FS 191
June 1972

Protein in Dairy Nutrition

Prepared by H. P. Adams and D. E. Anderson
Extension Dairy Specialists
Oregon State University, Corvallis

Protein is required by all forms of animal life. It is a major constituent of meat, milk, eggs, enzymes, and some hormones. When dairymen talk about nutrition, protein is the most discussed nutrient because protein is needed in fairly large amounts by the cow and is relatively expensive.

Ideas about protein requirements have changed in the past and probably will change in the future as new knowledge is gained. Thirty years ago many feeders preferred a grain concentrate with 20 to 24 percent protein. Better forage programs, furnishing more protein, allowed dairymen to use low protein grain rations. Many dairymen overevaluated the protein in their forage, however, and underfed protein to their herds. This cost them money.

There are a number of ways of estimating the protein needed in a dairy ration. One way is to calculate the amount needed for maintenance and production from nutrient allowance tables. (See "The Nutrient Requirements of Domestic Animals, No. 3, Nutrient Requirements of Dairy Cattle, 4th ed., 1971, National Academy of Sciences.)

California research workers have reported that a complete dairy ration containing 13 percent crude protein is adequate for high milk production. Table 1 gives some guidelines on grain protein levels needed to adequately balance different forage programs.

Table 1. Level of Crude Protein Needed in the Grain Supplement to Balance Forage Rations

Type of forage	Protein content	Protein required in grain supplement
	Percent	*Percent*
Legume hay or haylage	15 or more	12
Early cut grass-legume mixes	14	14
Grass hay or corn silage legume mixed	10-12	16
All corn silage or late cut grass hay	10 or less	20

The most accurate way to balance your forage program is to submit forage samples for analysis. Use proper methods to get samples that truly represent the feed supply. A commercially available forage sampler will do the job adequately when used according to directions. When you know the protein content of the forage, it is easy to determine the level of protein needed in the grain.

In calculating protein requirement, remember that only a small protein reserve can be stored in the body compared to the amount of energy stored as fat. Therefore, high producing cows in a negative energy balance (losing weight) require extra protein in their diet to balance energy from the stored fat.

Protein Quality

In monogastric animals, protein quality depends on its amino acid balance. Certain essential amino acids must be furnished by the diet, or the animal will not thrive. However, the ruminant is not dependent on its diet for essential amino acids, because the bacteria in the rumen break down dietary protein and make microbial protein. The cow finds her supply of essential amino acids in the microbial protein that she digests. In fact, the rumen bacteria are able to use simple nitrogenous compounds called non-protein nitrogen (urea) to make high quality protein. Since the micro-organisms use non-protein nitrogen or complete proteins to make their characteristic protein, the cow gets the same protein quality whether she is fed urea or soybean oil meal. This does not mean that all protein feeds are equal, as some may furnish more energy or be more palatable than others.

Feeds have often been evaluated on their digestible protein content. This is determined by subtracting the protein in the feces from the protein in the feed. The result, after adjustment for protein loss from digestive secretions, is called digestible protein. While digestible protein is of value in calculating rations for monogastric animals, it can be very misleading in ruminant rations. This is because some very soluble proteins or

This is one of a series of *Fast Sheets* reporting Cooperative Extension work in agriculture and home economics, Lee Kolmer, director. Printed and distributed in furtherance of Acts of Congress of May 8 and June 30, 1914. Oregon State University, Oregon counties, and U. S. Department of Agriculture cooperating.

nitrogen materials may be absorbed from the rumen and then immediately excreted by the kidney. Such a feed would have a very high digestible protein value and yet have little real or metabolic value to the animal.

Because of this, crude protein in a ration or ingredient is more useful than digestible protein in calculating for ruminant rations. The one exception is that when some proteins are heated, they become very insoluble and unavailable to the cow. Hay that has heated in the mow or stack, or silage that has heated excessively, furnish much less protein to the animal than their analysis would indicate. Proteins that are either extremely soluble or insoluble are not used as well as moderately soluble proteins.

Much research has been done comparing a single protein feed, such as soybean oil meal, to a mixture of several protein feeds as a supplement to forage. Simple protein supplements have been equal to complex ones for high milk production, reproduction, and maintenance. However, less palatable ingredients such as urea or malt sprouts can be used more effectively in limited amounts blended with other ingredients.

The value of a protein supplement is influenced by its energy content and palatability. Soybean oil meal is lower in fiber and higher in total digestible nutrients than cottonseed meal, and malt sprouts are used sparingly because they lower palatability.

Non-protein nitrogen has received a great deal of attention since World War II. A non-protein nitrogen source is not a protein, but rumen bacteria can combine it with starch from cereal grains to make protein. Urea and diammonium phosphate are the primary commercial sources of non-protein nitrogen for dairy cattle. Feeding trials have shown that urea at the level of 1 percent of the grain ration or 0.45 percent of the total ration is equal to natural protein sources providing sufficient starch is available. Larger amounts of urea will lower palatability of the ration, and amounts over 1 percent of the total ration may be toxic.

Lately there have been a number of liquid protein supplements on the market, and when they are fed in a measured amount they appear to be equal to dry supplements. Some work indicates that liquid supplements based on urea or ammonia will be most efficiently used if added to corn silage as it is ensiled. Economics will dictate whether you should use a liquid supplement.

Dairymen should not feed large excesses of protein, as it is usually expensive. Over the years, dairymen have associated high dietary protein with mastitis outbreaks. While protein will not cause udder infections, it is possible that high protein will cause acute mastitis when the udder has a previous dormant infection.

Summary

The best practical biological measure of a protein supplement for dairy cows is its crude protein content. Also important are its energy and palatability. Digestible protein can be misleading in ruminant feeds. Non-protein nitrogen sources such as urea apparently have the same value as natural protein when limited to 1 percent of the grain ration. Liquid protein supplements are equal to dry ones and their use should be governed by economics. A complete dairy ration should contain at least 13 percent crude protein. Levels much higher than this are costly and may induce chronic mastitis to become acute. Lower levels will adversely affect milk production and health.