When a Balanced Ration is Not Balanced

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

(Continued from last week.

THESE experiments for the first time show the limitations of the theory of a balanced ration and indicate the very great importance of other factors besides protein and energy in the successful diet. It was, indeed, surprising to find that the common wheat kernel had a definite though low toxicity, and that mineral matter is of such great importance. It is well to keep in mind that, while from the economic standpoint it is important to prevent waste by conforming in feeding practice to the lowest requirements of our standards, it is also important to remember that it is well to have sufficient excess of the various necessary constituents in order to provide a safe margin for the animal. The restriction of the amounts of two indispensable constituents to the border line of deficiency between two different rations may not be a serious matter, but when both are restricted in one ration the effects may be disastrous. Similarly, as brought out with the animals fed with wheat grain, the presence of toxicity may or may not be shown by the animals, depending entirely upon the character of the other constituents of the ration. The necessity of considering such factors as toxicity, suitable proteins, growth-promoting substances or vitamines, and a proper balance of salts, indicates how complex the problem of nutrition really is and how necessary it is that the relative importance of the factors be clearly exposed in order that we may place the various feeds in their proper category.

Two Rats of the Same Age. Food Made the Difference.

The rat on the right received a small amount of butter fat; the one on the left received an equal quantity of vegetable oil similar to the oils from which oleomargarine is made. Otherwise their rations were the same. The second ration lacked "vitamines." Those vitamines, which are necessary in both animal and human rations, are also found in the yolks of eggs and in the leaves of plants, as well as certain other plants of animal origin. The illustration explains why the universal substitution of oleomargarine for butter would be disastrous to the human race. It also throws light on the newest problem of animal nutrition.

The Effect of Adding Alfalfa to a Wheat Ration.

A cow and her calf showing the effect of a ration of wheat grain, wheat straw, and alfalfa hay. With half the roughage as alfalfa hay, reproduction in the first gestation period was successful. The calf was normal and strong and the cow was apparently healthy and vigorous. This illustrates the great influence of a good roughage.

Vitamines.

A word about vitamines. These are as yet unidentified chemical substances in foods, which are absolutely necessary for growth and reproduction. Without them no growth will take place. They appear to be abundant in milk and eggs and in the leafy portion of plants. One class—soluble in water—is abundant in seeds, while another class—soluble in fat—is apparently not so abundant in seeds. We know very little about either class, but we know that both kinds must be present in ample quantity if a ration is to be complete. Our results with the wheat ration are not to be attributed to a low supply of the fat soluble vitamine since the addition of butterfat, which contains it in abundance, did not improve it for reproduction. The other class of vitamines—the water soluble type—was abundantly supplied by the wheat grain.

A number of years ago chemists tried to get young animals to grow on rations which were made up of mixtures of carefully purified proteins, carbohydrates, fats and salt mixtures from the chemical laboratory. These salt mixtures must contain all salts which are left as ash when the body of the animal is burned, and include potassium, sodium, calcium and the magnesium salts of sulphuric, phosphoric and hydrochloric acids. When such rations are fed, the animals not only do not grow, but they will not live any great length of time, ordinarily not over two months. The essential thing to remember about these experiments is that the foods used were highly purified.

If we take such a mixture of foodstuffs which do not allow an animal to grow and stir into it a small quantity of egg yolk, say for a pound of the ration an ounce of egg yolk, growth can be induced. The same result would be obtained if we had put in an ounce of evaporated milk instead of the egg yolk. Suppose, now, that we take all the fat out of this satisfactory ration by extracting it with something that dissolves fats. Then it will be found that, though the ration will be able to maintain young rats without any increase in weight for about a month, it will no longer be able to induce growth. Only on restoring the extracted fats to the ration will prompt resumption of growth ensue.

A similar result could have been obtained by adding butterfat or the fats obtained from certain animal organs; but other fats, such as lard, almond oil, and cottonseed oil, would not have brought about the same result. These facts might well cause us to stop and think. Because of the fact that some fats naturally contain substances necessary for growth while other fats do not contain such substances, there has arisen the necessity of speaking of the presence or absence of fat soluble vitamines. These vitamines are closely, though not exclusively, associated with fats, as seeds to a certain extent and the leafy portion of plants to a considerable extent also contain these substances. Alfalfa leaves are a very good source of these unknown constituents, although there is every reason to suppose that the forage portion of plants in general is a better source of this class of vitamines than the grains.

Another Class of Vitamines.

Besides the fat soluble type of vitamines we have still another class to consider. Suppose that to our unsatisfactory ration of proteins, carbohydrates and salts there is added the egg yolk fat or butterfat; we will find that the ration will still be unsatisfactory. If now we make a water extract of the egg yolk from which the fat has been previously removed and add this to our ration prompt resumption of growth will occur. It was not, then, the addition of fats alone, or substances carried by them that caused resumption of growth when untreated egg yolk was added, but it was the addition of fat soluble vitamines and water soluble vitamines. Both are indispensable for growth. Like the fat soluble vitamines, the water soluble vitamines can be obtained from various sources. They are found in abundance in eggs, milk, grains and in the leafy portion of plants, from which they can be readily extracted with water. They are not present in starch, sugars and fats and are found only to a very limited extent in polished rice.

The fact that the leafy portion of plants appears to carry a bountiful supply of both classes of these indispensable vitamines adds another good reason for the use of good roughages in feeding our stock. It is just those roughages with plenty of leafy material remaining, such as clover hay, alfalfa hay, and corn fodder, that are the most valuable. Those with practically no leaves and only the stems, as in the case of the straws, constitute the poorer class of roughages.

While the experiments outlined above show that our knowledge of feeds is incomplete and that there is much to learn about physiologically balanced rations, yet the farmer would gain nothing by discarding his present methods of balancing rations and would indeed lose much by so doing. Energy and proteins are the nucleus of good ration construction and calculating their proper proportion as prescribed in the standards should be continued. It will in the majority of cases bring success. What we learn in addition in the future about the balancing of salts in a ration, about the supply of vitamines and their preservation in the handling of our farm crops, about the inequality of the nutritive value of the proteins, about the content of toxic materials, will be so much gained, and we want such knowledge; but the central nucleus of ration construction is sound and such results as given here should only whet our appetite for more knowledge and should not in the least shatter our faith in what we already possess.

Eventually the balanced ration will mean the complete ration, but that only when more knowledge is available; and the complete ration which we hit most of the time now (but when we miss it are at a loss to know the reason thereof) will include more than protein and energy; it will include both of these, and in addition it will mean a proper mineral content, an absence of poisonous materials, an adequate supply of vitamines, and possibly things yet to be discovered. Our understanding of nutrition must expand. Under conditions of forced restriction it is not impossible for a feeder or breeder to enter the danger zone, as in the case of the Nebraska farmers, and only when we have complete understanding of all the nutritional factors required by animals and

(Continued on page 13.)

The Effect of the Wheat Ration Fed Continuously.

The same cow shown, showing the effects from the continuous feeding for the second gestation period of a ration of wheat grain, wheat straw, and alfalfa hay. This calf was carried to the full time, but was weak, and at first was fed from the bottle. It grew strong, but the fore legs were so weak that it stood for the first few days of its life on the first joints. This calf was blind. The mother however, remained in an apparently good condition.