Table 3.—Dehydrated alfalfa meal and molasses in supplements for wintering calves (4-year ave.).

	Lot 1 Corn, CSM	Lot 2 Corn, CSM Dehydrated alfalfa meal	Lot 3 Corn, CSM Molasses
Total number of Calves	40	40	40
Average weight per calf (lbs.)			
Initial	422	420	420
Final	426	435	439
Gain (ave. 118 days)	4	15	19

and molasses are more likely to be present in prairie hay or the dry forage available in a native grass pasture during the winter months than in the weathered hay fed in our tests.

Although conclusive data are not available, it might be assumed that the addition of dehydrated alfalfa meal or molasses to pellets fed as supplements to higher quality roughages such as prairie hay is not as valuable as when the addition is made to pellets fed as supplements to poor-quality, weathered hay.

The Response of Dwarf Carrier and Normal Beef Cattle to Insulin Induced Stress

E. J. TURMAN

Although dwarf individuals have been observed in practically all species since ancient times, their occurrence was sporatic and usually regarded as a curiosity. In contrast, dwarfism in beef cattle has shown a sharp increase within the last decade, and has become a serious economic problem. Not only does the dwarf calf represent the loss of a cow's production for the year, but considerable stigma has been attached to animals and lines of breeding known to produce dwarf calves.

While some have suggested that non-genetic factors may be responsible, careful analysis of many records has clearly demonstrated that dwarfism in beef cattle is hereditary. The dwarf calf is homozygous for a single autosomal recessive gene. Non-dwarf calves are either homozygous for the dominant normal gene, or heterozygous and thus carriers of the recessive dwarf gene. Heterozygous animals, while apparently normal themselves, can produce dwarf offspring. Homozygous normal animals, on the other hand, cannot transmit a recessive dwarf gene, and would produce no dwarf calves regardless of the genotype of the animal to which they were mated.

The problem facing the breeder has been the identification of the carrier animals among his normal individuals. To date his only method has been the mating of animals of unknown genotype to animals known to carry the dwarf gene. Such progeny tests will either prove an animal a carrier if a dwarf calf is born, or make the odds against his being a

carrier so great he may be presumed clean. For example there is only one chance in one hundred that a carrier bull would sire only normal calves when mated to sixteen known carrier cows. The odds decrease or increase as fewer or more carrier matings are produced. It is evident that the progeny test is not only expensive and time consuming, but also limited almost entirely to testing bulls. The productive life of a cow would be ended before she had produced enough calves to test her to a very high level of probability.

Progeny testing of prospective herd sires has been largely limited to the larger purebred herds. Most breeders have been forced to rely upon pedigree information. This has resulted in discrimination against certain lines of breeding and the possible elimination of animals that carried superior germ plasm for important performance characteristics. It is readily apparent that an accurate diagnostic technique that would permit early detection of carrier animals would be a definite contribution to breed improvement.

Early dwarfism research was directed toward studying differences between dwarf and normal calves. It was hoped that such differences might also be manifest, to a lesser degree, in carrier animals when compared to clean animals. One of the big handicaps in this research is the lack of a method, other than the slow and time consuming progeny test, for determining the dwarfism genotype of the normal animals.

In general the methods proposed as a result of these studies have not permitted a clear-cut differentiation between clean and carrier animals. One such method, which shows some promise, is the x-ray technique discussed in the report starting on page 33 in this publication.

Research has also been directed towards studying the basic physiological differences between dwarf and normal calves. In general these studies have failed to reveal any gross physiological differences between dwarf and normal calves under normal conditions. However, several new studies have been initiated in which the physiological response to stress is being studied. As an outgrowth of one such study utilizing insulin as the stressor mechanism, a new, and very promising, technique has been proposed by workers at the University of Missouri. The object of this paper is to discuss briefly the procedure of this test and present some preliminary results.

Procedure

The animals under test are restrained and a 3-5 ml. sample of blood is drawn from the jugular vein. As soon as the blood has been collected, 0.36 units zinc insulin per pound of body weight is injected into the jugular vein through the same needle. Two additional blood samples are drawn at intervals of 1 hour and 2 hours after the intravenous insulin injection. The blood collecting tubes contain an anti-coagulant to prevent clotting of the blood. Care is exercised in handling the animals to prevent undue excitement.

As soon as possible after the blood is drawn, blood smears are prepared to be stained with Wright's stain for later differential counts.

Samples of blood are then diluted in standard white cell pipettes, using either a 1% acetic acid or 0.08 N hydrochloric acid solution as the diluting fluid. After diluting and shaking for approximately two minutes the blood cells in the diluted samples are counted immediately under low power of a microscope in a standard haemocytometer using the large white blood cell squares.

Results and Discussion

The characteristic changes in blood cells in clean and carrier animals following the insulin injections is given in Table 1. These counts include both the true white blood cells, and the smaller cells that are present but have not yet been positively identified. The large increase in these small cells within one hour in the clean animals is the diagnostic feature of this test. As can be seen in the sample results given in Table 1, clean animals exhibit a marked increase from zero to one hour after insulin, reaching a peak at this time and decreasing in numbers of cells between one hour and two hours after insulin. Carrier animals on the other hand do not increase as rapidly from zero to one hour after insulin, but either continue to increase or remain at relatively the same level from one hour to two hours.

The Missouri workers have also reported that certain characteristic changes occur in the kinds of white blood cells as observed on the stained blood smears. The clean animals show a decrease in lymphocytes and an increase in neutrophils from zero to one hour after insulin. In general, carriers show the reverse change. Stained slides have been

Table 1.—Cells per cubic millimeter of blood of Angus cattle before insulin and at 1 and 2 hours after an intravenous injection of 0.36 units insulin per lb. body weight.

Animal No.	Sex	Dwarfism Status	Cells per mm³ at Hours After Insulin 0	1	2
	Group Predicted Clean				
1	F	Pedigree Clean	8,000	19,150	14,600
2	F	" "	10,300	22,300	15,900
3	F	" "	9,800	14,900	9,900
4	F	" "	13,800	25,300	16,800
5	F	" "	14,050	30,550	16,500
6	M	" "	12,300	18,300	10,850
7	M	" "	12,000	19,400	12,000
8	M	" "	13,500	25,000	16,500
Average for predicted cleans			11,719	21,863	14,131
	Group Predicted Carrier				
1	F	Known Carrier	11,050	16,900	16,000
2	F	" "	9,900	14,100	15,000
3	F	Carrier Parent	13,800	15,200	13,550
4	F	" "	14,150	15,000	15,850
5	F	" "	12,500	14,200	18,100
6	M	" "	15,450	16,800	20,300
7	M	" "	9,650	12,000	15,400
8	M	" "	7,450	10,200	14,900
Average for predicted carriers			11,744	14,300	16,138

prepared from animals tested at this station and will be studied at a later date, but such data cannot be reported at this time.

The data included in Table 1 were selected to show one of the characteristic responses that appears to differentiate clean and carrier animals in this test. Although these data were obtained with Angus, similar results have been obtained for Herefords that have been tested. No differences have been observed in the response of bulls as compared to cows under insulin stress.

Much of the work to date at this station has been preliminary studies designed to develop skill in counting the cells. In these studies young animals, whose genotype for dwarfism was not known, were used to avoid the bias that might result if the technician was aware of the results he should obtain. It was found that young animals, one to four years of age, gave a very definite response. However, the older animals that have been tested show little or no response at the dosage level that has yielded excellent results with young cattle. This apparent influence of age on the test has prevented an appraisal of the accuracy of the test since most of the available animals of known genotype were older animals. Further work is needed to determine how age influences the test, not only in the case of older animals, but also to determine the earliest age at which the test may be safely conducted.

In general the results that have been obtained on young animals at this station agree very closely with the expected based upon pedigree information. Approximately 90 percent of the animals believed free of the dwarf gene from pedigree information have given the response assumed to be typical of clean animals. Slightly more than one-half of the offspring of a carrier parent have given a reaction typical of known carriers. One would expect slightly more than one-half of these offspring to be carriers since it was probable that in some cases both parents were carriers. Three young animals known to be heterozygotes have been tested and all gave a carrier response.

Although the results that have been obtained at this station, and other stations, indicate that this technique has promise, it is still in the research stage. There are many questions which remain to be answered by additional research. Work is under way at the present time to determine the accuracy of the test, its limitations, and the factors that influence it. Whether this test will be suggested for routine use in the field will depend upon the results of this research.

Levels of Supplemental Winter Feeding of Beef Cows and Creep-Feeding Fall Calves

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In recent years there has been an increased number of cows calving in the fall. This change in calving season has resulted in a need for additional data on feeding and managing such cattle grazing