PROCEEDINGS OF THE NUTRITION SOCIETY

The Three Hundred and Third Scientific Meeting was held in the Biochemistry Department of the University of Liverpool on 24 March 1977

SYMPOSIUM ON 'METHODS FOR EVALUATING FEEDS FOR LARGE FARM ANIMALS'

Introductory remarks: the definition of feeding value

By K. L. BLAXTER, *Rowett Research Institute, Bucksburn, Aberdeen AB2 9SB*

The nutritive value of a diet is a measure of its ability to maintain or promote growth or some other biological activity in an animal, and this Symposium is concerned with the techniques which can be used to make such measures in large farm livestock. Before discussing these techniques, however, it is desirable to examine more closely what is to be measured and the meaning of the terms nutritive value and nutrient content.

The methods we adopt to design diets for animals all involve firstly a tabulation of their nutrient requirements and secondly a tabulation of the nutrient contents of all those feeds which might conceivably be included in their diets. The computation of a diet for a particular animal is then a matter of simple arithmetic; even the adoption of linear programming techniques, which might seem complex, does not negate the associative and distributive laws of the simple arithmetic manipulation involved. Tabulations of requirements are invariably multiple ones which recognize biological variation in nutrient need with age, sex, body-weight, rate of growth and other attribute or circumstance. Tabulations of the nutrient contents of feeds, however, have a singularity; the basic assumption is made that a unique value can be assigned to the concentration of a nutrient in a feed and that this is unaffected by variation in animal requirements, that is by the physiological state of the animal. Furthermore, the units in which nutritive value is expressed are assumed to be additive and non-colligative, that is a unit in one feed is assumed to be precisely the same as that in another feed and when two feeds are mixed it is assumed that there is no interaction such that the value of the mixture is greater than or less than that to be expected from a direct proportionality.

Combinations of tables of requirements and tables of nutrient contents of feeds are termed feeding systems, and one of the greatest difficulties in designing them is in the definition of a nutrient, that is an attribute of a feed which has these characteristics of additivity, proportionality of substitution, and immunity to variation in the physiological state of the animal to which it might be given. Some examples can be given to illustrate these three difficulties.

https://doi.org/10.1079/PNS19770029 Published online by Cambridge University Press

Firstly, analytical determinations of the total lysine contents of feeding-stuffs given to simple-stomached species are not an adequate expression of their ability to supply lysine because, as judged by animal responses, lysine in cereals is not equivalent to lysine in fish meals. Available lysine is obviously a more satisfactory measure since it distinguishes that component of the total lysine which is biologically effective. Total lysine itself is not an additive entity. By contrast analytical determination of sodium contents of feeds is an excellent measure of their ability to replace one another, since there is at present no evidence that Na in one feed has any different effect than Na in another.

Secondly, in simple-stomached species the total protein content of a feed is not a good measure of its ability to meet protein needs, since as judged by animal responses mixtures of some feeds are better than might be supposed from their value as sole sources of protein. The classic example of this non-proportional substitution is the supplementary value of milk and cereal proteins. Examples in ruminants are the effects of additional starch in some diets on fibre digestion; changes take place in ruminal fermentation which are not always proportional to the amount of starch added.

Thirdly, there is much evidence that in ruminant animals the relative value of feeds as energy sources depends on the type of production of the animal to which they are given. There is less variation from feed to feed when lactational performance is the criterion of response than when fattening and growth is considered. Such relationships either predicate classification of feeds as energy sources for different purposes, or alternatively an approach which allows for variation with the type of production such as that included in the ARC (1965) feeding system for energy.

These examples show that the ultimate test of the validity of any measure of the value of a feed as a source of nutrient is a biological one. They also imply that it is often difficult, because of associative effects or because nutritive value varies with the physiological status of the animal, to achieve an ideal solution. Some tautology is involved. Nutrient requirements are defined in terms of nutrients supplied by feed; feed values are defined by their ability to provide nutrients to meet requirements.

Currently nutrients have been defined in a variety of ways. Some are expressed as amounts of a substance in feed assuming the substance is equally available in all feeds. The best example is that of Na, although many mineral nutrients are expressed similarly thus ignoring differences between sources in their availability. Other nutrients are defined in such a way that they take cognisance of possible differences between feeds in the ways in which the nutrient is digested or metabolized. Examples are apparently digested nutrients, available nutrients and metabolizable energy. Still others define nutrient content in terms of the final biological response. The best example of this is the net energy system which assigns to individual feeds an intrinsic capacity to support energy deposition in the body as in the DDR net energy system (1970) or to secrete energy yielding substances in milk as in the American net energy (lactation) system (NRC, 1971).

https://doi.org/10.1079/PNS19770029 Published online by Cambridge University Press

This wide divergence of approach illustrates the difficulties of finding measures of feed value which have the attributes of additivity, proportionality of substitution and universality of application within a species of animal.

Generally, however, evaluation of feeds in terms of the nutrients estimated to have been absorbed from the gut appears to be the most useful approach, and most of the discussion today will deal with measurements of apparent absorption, true absorption and incremental retention of nutrients as indices of nutritive worth.

REFERENCES

ARC (1965). *Nutrient Requirements of Farm Livestock.* no. 2: ***Ruminants.*** London: ARC.
DDR (1970). *Das DDR Futterungbewertungs-system.* Berlin: Dtsch. Landw.
NRC (1971). *Nutrient requirements of Dairy Cattle.* 4th Edn. Washington: National Academy of Sciences.

Printed in Great Britain

https://doi.org/10.1079/PNS19770029 Published online by Cambridge University Press