QUALITY EVALUATION OF FEED INGREDIENTS

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Quality is defined as the degree of excellence that a raw material posseses. Good quality feed ingredients are thus excellent in terms of nutrient levels present and availability. Poor quality ingredients are low in nutrient content and may be contaminated, adulterated or contain antinutritional factors or toxic substances that impair the nutrient utilization. The types of feed ingredients are widely diversified; therefore, quality also varies due to many related factors. For example, fish meal though produced by the same manufacturer may have a protein range from 50 to 70 percent with several levels of contaminants and/or adulterants. Therefore, it is important for a feed microscopist to acknowledge the nature of variation in the quality of a feed ingredient.

Variation in Quality of Feed Ingredients

Formula feeds with varying quality ingredients are prone to have a fluctuating nutrient content. The nutritive value of a feed ingredient originating from the same source may exhibit a certain range of variation. This is caused by a number of factors including natural ones and those introduced during processing, handling or storage. The following examples are some of the significant variables.

1. Natural variables.

Among the natural variables, soil mineral content and fertility, geographic location, weather and genetic variety affect the level of protein, fiber and other nutrients in plant products used in animal feeds. Seeds vary less than the vegetative parts of plants. Ingredients derived from animals have the highest variation. Animal protein, particularly fish meal that is not selected for species, size (meal-to-bone ratio), age, protein content or other factors, possess a high variation in nutrient levels from batch to batch. Species differences and fluctuation of various tissues and organs obviously cause a wide variation in protein quality of meat meal. Similarly, fluctuation in the amount of bone tissue present will cause wide variation in phosphorus content. According to the American Association of Feed Control Officials (AAFCO), meat and bone meal should contain a minimum phosphorus level of 4.4 percent. Microscopy is thus invaluable in identification of components of feed ingredients such as particles of meat and bone.

2. Introduced variables.

These sources of variation are introduced, intentionally or unintentionally, at the points of processing, post-process handling and/or storage.

2.1 Processing. Different processing techniques will yield products or by-products of different quality. For example, dehulling and solvent extraction of soybeans will yield a meal with higher crude protein and available lysine and lower crude fiber and fat than meal produced by mechanical pressing. Meat meal tankage produced from wet rendering has a different color, odor and protein content when compared to meat scrap produced by the dry rendering process. Processing variables such as proportion of raw materials (e.g. bone, head and flesh), temperature of heat treatment or drying, microbial modification, hammer milling, steam pressure conditioning prior to pelleting, extrusion or expansion will affect nutrient level and availability. Color, odor, texture and levels of antinutritional factors of ingredients and finished feeds are also affected by processing variation. A good feed microscopist should recognize this variation and choose the right methods of analysis to evaluate ingredient quality.

Adulteration is another important introduced variable at the point of processing. The higher priced and higher quality ingredients are generally adulterated (intentionally contaminated) with cheaper and lower quality ingredients to reduce the cost and nutritive quality to just meet the specification. Adulterants, such as rice hulls, oyster shell, feather meal, leather meal, ground limestone, non-protein nitrogen such as ammonium nitrate and urea, and others, are generally finely ground and not easily identified by low power microscopes. However, chemical tests and in certain cases, high power microscopy can generally detect most of these adulterants. It is necessary therefore to check for adulteration when buying the expensive and fine-particle feed ingredients.

2.2 Post-process handling and storage. Feed ingredients may lose their quality through damage and deterioration due to inappropriate post-process handling and storing. Ingredient damage can occur from overheating in unprotected storage or during shipping. Storing of ingredients that contain excessive moisture may cause increased bacterial or fungal activity. This generates heat which accumulates to cause denaturation of protein, the Maillard or browning reaction, oxidation of fat and other chemical reactions. Feed grains and root products may also be damaged by insect and pest infestation during storage, especially if conditions are warm and moist. Consequently, quality control, handling and storage of feed ingredients are the

most important factors in the manufacture of quality formula feeds. Feed microscopy can be applied at every stage of the manufacturing process; however, the most effective step is at the point of ingredient receipt.

Methods of Quality Evaluation of Feed Ingredients

Feed ingredient quality is best measured by a combination of chemical and physical evaluations. Chemical analysis gives information on the levels and availability of nutrients contained in the ingredients, whereas feed microscopy provides information on sources of nutrients, the presence of contaminants, adulterants and other visible characteristics. To define the quality of an ingredient, the analyst has a choice of many single or multiple test procedures. It is important that the chosen test measures the characteristics accurately without confounding influence from adulterants or contaminants. A true measure of quality must be assured even if it is only relative as compared to established quality standards. Routine analyses of both categories can be outlined as follows.

1. Chemical analysis.

Chemical analyses are conducted to determine the quantities of major nutrients, i.e. moisture, crude protein, crude fat (ether extract), ash (minerals), calcium and phosphorus. Additional information on the content of salt, non-protein nitrogen, amino acids, fatty acids, toxins and others may be occasionally needed and determined. The nutritive quality is then evaluated against established quality standards. However, results obtained by chemical analysis cannot reveal whether a specific nutrient has originated from the ingredient or from a contaminant. Likewise, chemical tests do not give much information on nutrient availability. Therefore, in order to give a more complete quality image of an ingredient, chemical analysis should be used in combination with feed microscopy and other evaluation methods.

2. Feed microscopy.

Feed microscopy evaluates the quality of a feed ingredient by identifying and quantifying the ingredient and foreign materials present. External or surface features are examined by stereomicroscopy and internal or cellular characteristics by compound microscopy. Most feed microscopists use the stereomicroscope for initial identification of the ingredient or contaminants and switch to the compound microscope to confirm these observations. Flotation techniques help separate various particles present and greatly facilitate

microscopic identification of ingredients or adulterants in the evaluated feeds. Subsequent separation and proportioned measurement of each ingredient or contaminant in finished feeds enables the analyst to make a judgement about quality. This information, in combination with results from quick chemical tests for feed additives or drugs, gives a complete quality profile of the feeds. The major advantage of feed microscopy is that it requires less time and expense than chemical analyses. However, a skillful analyst is needed.

3. Spot and quick chemical tests.

By applying qualitative analysis principles, a number of spot and quick chemical tests have been developed for detecting the presence of various chemicals in complete feeds or feed ingredients. Precipitation, color formation, color changes of indicators and/or gas generation by specific chemical reactions are used as the detecting criteria. Spot and quick chemical test kits are now common and have proved to be very useful as they provide rapid answers concerning the presence of drugs or chemical contaminants which are generally finely ground. Examples of these test kits are: urease activity test for adequacy in cooking of soybeans; Nessler test for ammonium ion; and peroxidase test for blood contamination. Information from spot tests adds to those obtained by microscopy enabling the analyst to evaluate the quality of a feed or ingredient more accurately. Spot tests therefore suitably act as a merging point between feed microscopy and analytical chemistry.