

USE OF TRACER ATOMS IN ANIMAL HUSBANDRY

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TRACER atoms are finding ever wider application in animal husbandry in the USSR. The method is not only becoming a permanent part of the work of research laboratories but also helps to solve practical problems on the farms.

An example of the solution of a practical problem is the determination of the conditions required to obtain fodder of full value. This is particularly important in districts where the soil is poor in minerals. Fodder plants grown in such areas contain an insufficient number of mineral nutritive elements, required to ensure the health and high productivity of livestock. In order to enrich the fodder with the necessary mineral substances special mineral fertilisers are applied to the soil.

The use of mineral fertilisers containing combinations of tracer atoms—radioactive isotopes of phosphorus-32, calcium-45, copper-64, cobalt-60, manganese-54, zinc-65, molybdenum-99, iodine-131 and other chemical elements—makes it possible to decide simply and directly in the field questions of great practical importance: e.g., what part of the compounds contained in the fertiliser and required by the plant is assimilated by the latter from the soil, how effectively certain compounds of microelements (microfertilisers) introduced into the soil are utilised by the plants, which of these are best assimilated by, and are most accessible to, the plants? The method of tracer atoms is the only way of directly solving these problems.

The new branch of agrochemistry, viz., isotope agrochemistry, is closely connected with the problem of feeding livestock. Livestock feeding of full value must be based not only on the data of the chemical composition of the fodder, but also on a study of the absorption of the fodder components by the digestive organs and of the metabolism in the animal organism. The chemical composition of fodder is determined by the usual chemical and spectral methods, but these cannot establish the degree of absorption. This factor or, what is called "digestibility" is determined by calculating the difference between the content of the given substance in the daily fodder ration and its content in the daily excrement. However, the values obtained for "digestibility" are considerably lower than the real. Errors in

determining "digestibility" depend upon the admixture, to the fodder substances contained in the digestive tract, of substances secreted by the peptic glands, and of internal substances secreted with the bile. The only way of determining this error is the method of tracer atoms. By intravenous introduction of salts, containing the radioactive isotope of an element (e.g., phosphorus-32, or sulphur-35), and the subsequent discovery of this tracer element in the excrement, we can determine what part of this element, contained in the excrement, is of endogenous origin. Thus, it was established, that phosphorus-32 is secreted from the organism by all the divisions of the intestine and the pyloric portion of the stomach. Therefore, the amount of endogenous phosphorus in the excrement may reach considerable dimensions. The real "digestibility" of phosphorus proved to be three to five times greater than the apparent. That shows how great the error due to endogenous phosphorus may be in determining the "digestibility" of phosphorus.

With the aid of the isotope of sulphur-35 it has been proved that about 20% of the sulphur contained in the excrement is not of fodder origin but is carried into the intestine with the bile and is secreted from the organism by the walls of the intestines. Such data have been obtained for many substances.

Tracer atoms are also being used to study questions concerning the biochemistry and physiology of the milk, meat and wool yield of livestock and the oviparous properties of poultry, the preservation of livestock, the prevention of disturbances in metabolism and endemic diseases due to insufficiency or excess of certain microelements in the environment.

In highly-productive animals one may expect not only intensification of the synthetic processes, but also to a certain extent new trends of these processes, particularly, ways and forms of increasing the activity and utilising the primary, intermediary and end-products of metabolism. An important problem connected with the synthetic activities of the mammary gland, particularly in highly-productive milch-cows, is the utilisation of the issue depots of the organism for milk secretion. With the help of tracer compounds the quantitative ratios of the chemical components of fodder, the depots and the milk are being studied. The degree of

utilisation of mineral sulphur in the synthesis of thiamine, secreted with the milk, has been established.

Great attention has been devoted in recent years to a study of sulphur metabolism in sheep in connection with wool production. In these researches organic and mineral compounds of sulphur-35 (methionine, cystine, thiourea, thiamine, sulphates and sulphides), were used.

The introduction of marked sulphur into the organism of a sheep, for instance, leads to the deposition of sulphur compounds in the wool, leaving a radioactive track in it. When the introduction of tracer sulphur is repeated a few days later a second radioactive track appears in the wool. A special method is used to obtain this track: the clipped wool of a sheep is placed on a sensitive film, the film together with the wool is wrapped up in light-proof paper, and left thus for several days. The film, after development shows clear marks of radioactive tracer substances, in this case due to radioactive radiation of the tracer sulphur contained in the albumens of the wool. By measuring the distance between the two radioactive marks we determine the speed of growth of the wool. Many such marks can be made. This makes possible an objective measurement of the acceleration and retardation of the growth of the wool in accordance with the conditions of feeding and the biological state of the animals.

This method can also be used to determine the specific features of the growth of the wool of the foetus, by giving radioactive substances

to the sheep, while with young, and measuring the distances between the marks on the wool of the lambs after birth.

The process of calcification of the egg-shell in hens with a high laying capacity was also studied. With the help of calcium-45 it was shown that the calcium contained in the feed is deposited in the bones, and that only the skeleton serves as the direct source of calcium in the formation of the egg-shell.

In connection with investigation of the Urov endemic disease in the Amur and Chita Regions a study was made of calcium, phosphorus and sulphur metabolism (with the aid of chloride of calcium-45, phosphate, containing tracer phosphorus-32 and sulphate, containing sulphur-35) in the bones of animals in cases of excess of strontium in the fodder. A study of bone-sections established the influence of strontium on the deposition of calcium and phosphorus in the bones, and on the content of phosphorus and sulphur in the epiphyseal and articular cartilage. These researches are helping to establish the causes of the Urov disease and to find methods of combating it.

The method of tracer atoms, a new one in research, has a short history as yet but it has already enabled us to penetrate into the innermost processes of metabolism and to study processes of life hitherto hidden from us. The use of tracer atoms makes it possible to expand and deepen the range of theoretical problems which have to be studied for the solution of practical tasks of the development of animal husbandry.

ANIMAL ORGANISMS BUILD UP PROTEIN FROM BREATHED-IN NITROGEN

IT has been known for a long time that bacteria assimilate nitrogen from the air. At present, we know the mechanism of nitrogen assimilation by the bacterial cell and have a good knowledge of the enzymes involved in the process. As to plants, existing theory holds that they can utilise free atmospheric nitrogen solely due to the activity of soil bacteria and those living on the tubercles of bean plants. In both cases, bacteria combine atmospheric nitrogen into chemical compounds that can be assimilated by plants. There has so far been no indication that plants can assimilate nitrogen directly from the air. The way to absorbing atmospheric nitrogen in animal organisms appeared to be longer still. It was thought that animals could receive it only as part of vegetable food and not, by any means, directly from the air.

Certain experiments which recently have been carried out by Professor Mikhail Valsky, a mechanical engineer, indicate that animal organisms build up protein from nitrogen breathed-in from the air.

Valsky placed eggs in an incubator with an atmosphere in which the nitrogen was replaced by the inert gas argon. Within four days the embryos were dead, while eggs from the same batch kept in an incubator with a normal atmosphere (all other factors being kept equal) developed normally.

In another experiment young chicks were placed in an atmosphere identical with that of the first incubator. Within six hours their wings dropped and twelve hours later they were dead. Their brood-mates, kept under the same conditions, except that they had nitrogen in the air they breathed, developed normally.