al_. (1963) compared the performance of steers fed rations based either on barley or corn. Daily gains of 1.18 and 1.27 kg were reported for steers on barley and corn rations, respectively. Live weight gain, age at slaughter, killing-out percentage and carcass weight were better for steers fed the corn diet. Kercher and Bishop (1963) studied the influence of an all-concentrate ration on the growth and carcass characteristics of beef cattle. Fifty-one yearling Hereford steers were fed either steam-rolled barley, steam-rolled oats, steam-rolled milo or beet pulp pellets as single grain in addition to a supplement of dehydrated alfalfa pellets (12.5% of the ration). Average daily gains in pounds and pounds of feed per pound 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 rations, respectively. The carcass yield (%) and carcass grade (9 = average choice) were 60.9, 8.9; 57.4, 7.9; 62.6, 9.2; and 60.8, 6.8 for the above rations, respectively. The beet pulp fed steers had significantly lower levels of propionic acid and significantly higher levels of acetic acid in the rumen than steers fed the other rations. Davis *et al.* (1963) observed that steers consuming a high-energy ration based on corn required 20% less feed per pound of gain and consumed approximately 20% less feed per day than steers fed a high fiber ration. Henrickson *et al.* (1965) studied the effect of rate of gain on carcass composition in beef calves fed a high-energy ration based on milo. Steers were given either 2 or 1 lb ground milo per pound body weight in a high-energy ration containing cottonseed meal, lucerne pellets and cottonseed hulls to give high and moderate levels, respectively. Steers on the high levels of milo reached slaughter weight (880 lb) sooner and more efficiently with higher grade of carcass, more marbling and less lean than those on the moderate level of milo. They also observed that those steers slaughtered at the lighter weight had less lean and fat and their carcasses were of poorer grade. Dyer and Weaver (1955) compared wheat, barley, molasses and rough rice with maize for fattening cattle. A mixture of equal parts of ground wheat and shelled maize gave slightly better results than maize alone. When ground wheat was given as the only grain digestive disorders were common and live weight gains and resulting carcasses were poor. The feeding of whole wheat proved wasteful since many of the kernels passed through the cattle without being digested. The addition of ground oats or maize silage to ground wheat produced better performance than when the latter was fed alone. Steers fed barley had greater live weight gains than those receiving maize. Molasses, either in limited amounts or full-fed, produced slower live weight gains than maize. Cattle given molasses required more feed per pound of gain and their carcasses commanded a lower selling price. Ground rice had a value equal to 75% that of maize. Carcass grades and live weight gains on the ground rice were found to be inferior to those produced on the maize ration. Baker and Baker (1960) reported that wheat was satisfactory for fattening cattle when used to replace 50% of the corn in an all-concentrate ration. However, wheat was not equal to corn when used as a total replacement in finishing rations. Oltjen _et al._ (1966) studied the performance of steers consuming all-concentrate rations based on 90% wheat; 60% wheat and 30% corn; 60% corn and 30% wheat and 90% corn. The authors observed that steers fed the 60% and 90% corn rations gained significantly faster (1.4 kg daily) than steers fed the 60% and 90% wheat rations (1.1 kg daily). During the first 70 days of the trial all groups had equal feed consumption. However, steers fed the high percentages of wheat had lower feed consumption during the last 28 days of the trial. Steers fed the 60% and 90% wheat rations had significantly greater ruminal concentrations of volatile fatty acids and ammonia, but significantly lower ruminal pH values. No significant differences were observed for the four groups of cattle in carcass grade, dressing percent, marbling score, rib-eye area, fat over rib-eye and taste panel desirability.

Sadovnikova (1959) studied the feeding value of beet pulp with urea supplementation. In a trial lasting 73 days, 4 groups of 19 Simmental cross-bred cattle were fed daily 40 to 43 kg of beet pulp silage in addition to a concentrate mixture. One group received no urea supplementation while the others received daily 45, 75 and 118 gm, respectively. Rations containing urea were consumed readily and no ill effects were produced. Groups receiving 0, 45, 75 and 118 gm of urea had daily gains of 1000, 1123, 1110 and 932 gm, and feed efficiencies of 6.7, 5.7, 5.8 and 6.6 feed units per kg gain, respectively. Dressing percent was higher for the urea-supplemented groups than for the control, while body fat was lowest for the group receiving highest level of urea. There was no significant difference in the quality of meat or fat among the groups. Lowest intake of concentrates and lowest feed costs were obtained for the groups receiving 45 and

75 gm of urea daily. Manuelian (1965) compared weight gain and feed efficiency in bulls fed either dry beet pulp or beet pulp silage. Equal amounts of concentrates were fed to both groups. Both dried molassed beet pulp and beet pulp silage were fed free choice. The intake in dry beet pulp averaged 45% of the total daily concentrate intake. Both groups had satisfactory gains; however, bulls receiving the dry beet pulp had a slightly higher non-significant daily gain (2.28 lb daily) than the group fed silage (2.06 lb daily). Hanjra (1966) compared growth and feed efficiency in steers and bulls on an all-concentrate ration containing 45% dried molasses beet pulp. Bulls had higher average daily gain (2.56 lb), and better feed efficiency (5.2 lb) than steers (average daily gain 2.29 lb and feed efficiency 6.4 lb). Carcass measurements showed slightly larger rounds (107.94 cm as compared to 105.66 cm for bulls) and higher fat percentage for steers (27.83 as compared to 20.75). However, bulls had a higher lean meat percentage (63.27 as compared to 56.13). An analysis of cost and net return showed bulls to be more profitable than steers.

Parisi (1959) reported trials comparing the performance of Holstein-Friesian and Brown Alpine bull calves. Ten Holstein-Friesian and ten Brown Alpine bull calves were weaned at 6 months of age and fattened intensively in stalls to 14 months on hay and concentrate. Average live weight of the respective breeds at 6 months were 180.6 and

196.8 kg and at 14 months 497.1 and 472.4 kg. The average daily gain for the 8 months period was 1.16 and 1.01 kg, respectively. Corresponding feed units per kg gain were 4.0 and 4.4. Both breeds had well-finished carcasses at the end of the trial and respective dressing percentages of 59.4 and 58.2. The Brown Alpine calves were considered ready for slaughter at 12 months of age.

The effect of supplementing vitamin A to animals fed an all-concentrate ration has been studied by several investigators and conflicting reports have appeared in the literature with respect to the vitamin A requirement of these cattle. Hale et al. (1962) studied various levels of vitamin A on the performance of beef animals. Six pairs of Hereford steers were fattened for 168 days on a ration composed of rolled milo grain, cottonseed hulls, cottonseed meal, dicalcium phosphate and salt. Vitamin A palmitate was added to the daily concentrate ration of the steers in the following doses: 0; 10,000; 40,000; 160,000; 640,000 or 2,560,000 I.U. Liver biopsies were performed at the beginning, on five occasions during the course of the experiment and after slaughter. Blood samples taken at more frequent intervals were also analysed for their vitamin A content. At the outset, vitamin A in liver was 112 ug per gm of wet tissue. At the end of the trial liver storage of vitamin A was found almost depleted in animals not supplemented with this vitamin, 50% reduced in animals receiving 10,000 I.U. daily and maintained at initial value in animals receiving 40,000 I.U. daily. Total serum protein, albumin and globulins were unaffected by vitamin A level in the feed. There was no significant difference in rate of gain, feed efficiency, dressing percent or grade of carcass. Ross and Knodt (1948) studied the effect of vitamin A supplementation to rations fed to Holstein-Friesian heifers. The basal ration for all calves supplied 114,000 U.S.P. units of vitamin A daily per calf. One group given an additional 129,400 U.S.P. units of vitamin A daily for 18 weeks gained an average of 235.9 lb in weight in contrast to 187.6 lb for the other group, the difference in gain being significant. It was also observed that the inclusion of vitamin A in the ration significanly increased the vitamin A content of blood plasma, but decreased its carotene content. Perry _et al_. (1962) reported increased appetite and feed efficiency for steer calves through vitamin A supplementation to a ration containing alfalfa meal. Gartner _et al_. (1962) reported similar findings to those of Perry _et al_. Quarterman and Mills (1964) observed a drastic reduction in liver vitamin A storage in steers fed an all-concentrate ration as compared to those fed conventional rations. Preston (1963) advised the use of 6.2 million I.U. per ton of feed rather than 4.1 for barley-fed cattle. Hubbert _et al_. (1962) reported that the administration of high levels of vitamin A to cattle in their feed or by intra-ruminal injections appeared to be associated with increased marbling of yearling steers fed for 100 to 120 days. However, Davis et al. (1963) reported no improvement in marbling due to high vitamin A supplementation. They also noted no significant differences in feedlot performance or carcass data between cattle receiving 2,500 I.U. of vitamin A per pound of feed and those receiving 500 I.U. Analyses of liver samples indicated significantly greater storage of vitamin A for cattle consuming the higher level of the vitamin. The authors concluded that cattle can gain well even with extremely low levels of liver vitamin A. Similarly, Hanjra (1966) compared the monthly intramuscular injection of either 250,000 or 500,000 I.U. of vitamin A to bulls fed an all-concentrate ration and observed no improvement in daily gain from the higher dose. Serum and liver vitamin A values at time of slaughter were higher in animals receiving the higher dose.

III. MATERIALS AND METHODS

Twenty-four bull calves (12 Red Danish and 12 Holstein-Friesian) were used in this experiment. All Red Danish calves and few Holstein-Friesian calves were purchased at approximately one-week of age from neighbouring farms to the Agricultural Research and Education Center (AREC). This measure has been necessitated by the shortage of bull calves at AREC, particularly those of certain breeds such as the Red Danish breed. The calves were fed whole milk for a period of 90 days. In addition, a calf starter and good quality alfalfa hay were fed during the total pre-experimental period.

The Red Danish calves and the Holstein-Friesian calves were assigned to groups A and B, respectively. Six calves from each breed were randomly assigned to two sub-groups for two treatments of vitamin A. The age, breed and weight of the bull calves at the start of the experiment are shown in Table 1.

Housing

The two groups of experimental animals were housed in two separate pens with concrete flooring and with an approximate area of 20' x 30'. A wooden manger (2' x 8')

Table 1. Age, breed and weight of bull calves at start of the experiment.

Group A Red Danish			Group B Holstein-Friesian		
Calf No.	Age (days)	Weight (lb)	Calf No.	Age (days)	Weight (lb)
2	119	202	15	132	280
3	102	175	16	132	221
4	97	150	17	132	252
6	117	215	18	130	235
7	117	185	19	129	252
8	115	220	20	91	235
9	114	245	21	101	236
10	114	225	22	101	190
11	112	165	23	94	206
12	105	183	24	91	180
13	105	192	25	91	165
14	89	142	309	89	180
Average	108.8	191.6		109.4	219.3

and an automatic waterer were provided for each pen. The pens were partly roofed for protection against sun and rain. The Red Danish calves were placed on experimentation on May 11, 1966 and the Holstein-Friesian calves on June 13, 1966. The average age of both groups at those dates was approximately 109 days.

Feeding

Both groups were fed solely on an all-concentrate ration during the experimental period. The ingredients of the concentrate mixtures (I and II) used are presented in Table 2 while their proximate and mineral analyses are presented in Table 3. Concentrate mixture I was fed initially for a period of 140 days after which concentrate mixture II was fed for the rest of the experimental period. Barley, cottonseed oil meal and wheat bran were reduced from 42, 16 and 30 percent to 28, 8 and 20 percent, respectively; dried molasses beet pulp was increased from 10 to 45 percent. Feed was offered ad libitum. Feed intake was adjusted daily in an effort to reduce or eliminate any weighbacks.

Weighings

Both groups were weighed at 28-day intervals.

Table 2. Percentage composition of the concentrate mixtures.

Ingredients	I	II
Dried molasses beet pulp	10	45
Barley	42	26
Cottonseed oil meal, 35%	16	8
Wheat bran	30	20
Limestone	1.5	0.5
Salt	0.5	0.5
Vitamin D_2	5.7 gm/1000 lb	5.7 gm/1000 lb

Table 3. Proximate and mineral composition of the concentrate mixtures (%).

Fraction	I	II
Moisture	10.86	10.91
Crude protein	14.67	12.27
Crude fiber	10.60	13.58
Ether extract	1.00	0.89
Nitrogen-free extract	57.35	56.95
Calcium	0.74	0.55
Phosphorus	0.81	0.57

Vitamin A Treatment

Since the experimental feed was extremely low in carotenoids, the effect of vitamin A supplementation on animal performance and liver storage was studied. Six animals in each group were injected intramuscularly with 5 cc (500,000 I.U.) of a vitamin A solution[1] at monthly intervals and the remaining six with 10 cc (1,000,000 I.U.) at bi-monthly intervals.

Liver Carotene and Vitamin A

Liver samples were obtained upon slaughter of animals. Since Anderson *et al*. (1962) reported significant differences in vitamin A content of different sites in the liver, all liver samples were consistently obtained from three locations in the liver. Determinations of liver carotene and vitamin A were made according to the method of Stanley *et al*. (1954).

Slaughter and Carcass Data

Each carcass was split along the backbone as accurately as possible into two equal halves. The carcass was then washed with warm water, weighed and transferred to a cooler operating at 32-34^{o}F for a period of 24 hours.

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1. Vitamin A water-miscible, Courtesy Hoffman-La Roche and Co., Basle, Switzerland.

Following chilling, the left side of each carcass was cut between the 10th and 11th ribs and the hind and fore-quarters weighed. The rib-eye area at the 12 rib-section was traced on a transparent paper and the area was measured by a planimeter. The 9-10-11th rib-section was taken from the left side and separated into lean, fat and bone as accurately as possible. The percentage of lean, fat and bone in the whole carcass was calculated according to the formulae developed by Hopper (1944). The 10th rib-cut of the left side was wrapped in polyethylene and kept frozen for subsequent chemical analysis.

The commercial value of the carcasses was assessed by means of a modified score card based on that recommended by the British Agricultural Research Council Group on Carcass Quality Studies (Preston et al., 1963); scoring was done by one person. The modified score card is shown in Table 4 together with the maximum marks awarded for each item.

Table 4. Modified beef carcass score card.

	Maximum mark
<u>Weight suitability</u> (one mark deducted for every 10 kg above or below the optimum carcass weight range of 228 to 273 kg).	
1. Cold carcass	10
<u>Conformation</u>	
2. Shape of leg (visual appraisal).	5
3. Balance (one mark awarded for every 0.5 kg by which the weight of hind quarter exceeds the weight of fore quarter).	30
<u>Muscle development and quality</u>	
4. The ratio of crude protein to ash in the tenth rib-cut (a ratio of 4.7 received a maximum mark of 20. Each decrease of 0.1 from the maximum was penalised by the deduction of 1 mark. The maximum deduction being 19 marks for a ratio of 2.8 or less).	20
5. Marbling of eye muscle (visual appraisal).	5
6. Color of eye muscle (visual appraisal).	5
<u>Fat development and quality</u>	
7. The ratio of ether extract to crude protein (a ratio of 2.0 received a maximum score of 15 marks. Each increase or decrease of 0.2 from this optimum value was penalised by the deduction of 2 marks, upto a maximum deduction of 14 marks).	15
8. Adequacy of fat cover over side (visual appraisal).	5
9. Fat color and firmness (visual appraisal).	5
Total	100

IV. RESULTS AND DISCUSSION

Live Weight Gains

Total individual gain and average daily gain for Red Danish and Holstein-Friesian bulls are shown in Tables 5 and 6. The data is based on 11 animals in each group, since two animals, one from each group, died during the course of the study. The average daily gains for Red Danish and Holstein-Friesian bulls were 2.4 $\pm$ 0.1 and 2.7 $\pm$ 0.1 lb, respectively. The difference in average daily gain was statistically significant (P   0.05) as shown in Table 7. The average daily gains obtained in this study are higher than gains of 2.33, 2.28 and 2.28 lb reported by Ivanov and Zahariev (1962); Prescott and Lamming (1964); and Manuelian (1966), respectively for bulls fed concentrate rations. It should be noted however that different concentrate rations have been utilized by these various authors. Hanjra (1966) reported an average daily gain of 2.56 lb for 11 bulls (7 Holstein-Friesian, 3 Red Danish, 1 cross) fed an all-concentrate ration based on beet pulp. The average daily gain of the Holstein-Friesian bulls was slightly higher than 2.55 lb, the value reported by Parisi (1959) for the same breed. The

Table 5. Individual daily gain of Red Danish calves.

No.	Experimental days	Initial wt. (lb)	Final wt. (lb)	Total gain (lb)	Average daily gain (lb)
Monthly injection (0.5×10^6 IU) of vit. A					
4	291	150	844	694	2.4
8	278	220	848	628	2.3
11	328	165	844	679	2.0
12	251	183	868	685	2.7
14	344	142	822	680	2.0
Average	1492			3386	2.3
Bi-monthly injection (1×10^6 IU) of vit. A					
3	268	175	846	671	2.5
6	245	215	853	638	2.6
7	297	185	852	667	2.2
9	219	245	852	607	2.8
10	230	225	850	625	2.7
13	245	192	856	664	2.7
Average	1504			3872	2.7
Total average	272.4	190.6	848.7	658.0	2.4 ± 0.1*

* Mean $\pm$ Standard Error (S.E.).

Table 6. Individual daily gain of Holstein-Friesian calves.

No.	Experimental days	Initial wt. (lb)	Final wt. (lb)	Total gain (lb)	Average daily gain (lb)
Monthly injection (0.5×10^6 IU) of vit. A					
15	217	280	856	576	2.7
17	273	252	846	594	2.2
19	215	252	848	596	2.8
21	205	236	859	623	3.0
22	226	190	848	658	2.9
Average					2.7
Bi-monthly injection (1×10^6 IU) of vit. A					
16	262	221	866	645	2.5
18	231	235	853	618	2.7
20	219	235	865	630	2.9
24	260	180	858	678	2.6
25	217	165	845	680	3.1
309	269	180	858	678	2.5
Average					2.7
Total average	235.8	220.5	854.7	634.2	2.7 ± 0.1*

* Mean $\pm$ Standard Error (S.E.).

Holstein-Friesian reached slaughter weight earlier than the Red Danish bulls. The Red Danish bulls required an average of 272.4 days to reach an average slaughter weight of 848.7 lb, while the Holstein-Friesians required 235.8 days to reach an average slaughter weight of 854.7 lb. The reduced length of period required for the Holstein-Friesian breed to reach the desired market weight is advantageous in that not only are the animals removed from the premises earlier, thus providing over a long range period additional cattle raised, but in addition reduces the chance of mortality which can occur during the additional period required by the Red Danish breed.

Table 7. Analyses of variance of daily gain.

Source	d.f.	S.S.	M.S.	F
Total	21	1.85		
Between breeds	1	0.38	0.380	5.2*
Within breeds	20	1.47	0.073	
Between vitamin treatments	1	0.13	0.130	
Within vitamin treatments	20	1.72	0.086	

* Significant (P 0.05).

Monthly Versus Bi-monthly Injections of Vitamin A

The daily gain of Red Danish and Holstein-Friesian bulls injected monthly with 0.5×10^6 I.U. of vitamin A or bi-monthly with 1×10^6 I.U. is shown in Tables 5 and 6 and Figure 1. Red Danish bulls injected bi-monthly gained 2.6 lb daily as compared with 2.3 lb for bulls injected at monthly intervals. On the other hand, Holstein-Friesian bulls showed no difference in daily gain due to the vitamin A treatments. Bulls on both treatments had a daily gain of 2.7 lb.

No clinical signs of vitamin A deficiency were encountered during the experimental period. The injection of one million I.U. of vitamin A at bi-monthly intervals appears to have provided adequate protection against the occurrence of a deficiency of the vitamin. Since no reduction in growth rate occurred in calves receiving bi-monthly injections, it can be concluded that monthly injections of the vitamin are too frequent and cause unnecessary additional handling of the animals.

Feed Efficiency

The average daily feed consumption of air-dry feed for the entire experimental period was found to be 11 lb and 13 lb for Red Danish and Holstein-Friesian calves, respectively. The amount of feed required per pound of

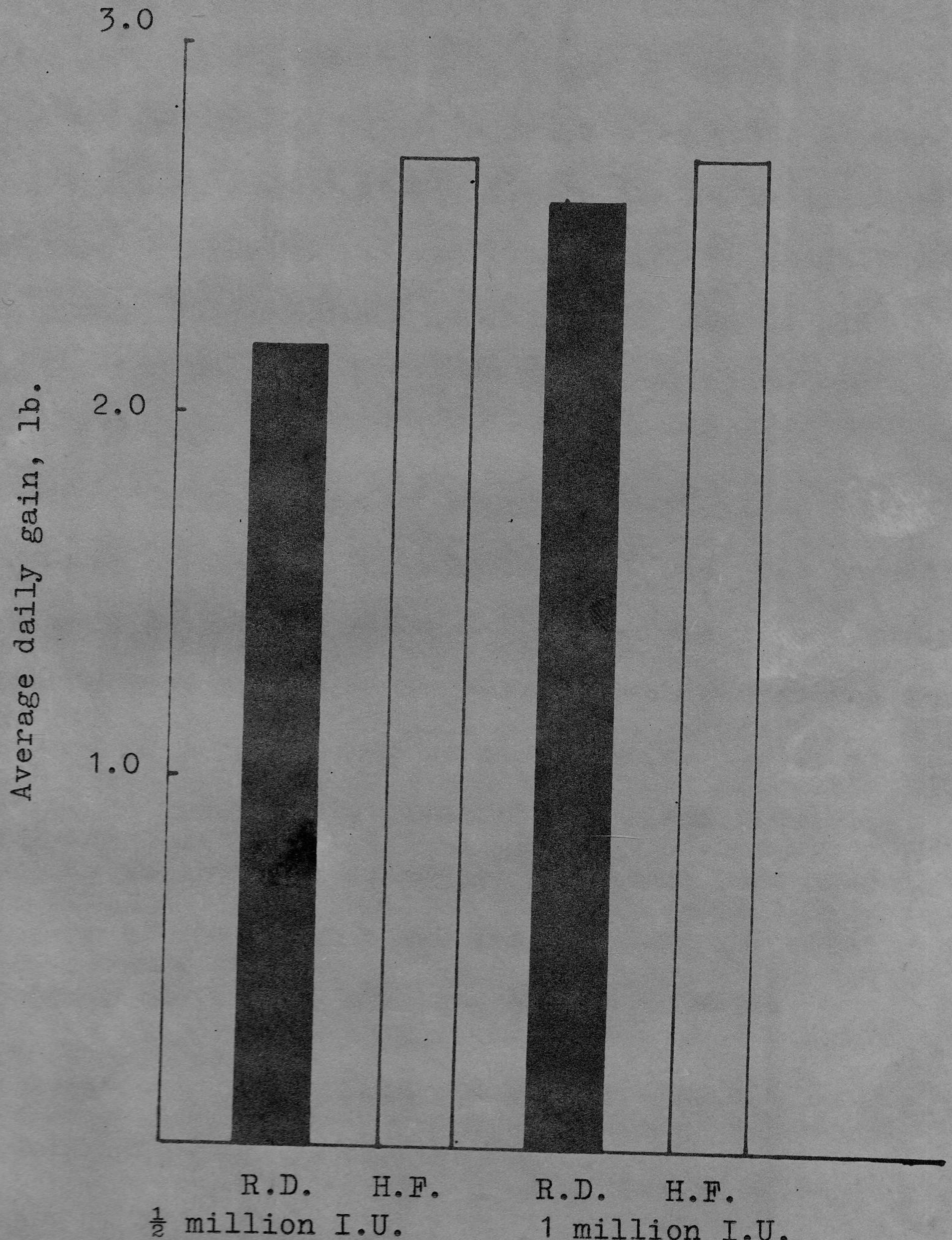

Figure 1. Average daily gains for Red Danish and Holstein-Friesian bulls on low and high vitamin A.

gain (feed efficiency) for the whole experimental period is shown in Figure 2. The feed conversion ratio varied from month to month, but there was a tendency for increased feed intake per pound of gain as the experiment progressed. The average pounds of feed required per pound of gain were 5.75 and 5.61 for the Red Danish and Holstein-Friesian bulls, respectively. The feed efficiency for Holstein-Friesian calves was slightly better than that of Red Danish calves. This is partly attributed to the slower gains achieved by the Red Danish bulls during the latter part of the experiment in spite of a sizeable intake of feed, and also to a higher fat content in the Red Danish carcasses (Table 10). Since the production of fat is more costly caloric-wise than that of lean meat, the production of carcasses with a higher fat percentage requires greater amounts of feed per unit gain than carcasses with a lower fat content. The feed efficiency obtained for both groups in this study is higher than values of 4.76 and 5.20 for bulls reported by Preston _et al_. (1963) and Hanjra (1966), respectively. Assuming a linear regression of feed efficiency on months on experiment, the following regression equation is derived:

$y = 1.81 + 0.78^{x}$, where y is the feed efficiency and x is months on experiment. The regression line is shown in Figure 3.

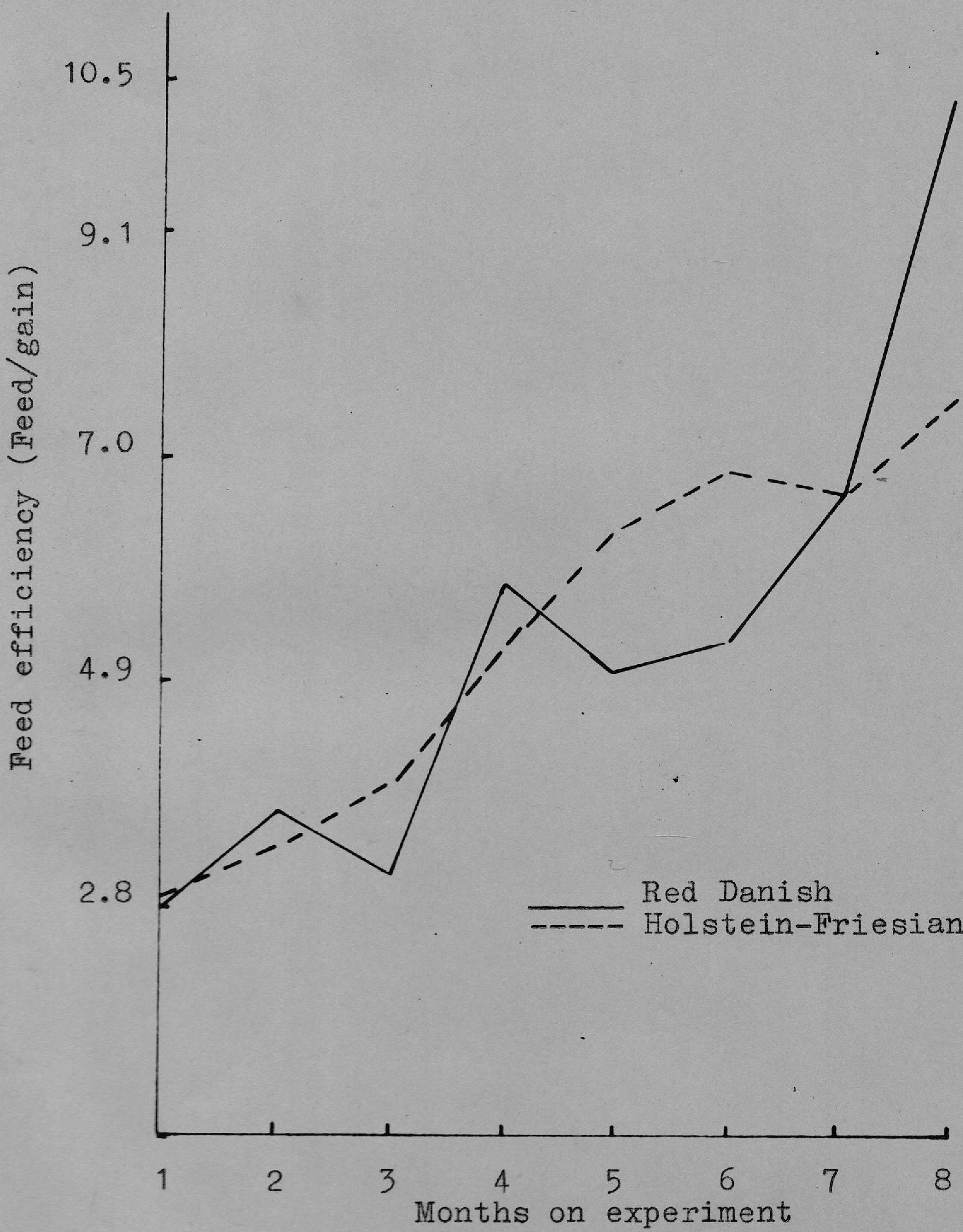

Figure 2. Feed efficiency for Red Danish and Holstein-Friesian bulls.

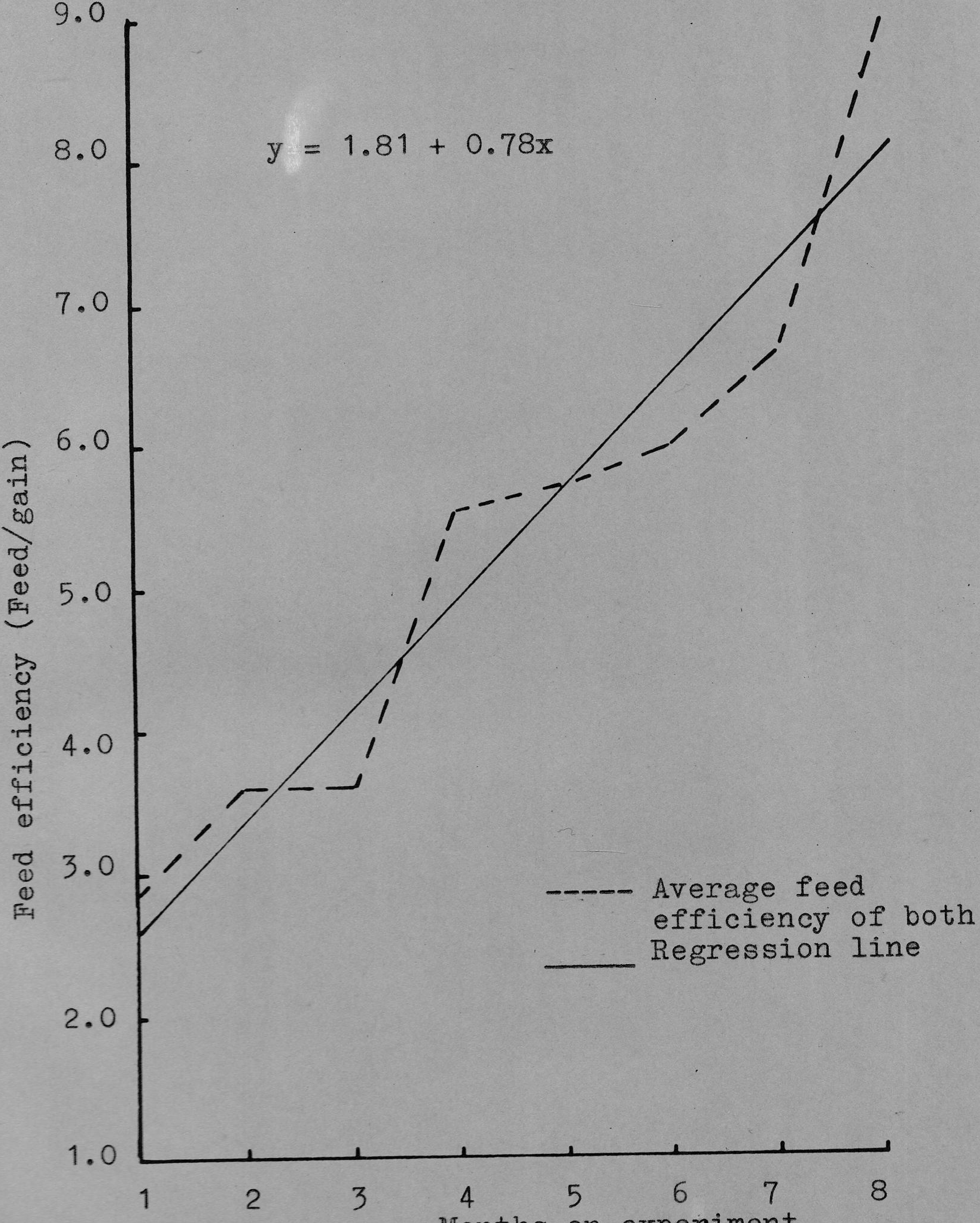

Figure 3. Regression line for the average feed efficiency of both groups.

Carcass Data of Red Danish and Holstein-Friesian Bulls

Dressing percentage and rib-eye area. The dressing percentage and rib-eye area are shown in Table 8. The average dressing percentage for Red Danish bulls was 58.2 $\pm$ 0.6 (55.0 to 60.2 range), while Holstein-Friesian bulls had an average dressing percentage of 59.3 $\pm$ 0.7 (55.5 to 62.2 range). These values are in agreement with those reported by Manuelian (1965) and Hanjra (1966), who obtained values of 58.0 and 59.0 for bulls fed all-concentrate rations, respectively. The average rib-eye area in Red Danish bulls was 73.6 $\pm$ 1.7 cm^2 with a range of 64.7 to 81.8; corresponding value for Holstein-Friesian was 72.9 $\pm$ 1.1 cm^2 with a range of 65.7 to 78.3. There was no significant difference in average rib-eye area between the two groups of bulls; there was however a significant difference in rib-eye areas between vitamin treatments as shown in Table 9. This finding is difficult to interpret, particularly in the light of the previous results which indicated no effect of vitamin treatment on total body growth (daily gain). The average rib-eye area for both groups was lower than 81.53 cm^2, the value reported by Hanjra (1966).

Percentage of fat, lean and bone in whole carcass. Percentages of fat, lean and bone in whole carcass calculated on the basis of percent of fat, lean and bone in the

Table 8. Dressing percentage and rib-eye areas.

Red Danish			Holstein-Friesian		
No.	Dressing %	Rib-eye area cm^2	No.	Dressing %	Rib-eye area cm^2
Monthly injection (0.5 x 10^6 IU) of vit. A					
4	60.0	72.8	15	62.0	74.2
8	58.4	69.3	17	57.6	69.4
11	55.3	72.5	19	61.3	77.0
12	57.6	68.8	21	59.0	65.7
14	55.0	64.7	22	59.9	71.3
Average	57.2	69.6		60.0	71.5
Bi-monthly injection (1 x 10^6 IU) of vit. A					
3	60.2	77.4	16	56.5	73.9
6	59.1	81.0	18	61.7	74.7
7	57.2	80.1	20	62.2	78.3
9	60.0	81.8	24	57.6	71.4
10	58.8	71.3	25	58.9	74.4
13	58.9	69.4	309	55.5	71.8
Average	59.0	76.8		58.7	74.1
Total average	58.2±0.6*	73.6±1.7		59.3±0.7	72.9±1.1

* Mean ± Standard Error (S.E.).

Table 9. Analysis of variance of rib-eye area.

Source	d.f.	S.S.	M.S.	F
Total	21	450.67		
Between breeds	1	2.22	2.22	0.99
Within breeds	20	448.45	2.24	
Between vitamin treatments	1	130.32	130.32	8.13**
Within vitamin treatments	20	320.35	16.02	

** Highly significant (P 0.01).

9-10-11 rib-cut are shown in Table 10. The average percentages of fat in Red Danish and Holstein-Friesian bulls were 16.8 ± 0.8 and 16.7 ± 0.60, and of lean were 65.9 ± 0.6 and 65.3 ± 0.5, respectively. The fat percentage obtained in this study was much lower than 20.75, the value reported by Hanjra (1966); the lean percentage however was higher than 63.27, the value reported by the same author for bulls. The carcass fat and lean percentages obtained in this study indicate a desired carcass for the consumer since in recent years a trend for lean cuts with less fat cover has evolved. The bone percentages in Red Danish and Holstein-Friesian bulls were 17.4 ± 0.3 and 18.1 ± 0.4, respectively.

Carcass quality score. The results of the carcass quality score are shown in Table 11. Since crude protein, ash and ether extract in the 10th rib-cut could not be determined because of the non-availability of a meat and bone grinder,

Table 10. Percentage of fat, lean and bone in whole carcass calculated on the basis of the percent fat, lean and bone in the 9-10-11 rib-cut.

Red Danish				Holstein-Friesian			
No.	% fat[1]	% lean[2]	% bone[3]	No.	% fat[1]	% lean[2]	% bone[3]
Monthly injection (0.5 x 10^6 IU) of vit. A							
4	16.2	65.2	18.6	15	14.3	68.5	17.3
8	20.1	62.9	17.2	17	15.0	65.2	19.5
11	11.6	69.1	19.1	19	16.3	66.1	17.7
12	20.0	62.5	17.6	21	14.5	66.7	18.6
14	16.2	66.0	17.9	22	18.8	64.9	16.6
Average	16.8	65.1	18.1		15.8	66.3	17.9
Bi-monthly injection (1 x 10^6 IU) of vit. A							
3	18.4	65.6	16.3	16	16.5	63.7	20.1
6	18.0	65.6	16.6	18	20.0	63.8	16.4
7	16.1	67.0	16.9	20	16.0	66.0	18.0
9	17.4	66.9	16.0	24	19.6	63.2	17.3
10	14.8	68.6	16.8	25	16.9	64.6	18.4
13	15.9	65.8	18.3	309	16.0	65.0	18.9
Average	16.8	66.6	16.8		17.5	64.4	18.2
Total average	16.8±0.8*	65.9±0.6	17.4±0.3		16.7±0.6	65.3±0.5	18.1±0.4

1 $y = 0.81774x + 2.27664$ for % fat in whole carcass.

2 $y = 0.80173x + 15.71220$ for % lean in whole carcass.

3 $y = 0.70750x + 3.47863$ for % bone in whole carcass. Where x is the % of the particular component in the 9-10-11 rib-cut and y is the estimated % of that component in the whole carcass.

* Mean ± Standard Error (S.E.).

Table 11. Carcass quality scores of calves.

Item	Red Danish	Holstein-Friesian
Weight suitability	9.5 ± 0.3*	9.8 ± 0.1
Shape of leg	2.9 ± 0.2	3.6 ± 0.2
Balance	5.1 ± 1.3	8.7 ± 1.2
Marbling	2.7 ± 0.3	2.3 ± 0.2
Fat cover over side	2.3 ± 0.4	2.7 ± 0.2
Fat color and firmness	2.7 ± 0.3	3.4 ± 0.2
Overall score	25.2 ± 1.7	30.5 ± 1.7

* Mean ± Standard Error (S.E.).

items 4 and 7 in Table 4 were omitted. After discarding those two items, the assessment of the carcass score was based on 65 points rather than 100. The commercial value of the carcass as evaluated by the score card method showed Holstein-Friesian bulls to be of higher quality than Red Danish bulls. The average overall score of Red Danish bulls was 25.2 $\pm$ 1.7, while that of Holstein-Friesian bulls was 30.5 $\pm$ 1.7. The difference in overall score between the groups was statistically significant as shown in Table 12. The main items of carcass evaluation contributing to the low total score obtained were: Balance, shape of leg, marbling and fat cover over side. In balance measurements, Red Danish and Holstein-Friesian bulls had scores of 5.1 and 8.7 points, respectively, out of 30. These extremely low values were responsible for lower overall score in both groups. It was of interest to note that although Red Danish bulls had similar fat percentage in the carcass but lower fat cover over side, they had relatively better marbling than the Holstein-Friesians. This favorable trait, however, did not influence to any great extent, the overall score favoring the Holstein-Friesian bulls. The findings presented here are in agreement with those of Preston _et al_. (1963) who reported lower scores for shape of leg and marbling of rib-eye muscle.

Table 12. Analysis of variance of carcass quality score.

Source	d.f.	S.S.	M.S.	F
Total	21	810.375		
Between breeds	1	166.375	166.375	5.17*
Within breeds	20	644.00	32.20	
Between vitamin treatments	1	35.933	35.933	0.93
Within vitamin treatments	20	774.442	38.72	

* Significant ($P < 0.05$).

Liver Carotene and Vitamin A

Liver carotene and vitamin A values for Red Danish and Holstein-Friesian bulls are shown in Table 13. The mean carotene values for Red Danish and Holstein-Friesian bulls were 293 ± 53 and 303 ± 48 mcg/100 gm of liver, respectively. These values are higher than 120.69 mcg/100 gm, the value reported by Hanjra (1966), but much lower than 1,500 mcg/100 gm, the value reported by Ralston (1959) for steers on pasture. Since the experimental ration was deficient in carotenoids, these levels of carotene in the liver reflect storage of carotenoids during the pre-experimental period when the animals received alfalfa hay free choice. The average liver vitamin A values of Red Danish bulls receiving monthly injections (1×10^6 I.U.) were 37.4 and 22.8 mg/100 gm, respectively; corresponding levels for Holstein-Friesian bulls were 27.2 and 53.6 mg/100 gm, respectively. Although the mean vitamin A value for Holstein-Friesian bulls was much higher than that of Red Danish bulls (41.6 ± 6.7 versus 29.4 ± 4.2), the difference was not statistically significant. The vitamin A values obtained for both groups in this study are much higher than 11.96 mg/100 gm of liver, data reported by Hanjra (1966) for animals receiving 0.5×10^6 I.U. of vitamin A at monthly intervals. They are also higher than

Table 13. Liver carotene and vitamin A of calves.

Red Danish No.	Red Danish Carotene (mcg/100 gm)	Red Danish Vitamin A (mg/100 gm)	Holstein-Friesian No.	Holstein-Friesian Carotene (mcg/100 gm)	Holstein-Friesian Vitamin A (mg/100 gm)
Monthly injection (0.5×10^6 IU) of vit. A					
4	264	56.0	15	161	36.7
8	272	46.0	17	713	30.0
11	0	28.2	19	391	28.9
12	699	28.2	21	249	10.6
14	231	28.7	22	248	30.0
Average	293	37.4		352	27.2
Bi-monthly injection (1×10^6 IU) of vit. A					
3	297	29.7	16	231	68.6
6	359	35.9	18	330	44.1
7	138	13.8	20	262	11.7
9	290	29.0	24	356	74.8
10	431	4.4	25	270	55.2
13	240	24.0	309	121	67.1
Average	293	22.8		262	53.6
Total average	293±53*	29.4±4.2		303±48	41.6±6.7

* Mean ± Standard Error (S.E.).

15,100 mcg/100 gm of fresh liver, data reported by Ralston (1959) for steers on pasture. The liver vitamin A values obtained for both breeds indicate that bi-monthly injections of the vitamin are satisfactory and result in good liver storage.

Economical Analysis

Feed prices, feed consumption and total feed cost from birth to slaughter for both groups of calves are shown in Table 14, while analysis of cost and net return are shown in Table 15. Net profit per bull was obtained by deducting total cost for each bull from birth to slaughter from its selling price. When the carcass was valued at 3.00 Lebanese pounds per kg (LL), a net profit (excluding mortality cost) of 98.82 LL and 144.88 LL was obtained for Red Danish and Holstein-Friesian bulls, respectively. Higher net profit (excluding mortality cost) amounting to 164.97 LL and 202.45 LL were obtained when the carcass was valued at 3.25 LL/kg. When losses due to mortality were included and the carcass was valued at 3.00 LL/kg, net profit of 50.72 LL and 100.78 LL were obtained for Red Danish and Holstein-Friesian calves, respectively. Higher net returns amounting to 116.87 LL and 158.35 LL resulted when the carcass was valued at 3.25 LL/kg. These net returns are mere estimates since the marketing of beef in Lebanon is not based on any well-grounded set of rules, one

Table 14. Feed prices, feed consumption and total feed cost for bulls from birth to slaughter.

Item	Price (PL*/kg)	Total consumption (kg)		Total cost (LL**)	
		R.D.	H.F.	R.D.	H.F.
Pre-experimental period					
Milk	30.0	415.0	415.0	124.50	124.50
Hay (alfalfa)	30.0	89.0	89.0	26.70	26.70
Concentrate	18.0	82.0	82.0	14.72	14.72
Total				165.92	165.92
Experimental period					
Concentrate					
I	19.65	848.30	815.02	166.69	160.15
II	17.58	872.07	801.44	153.31	140.89
Total		1720.37	1616.46	320.00	301.04

* Lebanese piastre.
** Lebanese pound (1 LL = 100 PL).

Table 15. Analysis of cost and net return.

Item	Group A (R.D.)		Group B (H.F.)	
Pre-experimental				
Cost of calf (LL)		100.00		100.00
Feed cost (LL)		165.92		165.92
Labor and housing (LL)		7.26		7.26
Total		273.18		273.18
Experimental				
Cost of concentrate (LL)		320.00		301.04
Labor and housing (LL)		26.77		26.77
Total cost per animal		619.95		600.99
Carcass at 3.00 LL/kg	663.77		690.87	
Carcass at 3.25 LL/kg	729.92		748.44	
Manure (LL)	30.00		30.00	
Liver and heart (LL)	15.00		15.00	
Hide (LL)	10.00		10.00	
Return per animal (LL) at 3.00 LL/kg carcass	718.77		745.87	
Return per animal (LL) at 3.25 LL/kg carcass	784.92		803.44	
Net profit (LL) at 3.00 LL/kg carcass excluding mortality cost		98.82		144.88
Net profit (LL) at 3.25 LL/Kg carcass excluding mortality cost		164.97		202.45
Net profit (LL) at 3.00 LL/kg carcass including mortality cost		50.72*		100.78**
Net profit (LL) at 3.25 LL/kg carcass including mortality cost		116.87*		158.35*

* Profit reduced by LL 48.10 due to the mortality of one calf weighing 757 lb.

** Profit reduced by LL 44.10 due to the mortality of one calf weighing 707 lb.

of which should be the grade of the carcass. With a better appreciation of meat quality on the part of the consumer, the selling price of the carcass is likely to be higher than the figures which have been used for calculating the return per animal. When the net profit per animal (selling price of carcass 3.25 LL/kg) including mortality cost is divided by the total cost per animal, profit amounting to 19% and 26% is obtained for Red Danish and Holstein-Friesian calves, respectively. It should be remembered, however, that interest on investments and depreciation of buildings and equipment have not been deducted from these percentages. It is apparent from such calculations that beef production in Lebanon could be a profitable enterprise.

V. SUMMARY AND CONCLUSIONS

1. Twenty-four bull calves (12 Red Danish and 12 Holstein-Friesian) were fed an all-concentrate ration containing dried molasses beet pulp, barley, cottonseed oil meal and wheat bran. Two of the bulls (one Red Danish and one Holstein-Friesian) died from bloody diarrhea during the experimental period.

2. The average daily gain for Red Danish and Holstein-Friesian bulls was 2.5 ± 0.1 and 2.7 ± 0.1 lb, respectively. The difference in average daily gain was statistically significant (P   0.05). No significant difference was observed in average daily gain between monthly or bi-monthly injections of vitamin A.

3. Feed efficiency was slightly better for Holstein-Friesian bulls than Red Danish bulls (5.6 versus 5.8). Daily intake of air-dry feed was slightly higher for the Holstein-Friesian group (13 lb versus 11 lb).

4. The average dressing percentage, rib-eye area (cm^2), fat and lean percentage in Red Danish and Holstein-Friesian carcasses were 58.2 ± 0.6, 59.3 ± 0.7; 73.6 ± 1.7, 72.9 ± 1.1; 16.8 ± 0.7, 16.7 ± 0.6; and 65.9 ± 0.6, 65.3 ± 0.5, respectively. No statistically significant difference was observed between breeds

for all the above measurements. The relatively lower fat percentage and higher lean percentage of carcasses produced in this study as compared to carcasses produced on other feed formulations indicate a desirable carcass presently demanded by the consumer.

5. The commercial value of the carcasses as assessed by the score card method showed Holstein-Friesian bulls to be of higher quality than Red Danish bulls. The average overall scores of Red Danish and Holstein-Friesian bulls were 25.2 ± 1.7 and 30.5 ± 1.7, respectively. Carcass score was based on 65 points rather than 100.

6. The mean liver carotene values for Red Danish and Holstein-Friesian bulls were 293 ± 53 and 303 ± 48 mcg/100 gm, respectively. The mean liver vitamin A values for Red Danish and Holstein-Friesian bulls were 41.6 ± 6.7 and 29.4 ± 4.2 mg/100 gm, respectively. Although the mean vitamin A value of Holstein-Friesian bulls was much higher than that of Red Danish bulls, the difference was not statistically significant. The liver vitamin A values for both breeds have indicated that bi-monthly injections of the vitamin are satisfactory and result in good liver storage.

7. An analysis of cost and net return per animal showed both breeds to be profitable, with the Holstein-Friesian bulls giving a higher net return. When the carcass was valued at 3.00 LL/kg, a net return (excluding

additional cost due to mortality) per animal of 98.82 and 144.88 LL was obtained for Red Danish and Holstein-Friesian bulls, respectively. Higher net returns amounting to 164.97 LL and 202.45 LL were obtained when the carcass was valued at 3.25 LL/kg. Lower profits were obtained when losses due to mortality were included in the calculation of the net profit (Table 15). Net profits of 50.72 LL and 100.78 LL were obtained for Red Danish and Holstein-Friesian calves, respectively (carcass value at 3.00 LL/kg). When the carcass is valued at 3.25 LL/kg the corresponding profits are 116.87 LL and 158.35 LL, respectively.

8. With the exception of the two fatalities which occurred during the experiment, no signs of ill-health or digestive disturbances such as bloat, diarrhea or liver abscesses which are often encountered on high-energy rations, were observed.

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