True Metabolizable Energy Of Sprouted Wheat

G. R. Wehner, R. L. Harrold and M. Wanapat

Five trials were conducted each involving six pairs of Single Comb White Leghorn (SCWL) roosters. The objective was to evaluate the true metabolic energy (TME) of field sprouted hard red spring and durum wheat samples. Hard red wheat of 20% sprout damage was not significantly different from the reported TME value of a sample of hard red spring wheat evaluated by Sibbald (1977), but as % sprout increased to 42 or 62%, the TME decreased significantly.

A 40% sprout damaged durum wheat sample had a significantly lower TME than a sample of durum wheat tested by Sibbald (1977).

The total digestible nutrient (TDN) system was an early attempt to summarize the digestion of energy. TDN consists of individual analysis of each nutrient fraction in the feed and feces (i.e., protein, lipid, fiber, etc.) with fat multiplied by 2.25 to compensate for the higher energy content. This system was tedious and cumbersome and is not specific for energy as it is measured in pounds or per cent rather than calories. Alternate systems have been developed to give more accurate and reliable results and to provide a system measured in calories. One such method is the digestive energy system (DE).

Digestible energy is measured in calories and is the difference between the energy of the feed consumed and the energy content of the resulting feces. The energy not accounted for in the feces is considered to have been digested, hence, digestible energy.

DE = Energy of feed - energy of feces

A further refinement of the DE system included a correction for urinary and gas energy losses. When this correction factor is added to the energy loss of the feces, a metabolizable energy (ME) value is obtained.

ME = DE - (urinary + gas energy)

In poultry, gas losses are approximately zero and the feces and urine are excreted as a mixture. Since the fecal and urinary energy cannot naturally be partitioned in birds, ME is determined instead of DE. (DE can only be determined in poultry if the birds are surgically modified to prevent mixing urine and feces prior to excretion.)

Prior to the development of Sibbald's True Metabolizable Energy (TME) system (8), bioassays for energy in poultry yielded apparent metabolizable energy (AME) values that assumed fecal energy resulted directly from the feed. These values were "apparent" because they failed to take into account the metabolic fecal energy (FE_m) which consists of unabsorbed feed residues plus metabolic products such as bile, digestive juices and cells from the lining of the digestive tract. Prior assays also failed to evaluate endogenous urinary energy (UE_e) made up of some compounds obtained directly from the feed plus the products of tissue breakdown which occurs during body maintenance. An important feature of the Sibbald TME scheme is that the FE_m and UE_e values are obtained through the use of paired birds. One bird of the pair is fed while the other is fasted for an equal period of time, which allows the calculation of $FE_m + UE_e$ from the excreta. The fecal material of the fasted bird represents the energy normally excreted by the bird's body. The AME system results in useful data but is not as accurate because of the variations due to species (1), (3), (10), strains (4), (6), (10), and (5), (11), and most importantly, level of feed intake (7) are not taken into account. The TME values are not affected by the potential shortcomings of the AME system and also are less variable. When the metabolizable energy is corrected for metabolic fecal energy (FE_e) and endogenous urinary energy (UE_e) the true metabolic energy value is obtained.

AME = Feed energy - excreta energy

TME = Feed energy - [excreta energy - ($FE_m + UE_e$)]

Although the correction factor of FE_m plus UE_e is small, it removes much of the variation connected with the AME values.

The wheat harvest of 1977 was delayed due to wet, humid conditions. As a result of these conditions, large quantities of wheat were sprout-damaged to various degrees while still in the field. Producers were questioning the feed value of these grains, therefore these trials were initiated.

Roosters were selected as the experimental animal because of the small amount of sample required for evaluation and because of the potential of the TME method of energy determination.

G. R. Wehner and M. Wanapat are graduate students, Harrold is associate professor, Department of Animal Science.

Three samples of sprouted hard red spring and one sample of sprouted durum wheat were obtained from producers in North Dakota and were evaluated for metabolizable energy using the TME scheme.

PROCEDURE

Five trials were conducted involving one wheat sample per trial. The Single Comb White Leghorn roosters were housed in individual cages with collection pans placed beneath. A blower unit was used to keep a light stream of air flowing continuously over the collection pans in an attempt to reduce scale and feather contamination.

The wheat samples were finely ground to pass through a 20 mesh screen of a Wiley mill. Each sample was then pelleted by manual methods to a diameter of approximately 0.5 cm.

The roosters were paired by weight prior to the start of each trial. The birds were fasted for 24 hours (after pairing) to empty the alimentary tract. One bird of each pair was randomly selected to be force fed 40 grams (g) of dry pellets via a 1.0 cm diameter glass tube inserted into the crop. The other bird of the pair was fasted an additional 24 hours to obtain the endogenous energy values $(FE_m + UE_e)$. Total excreta was collected for exactly 24 hours after feeding and was freeze dried. After allowing the freeze dried sample to equilibrate to atmospheric moisture, gross (total) energy values of the samples were obtained by bomb calorimetry techniques. Gross energy values were obtained for the ground wheat samples to permit calculation of energy digested (retained) by the roosters.

An alternative method of feeding, referred to as the slurry method, was developed to alleviate the potentially stressful condition due to force feeding dry pellets. The slurry consisted of 20 grams of very finely ground sample in 55 cc of water delivered by syringe into the crop via a 1.0 cm diameter glass tube. Comparison of the dry pellet and slurry feeding methods was conducted on one wheat sample to investigate differences, if any, in the TME values due to this new method of feeding.

RESULTS AND DISCUSSION

A consistant decrease in bushel weight with increasing per cent sprout was observed in the preliminary comparison of the wheat samples (table 1). The difference in bushel weight between standard (0.0% sprout) and 20% sprouted hard red spring wheat was not markedly different. Appreciable differences in bushel weight between "standard" and 48% or 62% sprouted hard red spring wheat were observed.

However, no marked difference in bushel weight occurred between the samples of standard (0.0% sprout) and 40% sprouted durum wheat.

The trend of decreased bushel weight with increasing per cent sprout damage was comparable to the effect of increased sprout damage upon the TME values of hard red spring wheat (table 2). The TME of 20% sprouted wheat was not markedly different than samples reported by Sibbald (9). Production date (2) concerning average daily gain and feed efficiency of Leghorn cockerels indicated similar results as these investigators found no difference between slightly sprouted and non-sprouted wheat. As per cent sprout increased, TME values decreased markedly. Unlike the bushel weight trend, there was a significant difference in TME between 48% and 62% sprouted HRS wheat, which would be anticipated. Sprouting had mobilized available carbohydrates required to provide energy for plant growth, thereby reducing the amount of energy available to the bird (or animal). There was a marked difference between the 40% sprouted durum wheat and samples reported by Sibbald (9).

Decreases in coefficients of digestion followed TME and bushel weight trends, decreasing as per cent sprout increased.

Within samples evaluated, 20% sprout-damage of HRS had no effect upon the energy (TME) available to adult

Table 2. TME Values and Coefficients of Digestion of Wheat Samples[1]

Sample % Sprout		✳TME	Coeff. of Dig.[2]
HRS A (dry)	20%	4.12 Kcal/gram$_a$	90.7%
HRS B (dry)	48%	3.05$_b$	72.3%
HRS B (slurry)	48%	2.93$_b$	71.5%
HRS C (dry)	62%	3.56$_c$	76.4%
Durum D (dry)	40%	3.95$_d$	86.8%
HRS	0.0%	3.86 Kcal/gram$_a$[3]	---
Durum	0.0%	4.01$_d$[3]	---

[a,b,c]Values with different subscripts are statistically significantly different (P<.05, t-test).

[d]Values with the same subscript are not statistically significantly different (P<.05, t-test).

[1]Average of 12 observations.

[2]Coefficient of digestion for TME.

[3]Values reported by Sibbald (9).

Table 1. Per Cent Sprout and Bushel Weight of Wheat Samples

Type of Wheat	Sample	% Sprout	Bushel Weight[1]
Hard red spring (HRS)	A	20.0[2]	58.6 lbs.[2]
Hard red spring (HRS)	B	48.0[2]	52.2 lbs.[2]
Hard red spring (HRS)	C	62.0[2]	51.7 lbs.[2]
Durum	D	40.0[2]	56.7 lbs.[2]

[1]"Standard" bushel weight of hard red spring and durum wheats is 60 lb. per bushel.

[2]USDA grain grades (1978). All grains were of sample grade.

roosters. It appears that detrimental effects on TME occur somewhere between 20 and 48% (or 40%) sprout-damage with both HRS and durum samples investigated

Several factors must be considered in attempting to translate the data presented here (as TME values) to commercial livestock production. It must be realized that the species of livestock fed will partially govern results. Cattle, pigs and poultry differ in the ability to utilize energy sources.

An important consideration in the feeding of sprouted wheats is the age of the animal. Young chicks, pigs or calves may suffer energy deficiencies if sprouted wheat is substituted on a pound-for-pound basis for non-sprouted grain. Young animals may not be able to consume enough of the ration to satisfy their energy requirements. This is especially true when relatively high roughage diets are being fed to young calves or lambs, since the added bulk further restricts feed intake. Adult animals consuming sprouted wheat in the grain portion of the ration may have the opportunity to consume more feed and thus overcome the energy deficiency since their energy requirements are lower than younger animals. High bulk (% roughage) rations will limit this compensation to some degree. Decreasing the amount of roughage in the ration would allow adult animals to consume more energy and compensate for the decreased energy of the ration.

Bushel weights may be used to estimate energy losses due to sprout-damage. From the data, sprouted wheat samples exhibiting bushel weights lower than approximately 56.0 lbs. might be expected to yield lower energy values. These samples should be expected to be of lower energy value for feeding purposes.

One aspect of the feeding of field sprouted grains that must be mentioned is the fact that molds and fungal infestations are more likely with sprouted grains. Care must be taken to avoid feeding moldy wheat to livestock to prevent mycotoxin poisoning.

Another parameter evaluated was the effect of type of force feeding on TME values. A nonsignificant difference was observed between 48% sprout-damaged HRS fed as dry pellets or administered as a slurry. These results are of value in that the stress placed on the bird at time of force feeding was alleviated. The time involved in feeding was also decreased by approximately 40%. Another benefit of the slurry method is that one researcher is able to feed the sample rather than two people as was necessary for the dry

pellets. The resulting reduction in the labor requirement is a desireable attribute for the slurry method.

The data presented in this report have stimulated interest in further research concerning TME methodology. Methodology under investigation include alternative methods of sample preparation and alternative feeding methods to determine effects upon TME values.

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