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When a Balanced Ration is Not Balanced

New Facts in Feeding for Growth and Reproduction That Upset Some Old Theories

By E. B. HART, H. STEENBOCK AND G. C. HUMPHREY.

THE prevailing theory of a balanced ration supposes that all the requirements for the successful growth and reproduction of an animal have been met with the supply of digestible protein and net available energy are adequate. This is the modern feeding standard developed and taught by all authorities on animal feeding and used with great success by countless animal husbandmen.

One would assume that, by its use under all conditions, splendid growth and strong, vigorous offspring could be produced, no matter what the natural sources of the materials involved might be. This would be true if protein and energy were the only necessities in an animal's ration; but it is becoming clearer every day that there are other important factors in the make-up of a successful ration. In this article there is discussed how rations balanced from restricted sources may affect growth and reproduction in cattle.

Ten years ago this experiment station began a series of observations with cattle upon the effect of balanced rations on growth and reproduction. The rations were, however, restricted in their make-up to a number of plants to test the adequacy of the prevailing theory that protein and energy are the only necessary factors in formulating a ration. Each ration was balanced—that is, so made up as to contain the foodstuffs in sufficient amounts and suitable proportions to supply adequate energy and adequate digestible protein—but in one case it was made up entirely of feeds obtained from the corn plant, in another from the wheat plant, in a third from the oat plant, and in a fourth from a mixture of the three. As an example, the corn plant ration was composed of five pounds of corn meal, two pounds of gluten feed, and seven pounds of corn stover, giving a nutritive ratio of 18.2 and 15 therms for each 14 pounds consumed.

In all cases it was necessary to include concentrates obtained from the respective grains in order to supply sufficient protein, but in the case of the oat ration, oat meal instead of the whole oat grain was used, as oat protein concentrates are not available.

The animals used in the first experiment weighed approximately 300 pounds. On all the rations they grew fairly well, although it could be seen that those receiving wheat were not as vigorous or as well developed as the other lots.

A group of Holsteins was started as young heifers on a corn and a wheat ration, respectively. Those receiving the corn ration gained as in the first experiment, grew well, matured, showed early oestrus (coming in heat), and were physically strong in every respect. There was every evidence of normal nutrition.

Those receiving the wheat ration grew at a fair rate, but when they reached 1,000 pounds they ceased to gain, they began to lose weight and showed lack of vigor. There was evidence of physical weakness—even blindness finally resulted. These animals would come into their oestrus and collapse under the slightest excitement. This collapse was followed by labored breathing and more or less trembling. These spasms would last but a few minutes, when the animal would again rise and appear perfectly normal. They showed no oestrus and to have continued them longer for breeding purposes would have been futile. They finally became so emaciated and the loss in weight became so great that it was necessary to kill them. It is doubtful whether even a change to the corn ration would have brought them back to normal.

When the animals of the first experiment were involved in reproduction, strong calves always resulted with the corn ration. These calves would be



The Effect of a Wheat Ration on the Calf.
This calf was produced by a cow fed continuously on a balanced ration derived wholly from the wheat plant. These calves were always born prematurely, and were either dead at birth or lived but a short time.

carried to maturity and no trouble was experienced at parturition. On the wheat ration the cows were never able to reproduce normally. Calves were born 25 to 30 days ahead of time, undersized and weak, and would never live over four or five days. The mother would often fail to properly "clean" and with the attendant dangers of infection. In several cases we lost mothers from this cause alone. It should be stated here that dry rations had nothing to do with the phenomena observed. The corn ration was as dry as the wheat ration, but it gave practically normal results. For this reason dryness of rations should not be thought of as a factor in disturbed reproduction.

This herd was absolutely free from contagious abortion. It had been under the observation of a veterinarian during the entire period of work and was found by him to be free from the contagious form of abortion disease.

On the ration balanced from the oat plant fairly good offspring were produced, but in no case did they appear quite as vigorous as in the case of the corn-fed group.

Later experiments with rations made entirely from the oat plant demonstrated more clearly than did those earlier experiments that a perfect ration cannot be made from it alone. In those later experiments the calves were born prematurely and seldom lived. The difference between the earlier and later results very probably lies in a difference in the mineral content of the two straws used. That used in our first experiments contained twice as much mineral matter as that used in these later experiments.

Influence of Feeding a Mixed Ration.

A mixed ration, according to our previous ideas, should have been the one giving the best results, and under our present limitations in information, feeding a mixture is undoubtedly the safest rule to follow; but in this case the offspring from the mixed ration were not as good as the offspring from the corn ration. The pulling down effect of some of the poor constituents of the ration, such as the wheat grain and straws, was plainly noticeable. This illustrates very clearly the fact that a ration may be restricted in variety but still be physiologically perfect, while on the other hand a mixed ration may carry something decidedly deleterious to its physiological soundness. Judgment as to the physiological value of a ration cannot be made until it has been given a definite feeding trial.

When an animal was changed from the corn ration to the wheat ration it always became exceedingly stiff, and if it was continued too long on the wheat ration prostration would result. This condition often led to a loss of the in-

dividuals under observation.

Wheat Plant Deficiency.

In our attempts to locate the trouble in the wheat ration we have fed rations made up of the corn grain and wheat straw. Here the offspring were also weak and often dead. When to that same ration, however, a suitable salt mixture was added so that the mineral content of the ration was made like that of the corn ration, perfect offspring resulted. This indicates, then, that one of the deficiencies in the wheat ration was a proper salt mixture. This is a fact of very great fundamental importance. When, however, the corn grain in the ration was displaced by the wheat grain and the ration consisted then of wheat grain, wheat straw, and a proper mineral content, disaster in reproduction again resulted. This shows the presence of a second disturbing factor in the wheat ration which here is shown to be located in the wheat grain. This factor is probably some inherent toxic (poisonous) material, as yet of unknown character.

Calves born to mothers on this ration held their heads in a strained position, either sideways or backwards. They were unable to get up or to suckle the mother and always died a few hours after birth.

These experiments indicate that in a ration made from the wheat plant alone there are two defects: namely, a poor mineral content and a toxicity inherent in the wheat grain. When the wheat grain was

coupled with corn stover we sometimes met with success and some times a failure in the character of the offspring. With strong mothers it appears that the addition of corn stover may act as an efficient antidote to the toxic factor, and, in addition, furnish sufficient mineral matter to enable the animal to reproduce normally.

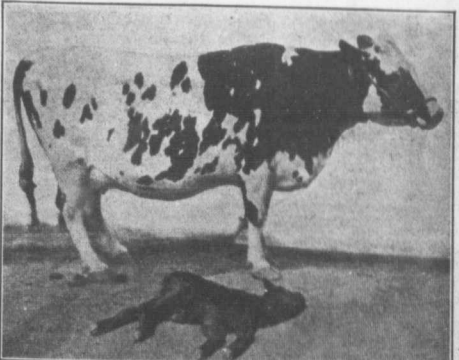
The possibility of the toxicity being destroyed by heat was also taken up, and baked wheat was used with corn stover. This had no effect whatever in improving the wheat kernel. In other cases the wheat grain plus corn stover ration had butterfat added to it for the purpose of supplying plentifully the newly discovered growth-promoting factor—fat (Continued on page 10.)



This shows the offspring from a mother fed a balanced ration from the corn, grain and wheat straw. The mineral content of the ration would always lead to disaster.



This calf was produced by a cow fed continuously on a balanced ration derived wholly from the corn plant. Upon this ration the calves were always produced.



Effect of a Ration Balanced from the Oat Plant.

This ration consisted of 7 parts oat meal, 7 parts oat straw. Two pounds of butyrate to 100 pounds of grain were added, but did not improve the ration weak as a rag. It could not stand, and it threw its head in a peculiar way content. The ration used here was too low in mineral and it is necessary to call a veterinarian to remove the afterbirth.