Nitrogen For Proteins and Protection Against Disease

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Provisions of our food and feed proteins is a serious problem. Getting meat, milk, eggs, seeds and similar body-building foods has long been a major part of the struggle to feed ourselves. An adequate supply of protein supplements is the problem in feeding our animals. We are not satisfied to nourish ourselves with seed proteins only. We want and need proteins of animal origin too. Not even all the animals can get along on only vegetable proteins as chickens and hogs show. Grains contain protein in their germ, and meat, milk solids and eggs are made up almost wholly of that essential food constituent, yet we have given little or no thought to the supply of nitrogen in the soil required for the plant's fabrication of protein and the solution of the food problem. We have not thought of nitrogen in the soil as necessary for the synthesis of different proteins. Much less have we given proper credit to proteins for the multilateral protection they provide against hunger in the life struggles of microbes, plants, animals and man.

How to accurately measure proteins is still an unsolved problem, even though nitrogen is accepted as synonymous with proteins, the measurement of nitrogen alone has not been a satisfactory gauge of the quantity or quality of a protein. This is suggested by the fact that nitrogen is generally regarded as constituting about 16 percent of protein, since in determining the protein content of a substance we usually multiply its nitrogen content by 6.25. The cereal chemist multiplies the nitrogen by 5.73 because he says that cereal protein has over 17 percent nitrogen.

This indicates that nitrogen is converted into organic compounds of carbon, hydrogen and oxygen to make proteins with different ratios of carbon, for example, to nitrogen. The very components of proteins are therefore highly variable. Gonsequently the process of igniting a substance in sulfuric acid, measuring the nitrogen obtained and multiplying it by a single arithmetical factor like 6.25, is not a very accurate measure of the protein. If it is the nitrogen that is significant in relation to the other constituents of the protein molecule, then surely the total nitrogen, including other than protein forms, handled by a mathematical factor in common usage by a majority of analytical chemists is not an accurate gauge of protein. Measuring this essential part of our foods is still a problem, with much to be learned for our better nutrition and improved health.

How proteins are put together from the elements is another baffling problem. They consist of combinations of smaller units, or amino acids, which, although they are called acids and will react with alkalies, are also reactors with acids. In that sense they are of dual nature as to chemical reaction. Much has been learned about the chemical structure of protein, but how Nature starts with the separate elements, i.e., carbon, hydrogen, oxygen, and nitrogen, and builds an amino acid is still unknown. How sulfur and phosphorus are put into the protein molecule is another unsolved mystery of the creative processes of growth. While we can separate a protein into its amino acids, and can separate them into their chemical elements, this gives no clue to the processes by which they are put together in Nature. We have to depend upon Nature to guide the chemical synthesis of them.

Animals Assemble Proteins

When we speak of animal proteins and vegetable proteins we do not mean to suggest that the animal has built them from the separate elements. Animals only assemble the proteins. They must find the required amino acids for that purpose in the vegetable or plant proteins they consume. Apparently it is their inability to create proteins that makes higher animals dependent on plants and microbes supposedly below them in the evolutionary scale.

Microbes and plants can take the elements, or simple compounds of them, and build them into amino acids. Although in simplest terms it appears that the plant uses air and water, under solar power, to make carbohydrates and then uses nitrogen from the soil or from the air to make amino acids, the process is far more complex. Were it not so, proteins might not be a problem. Instead they should be as plentiful as carbohydrates. All plants are made up mainly of carbohydrates. Microbes and plants are able to synthesize proteins from the elements, but not without a struggle for it is a problem for them too, even to make the simpler proteins by which they live but which alone would not support us or our animals.

Microbes synthesize only limited kinds of amino acids and limited combinations of them as proteins. Some protein products may be very important to us but microbes require more than their component elements for their fabrication. Apparently more is required for protein elaboration by plants than the combination of nitrogen, sulfur and phosphorus from the soil with carbohydrates. Legumes, that are particularly appreciated as synthesizers of protein, require calcium, phosphorus, potassium, magnesium, boron, manganese, copper and other elements from the soil for their growth processes. When we say that these better forage feed crops are "hard to grow", we mean that it is difficult to get these plants to produce proteins. These essential food constituents for us are not readily manufactured. They require not only nitrogen (so commonly deficient) in the soil, but they also require soils fertile in more respects than is commonly recognized.

It is natural to expect, then, that microbes with simpler requirements for growth will produce only the simpler proteins. Plants, which we think of as easy to grow or which are growing on less fertile soil, will also create the simpler proteins, proteins simpler than those created by plants failing to grow on such soils. Shall we not then expect a larger variety of amino acids and a greater total of them, in plants growing on soil better supplied not only in the major nutrient elements, but also in what are commonly thought of as trace elements?

If animals have more complex food requirements, particularly for the amino acids of proteins which they cannot synthesize, it is not difficult to believe that an extensive list of soil fertility elements will be required to synthesize the various kinds of proteins they need. Man doubtless is in the same category as the animals. If the soil, then, fails to provide adequate supplies of the required fertility elements, shall we not look for deficiencies first in the variety of proteins needed by animals, and second in those proteins needed to grow the plants commonly considered as being more nutritious as animal feeds? If so, is it not reasonable to suggest that the output of proteins in terms of the supply of the different amino acids and of the sum total as protein is a direct reflection of the fertility of the soil?

Nitrogen Builds Proteins

If animals are to obtain all of the amino acids they need, they must gather their feeds from many simple sources and many soils, or from a single soil that is highly complex in its content of fertility elements. Complete proteins, therefore, in terms of animal and human nutrition, require a very fertile soil. Conversely, it is not surprising then if a shortage of nitrogen, phosphorus, calcium, boron, manganese or of any other essential nutrient element in the soil should produce crops in which the total protein content though high, might be inadequate in respect of the required amino acids needed by animals or man for good substance and good health.

The production of proteins, in their fullest amounts and variety through plant growth may constitute a complex demand upon the fertility of the soil. Nevertheless, there seem to be no greater values to be had from soil treatments than the contributions they make to the elaboration of proteins in the crop. Traditionally, nitrogen has been used to grow larger crops, but should we not give some consideration to its undoubted association with the protein content in the crop? Nitrogen and proteins are synonymous in the mind of the chemist, but nitrogen put into the soil has not been a guarantee of the fullest amount of protein or of the food quality of the subsequent crop. It has not been related to the complete array of amino acids to provide a balanced protein for animals and man. We may well give attention to the services and functions which proteins render in growing the body, whether that body be microbe, plant, animal, or man. We need to give more attention to proteins for their services in keeping bodies in good health by protecting them against the invading forces of disease.

Carbohydrates build plant bulk, but neither they nor the fats carry the power to grow. Only the proteins can propagate themselves, transmit life, multiply themselves and regenerate new cells by their own division. Life chemistry is carried on by means of the proteins. Some we call enzymes. They give speed to chemical reactions. Some we call hormones. They coordinate our body activities. Some we call viruses, producers of diseases. And some we call antigens that serve to protect us against disease. But all of them are of such chemical composition as to be classified as proteins. "Good healthy growth" in young people, we say can be had only by their consumption of plenty of proteins. Milk is the food commonly used to supply them. Recovery from sickness calls for protein-rich food. Tuberculosis is now arrested, and "cured" by a high-protein diet and rest. Protein in nutrition has come to be protection and guarantor of human good health, but we have not yet been ready to believe that nitrogen in the soil along with other fertility can similarly protect other forms of life like plants themselves. That fertile soils make plants rich in protein by which they protect themselves against fungus diseases and insects is a fact not yet accepted even though we are beginning to accept the idea that protein is protection for mankind.

Increasing the calcium content of a clay-sand medium growing soybeans demonstrated their increasing freedom from an attack by a fungus resembling "damping off". This increase in calcium in the medium was brought about by merely increasing the clay content in the sand. The clay was one of standardized proportions of exchangeable calcium and hydrogen leaving it acid at a pH of 4.4. Merely increasing the acid clay, and thereby the available calcium through root contact with more clay and calcium for larger amounts of this in the crop and for more nodulation and nitrogen fixation in the plants, was the sole difference between complete immunity from fungus attack and the complete destruction of soybean plants.

Protection Against Insects

In another demonstration, more protein in a spinach crop increased its ability to protect itself against the attack of leaf-eating thrips. Here the nitrogen offered per spinach plant was varied through a series of 5, 10, 20 and 40 millequivalents (M.E.). Each of these levels of nitrogen was also combined with a series of 5, 10, 20 and 40 M.E. of calcium, the element commonly associated with the elaboration of nitrogen into the protein compounds synthesized by plants.

While all the plants were equally exposed to the thrips on the weeds growing nearby, the insects attacked only those spinach plants given the lower amounts, namely, 5 and 10 M.E. of nitrogen. Even on these, the attacks were less damaging as the amount of calcium associated with each unit of nitrogen was increased. With replications in which the content of calcium and nitrogen was increased ten times there was a clear cut demonstration that as these two factors, nitrogen and calcium in the soil were increased to favor increased protein synthesis by the spinach plants, there was increased protection to the point of immunity against the insect attack. Here more protein within the plant provided more protection not against "disease" as it is commonly considered but against an invasion of and consumption by insects. Here was the suggestion that nitrogen, calcium, and other chemical fertility elements put into the plant meant not only protection but also higher food values. This constituted a far more effective escape from the insects than could have resulted from complex pesticides which offered no nutritional values to the plants.

Proteins Fight Disease

One may well raise the question whether an increased supply of available nitrogen and of other fertility, including the trace elements, in the soil is protection for crops because of the production of more of any one kind of amino acid and simple protein in the plants or because of the production of a more complete array of the different amino acids making up the proteins. When some trace elements seem to be more effective for animals and perhaps humans in consequence of their intestinal microbial synthesis into compounds; when trace elements in soil seem to come through the corn grain to encourage apparently healthier liver tissues in test rabbits; and when these same elements increase synthesis by alfalfa of the amino acids commonly deficient in corn, it appears to be evident that something more is necessary to provide a complete explanation than an arithmetical formula.

Nitrogen can be synonymous with protein and protein can mean much more in the way or protection against disease —even against insects—when once we understand more completely what a truly fertile soil is.

VICTORY FARM FORUM

SEPTEMBER 1949

Published by Chilean Nitrate Educational Bureau, Inc., 120 Broadway, New York, N. Y., in the interest of American Agriculture.