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Review Article

FEED QUALITY - A TOOL TO MONITOR ANIMAL NUTRITION

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Introduction

Feed is the single most important element of animal production irrespective of species and production system wholly on economic point of view as it accounts for up to 70% of the total cost. Availability of feed in a sustained manner, of desired type and quantity highly influences the livestock production system. Optimal use of available feed decreases feeding costs and increases economic viability of the livestock operation (Makkar and Beever, 2013). The global demand for livestock products is likely to increase by over 60% by 2060. By 2020 itself, developing countries will be producing roughly half of the milk of the world with India leading the output. Hence livestock sector is under significant pressure to greatly increase the volume of safe and nutritious feed, make them available to the animals in the suitable form so as to produce and provide significantly high quantity of good quality animal products. But, achieving high production is not only sufficient; its compatibility with animal product safety and quality, animal welfare and health, protection of environment and bio diversity are also increasingly demanded. So, nowadays an animal diet may be defined as the one that is balanced in nutrients, free from deleterious components, meets the production objective, generates animal products that are safe for human consumption integrating principles of sustainability (Makkar and Ankers, 2014). Therefore, ensuring the quality of animal feed alone will be able to really assist in achieving these objectives.

Feed Quality Control

Feed quality is defined as "any of the features in the feed that makes it what it is" and "the degree of excellence which the feed possesses." A good quality feed will supply all the nutrients in adequate quantity with high palatability and digestibility. The objective of quality control of feeds is to ensure that a consumer obtains feeds that are unadulterated, true to their nature, provide the intended nutrients, involve less processing and produce desired results in

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animal production. To achieve this control in quality, the feeds have to necessarily undergo various steps of quality evaluation. Feed evaluation is the testing of feed quality, providing information on the composition of feed or feed ingredients as well as their suitability for livestock and poultry. Feed quality can be ensured by knowing the physical nature and the actual composition of the feed both in terms of nutritional and anti nutritional constituents.

Generally feed is made up of many ingredients, which are broadly grouped into providers of energy (fats, oils and carbohydrates), protein (amino acids), vitamins, minerals and products for quality enhancement. Feed ingredients like cereal grains such as maize, wheat, sorghum provide energy; while meals and oilcakes of soybean, groundnut, mustard, linseed, sesame and sunflower and animal byproducts like fishmeal, meat meal provide protein. Byproducts such as wheat bran, rice bran, rice polish, deoiled rice bran, maize gluten, gram husk, broken gram etc. are also used in animal feeds to provide the desired nutrients. In order to know what amounts of these ingredients should be included in the diet during feed formulation, the ingredients are first evaluated, to see what nutrients they contain in what quantities. After the diet has been prepared, it may also be necessary to evaluate the complete product, to determine its suitability for the class of livestock and poultry to which it will be fed. It may also be necessary to conduct random checks on the quality of stored finished feeds for any decrease in nutritional quality. Feed evaluation is a key process that provides different types of information, as required by nutritionists, farmers and traders.

Feed Quality Evaluation

Feed quality evaluation is important because ingredients that belong to the same class contain different nutrients; for example, maize provides more energy than wheat while soybeans contain more proteins than sesame and sunflower seeds. The same ingredient varies in its quality from one supplier to the other, between years and between seasons within a year. Feeding standards have already been set for various classes of livestock and poultry, so the requirements for different nutrients must be met precisely. It is possible, with the current state of knowledge, to predict animal growth, meat yield, egg production by modelling feed quality and duration of feeding. The central key issue in these models is feed quality, which can only be obtained through feed evaluation. Moreover, adulterants, contaminants, toxins should also be taken into account as their presence in feed ingredients render them inferior and harmful, adversely affecting the overall quality of the finished feed. To identify and avoid such low quality feed ingredients, feed quality evaluation is of paramount importance. Hence, it can be termed that feed analysis provides information for i) farmers to optimise

nutrient utilisation in animal feeds, ii) feed compounders to prepare feed mixtures suitable for different animal production systems, iii) researchers to relate animal performance to feed characteristics and iv) plant breeders to optimise the nutritive value of new varieties of feed ingredients.

The direct and indirect benefits of accurate feed evaluation are i) Generation of reliable data on the chemical constituents of feeds; ii) Ensuring more efficient use of available feed resources; iii) Helping the producers to reduce the cost of inputs by identifying least cost rations thereby increasing the profitability; iv) Promoting the use of locally available feed resources, creating employment thereby boosting local economy; v) Helping researchers to develop more cost effective and sustainable feeding strategies and vi) Promoting trade and economic growth not only involving livestock production but also the feed itself both regionally and internationally

Measures of feed quality

Feeds and feed ingredients can be evaluated for quality by physical, sensory evaluation methods in the field as well as in the laboratory adopting chemical methods.

i) Physical evaluation: The physical inspection and sensory evaluation of feed mostly provides preliminary information on the quality of the material and therefore mostly useful to identify gross adulteration. Physical qualities such as weight, colour, smell and contamination by other materials are usually assessed. Good quality feed ingredients can be identified by following few simple field methods as described by Reddy (2011). Cereal grains must be free from dust, stones, extraneous materials, insect infestations and fungal growth. Byproducts must be free from musty or stale odour, lumps, dirt, extraneous material, fungal growth or insect infestations. If a pinch of rice bran is taken and rubbed between fingers and felt coarse and rough, adulteration with rice husk could be easily identified. A good quality rice polish will be soft to touch, free from rancidity and with fine aroma; will show finger impressions on pressing with hand whereas adulterated one crumbles. Oilseeds cakes and meals should retain their original texture, free from rancidity, insect or fungal infestation, musty or other objectionable odours. Animal by products such as fish meal, meat meal should have the characteristic odour and should be free from any off smell, indicative of spoilage; free from contaminants, insect or mite infestation and also free from visible fungal growth.

ii) Chemical evaluation: Chemically, feed is made up of water and dry matter containing organic and inorganic compounds. The organic part is made of mainly carbohydrates, proteins, vitamins, fats and oils. The inorganic part is made of mineral elements, also known

as ash. Feed or feed ingredients can be analysed to provide values of each of these components. The chemical methods include laboratory analysis of moisture, crude protein, crude fibre, ether extract, nitrogen free extract, total ash, acid insoluble ash (sand and silica), starch, salts, free fatty acids, urea, amino acids etc. and antinutritional factors like mycotoxins, insecticide, herbicide, fungicide, phytoestrogens, glucosinolates, saponons, tannins, ricin, sinapine, gossypol, lipoxygenase, trypsin inhibitor etc. Other tests include rancidity test, acid value, peroxide value of fats and oils and protein quality tests like protein solubility, maillard reaction products, pepsin digestibility and amino acid digestibility. Nutritive value is also measured by *in vitro* digestibility studies. Chromatographic, mass spectrometric methods and immune assay are adopted for analysis of plant secondary metabolites.

Among the new analytical techniques, NIRS is more promising and has many advantages over traditional methods of feed analysis (Givens and Deaville, 1999) though it requires high initial investment and time consuming calibrations. The main advantages are i) Non destructive, rapid and on the spot analysis of whole sample ii) Minimal or no sample preparation is necessary, iii) High precision of results, iv) Simultaneous analysis of several parameters and v) High throughput makes it a cheap technique on per sample basis

Quality assurance in feed analysis

Quality assurance of feed involves a multi pronged strategy approach and hence there is a need to establish an effective quality assurance system in feed analysis. Moreover, the feed testing laboratory needs to continually assess its performance against its own standards to strive for improvement. A comprehensive quality assurance programme includes proper and adequate training of the laboratory personnel, maintenance of ingredient specifications and traceability, a laboratory specific quality assurance manual, standard operating procedures, result reporting systems and review processes that will ensure production of safe and high quality feed (Charles Stark and Frank Jones, 2010). Moreover, adoption of these practices and procedures will assist laboratories in acquiring the recognition of competence required for certification or accreditation. In order to achieve valid and consistent data in feed analysis the following steps are necessarily to be taken into consideration.

i) Measurements should be made using properly validated methods or analytical techniques with accuracy, precision, ruggedness, operating range, selectivity

ii) Quality assurance protocols should incorporate certified reference materials (CRM) to ensure traceability of measurements.

iii) The feed testing laboratory should participate in national and international proficiency testing schemes (PTS) which is a means of seeking independent assessment of their performance in particular analytical tests.

iv) The laboratory should get appropriate accreditation or licensing to a recognised quality standard.

Hence, concerted efforts oriented towards achieving excellence in feed quality control will invariably result in the forward development of feed manufacturing industry and also assist in maximum exploitation of production efficiency of farm animals.

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