ABSTRACT Research by Ian Sibbald resulted in the development of a practical method of measuring the TME content of feed ingredients. The method was expanded to include measuring the true digestibility of several nutrients, most importantly amino acids.

Key words: true metabolizable energy, feed ingredient, Ian Sibbald, rooster

INTRODUCTION

Ian Sibbald devoted much of his professional career to the study of the nutrient content of feed ingredients. His PhD research at the University of Alberta (Edmonton, Alberta, Canada) concerned the relationships between dietary energy, food intake, nitrogen balance, and carcass composition of rats. As an assistant professor at Ontario Agricultural College (subsequently Guelph University, Guelph, Ontario, Canada), Sibbald worked with Stanley J. Slinger evaluating the ME content of feed ingredients and the methodology of measuring ME with chickens. This was at a time when Fred Hill at Cornell University (Ithaca, NY) and Larry Potter at Virginia Tech (Blacksburg) were also actively evaluating the measurement of ME.

Following a 9.5-yr detour to a commercial job, where he worked primarily with ruminants but latterly with human food, Sibbald secured a position at the Animal Research Centre, Agriculture Canada, Ottawa, Ontario. At the Animal Research Centre, Sibbald had the freedom to devote his full effort to the study of the measurement of the ME value of feed ingredients.

Before the development of the TME method, the standard procedure for measuring the energy value of feed ingredients was the AME method. The AME determination required about 3 wk to complete. The assay was based on ad libitum feed intake and therefore required that the test ingredient be reasonably palatable. From the results obtained, it was clear that the AME values were influenced by many variables including species, strain, age, and level of feed intake.

Level of feed intake was perhaps the most important variable. The AME values are apparent because they fail to take account of the energy losses associated with metabolic fecal energy and endogenous urinary energy. At low levels of test ingredient intake, the energy voided as metabolic and endogenous energy becomes a large and significant portion of the total energy excreted.

The energy values obtained for various ingredients must be additive to be useful to the commercial nutritionist. In many cases, AME values were found not to be additive.

THE TME METHOD

Sibbald felt there had to be a better way.

True ME is AME corrected for the losses associated with metabolic fecal energy and endogenous urinary energy. Theoretically, TME values would be independent of test ingredient intake and would be additive. The concept of TME had been explored theoretically but there was no realistic bioassay for the measurement of TME. Guillaume and Summers (1970) anticipated the importance of TME values in a paper reporting on the effect of plane of nutrition on the measurement of ME. They calculated a TME value based on the regression of energy excretion on several levels of ingredient intake.

Sibbald determined the fundamentals of the TME method would be:

• It should be rapid and economical (reduce the time required from a few weeks to a few days).
• The analytical methods should be simple and reproducible (a scale and adiabatic bomb calorimeter).
A series of assays were developed and tested between 1974 and 1989. In 1976, the landmark paper was published summarizing the results of 12 experiments (Sibbald, 1976). This first description of the TME bioassay was:

1. Adult roosters housed in individual cages, with free access to water, are starved for about 21 hours.
2. A bird is selected, weighed, and force fed an accurately weighed amount (20 to 25 g) of the feedingstuff under investigation.
3. The bird is returned to its cage, a plastic tray is placed under the cage and the time is recorded.
4. A bird of similar BW is selected and returned to its cage without feeding, a plastic tray is placed under the cage and the time is recorded.
5. Steps 2, 3 and 4 are repeated to provide the desired number of replications.
6. Exactly 24 h after placement, the plastic trays are removed, the excreta is collected quantitatively, frozen, freeze-dried, allowed to come to equilibrium with atmospheric moisture, and weighed.
7. Samples of the feedingstuff and excreta are ground to pass through a 20-mesh sieve and assayed for gross energy.
8. TME (kcal/g air dry) = (GEf × X) – (Yef − Yec)/X, where GEf is the gross energy of the feedingstuff (kcal/g); Yef is the energy voided as excreta by the fed bird; Yec is the energy excreted by the unfed bird; and X is the weight of the feedingstuff (g).

It would seem unlikely that even a gifted researcher could achieve this level of detail in a new method, seemingly in a single bound. However, Sibbald had been studying methods for measuring the nutrient content of feed ingredients for many years. The pieces had finally fallen in place to make a major improvement on the AME method, which was then the standard method of measuring bioavailable energy.

Following the landmark publication in 1976, several experiments were conducted that resulted in incremental improvements to the basic TME assay. In 1981, the Animal Research Centre published Technical Bulletin No. 3: Bioassays Based on Precision Feeding of Poultry. A revised version was published as Contribution 1983-20E of the Research Branch of Agriculture Canada: The TME System of Feed Evaluation. Approximately 1,200 copies were distributed in less than 2 yr.

Technical Bulletin 1986-4E, an update of the 1983 bulletin, was subsequently published: The TME System of Feed Evaluation: Methodology, Feed Composition Data and Bibliography. The 1986 bulletin included a detailed description of the bioassay procedures (including equipment design and specifications). There were also feedingstuff composition tables showing nitrogen, fat, fiber, mineral, TME, TME\textsubscript{n} and total, true available, and bioavailability for 16 amino acids. All of these values were reported for approximately 470 individual samples of ingredients. There were many values for each of the most important ingredients to show the variation that could be encountered in these ingredients. In 1986, this bulletin may have been the only significant collection of TME, TME\textsubscript{n}, and true available amino acid values in existence. It was certainly the largest.

There was also a bibliography of 561 literature citations (185 were published in Poultry Science; Sibbald was the senior author of 55). The year of publication, 1986, was also the centennial of the Research Branch, Agriculture Canada.

For a detailed understanding of AME, TME, AME\textsubscript{n}, and TME\textsubscript{n} please refer to Wolynetz and Sibbald (1984).

THE COMMERCIAL IMPORTANCE OF THE TME METHOD

The development of the TME method made an enormous contribution to commercial feed formulation. Commercial feed formulation is the science-art of combining feed ingredients to provide the minimum nutrient requirement for optimal performance at minimum cost. With better information for the nutrient content of the ingredients, diets could be formulated that minimized the excess nutrients thus reducing cost while improving the consistency of performance. The TME method provided nutrient values that were closer to the actual biological value for the chicken than had previously been achieved. For ingredients that were low in palatability (meat and bone meal, corn gluten meal), the nutrient values were a major improvement. True ME was the only way to measure the nutrient value of some ingredients (blood meal). The method was also relatively rapid (a few days vs. a few weeks) and inexpensive.

For the first time, commercial companies had a method that allowed them to measure the available nutrient content of ingredients from several suppliers quickly enough that they could actually use the data. A current example is dried distillers grains with solubles, an ingredient that is growing rapidly in volume but can vary widely from supplier to supplier.

Professor V. (Ravi) Ravindran, director of education-postgraduate research, Institute of Food, Nutrition and Human Health, Massey University, Palmerston North, New Zealand, recently stated (personal communica-
tion): “Dr Sibbald’s classic research on energy and amino acid evaluations during the 70’s and 80’s has led to significant improvements in the nutrition of poultry, resulting in hundreds of millions (if not billions) of savings to the industry world-wide.”

TECHNICAL PRESENTATIONS

Sibbald was invited to 20 to 25 countries (including Kenya, Indonesia, Australia, Singapore, Israel, France, Germany, Scotland) to make technical presentations and conduct demonstrations of the TME method, spending as long as 3 wk in some countries. Sibbald was invited to present papers on the TME method at numerous nutrition conferences.

A 6-min, 16-mm, color, sound film entitled “Poultry Force Feeding – An Experimental Technique” was available from the Communications Branch, Agriculture Canada.

TME-AVAILABLE AMINO ACID LABORATORIES

The acute interest in ME and digestible amino acid values of feed ingredients spawned the development of many laboratories to measure these values: Hobe Halloran (Halloran Research Farm, Modesto, CA), Keith Rinehart (Perdue Farms Inc., Salisbury, MD), David Snetsinger (Ralston Purina, St. Louis, MO), Henry Likuske (Canada Packers, Toronto, Ontario), Lloyd Campbell (University of Winnipeg, Winnipeg, Manitoba, Canada), Marcelo Schang (Instituto Nacional de Tecnologia Agropecuaria, Pergamino, Argentina), Jim McNab (AFRC Institute of Grassland and Animal Production, Roslin, Midlothian, UK), Jeff Firman (University of Missouri), Arturo Garcia (Cargill, Elk River, MN), William A. Dudley-Cash and Sun Kim (Foster Poultry Farms, Livingston, CA), Todd Applegate (Purdue University, West Lafayette, IN), and Martin Nyachoti (University of Manitoba, Winnipeg, Manitoba, Canada). The most active laboratories currently are Carl Parsons (University of Illinois, Urbana); Nicolas Dale and Amy Batal (University of Georgia, Athens); Paul Tillman and Rob Shirley (Ajinomoto Heartland LLC, Eddyville, IA); Evonik Degussa Corporation, Essen, Germany; Pierre-Andre Geraert (Adisseo, Commentry, France); and V. Ravindran (Massey University).

Many of these laboratories use procedures that are highly modified from the method that was reported in 1976. However, all owe their ancestry to the original Sibbald method. Dale recently stated that they are busier than ever. With the high cost of feed ingredients, everyone wants more information about the nutrient content of the ingredients they are using.

HONORS AND AWARDS

Sibbald received at least 4 awards that were recognition of his research on the TME method, including the 1979 American Feed Manufacturers Award of the Poultry Science Association.

In 1986, Current Contents named “A bioassay for true metabolizable energy in feedingstuffs” (Sibbald, 1976) a citation classic. This paper, cited over 185 times, is among the most cited in Poultry Science.

BIOGRAPHICAL INFORMATION

Sibbald married Shirley Jones in 1955. They have 4 children. Sibbald has been retired for 19 yr and enjoys crop art (pictures made with seeds), gardening, reading, poor-quality golf, and traveling.

REFERENCES

