

DETERMINATION OF THE TRUE METABOLIZABLE ENERGY (TME) OF RAW AND HEAT-TREATED *Mucuna cochinchinensis* USING ADULT BROILERS

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Target Audience: Animal nutritionists, feedmillers, poultry farmers.

ABSTRACT

An experiment was conducted to determine the biologically available energy of *Mucuna cochinchinensis* seeds in term of true metabolizable energy using adult broilers. The seeds were subjected to three heat processing methods of boiling at 105°C for 90 minutes, toasting at temperature that fluctuated between 105°C and 110°C for 60 minutes, and pre-soaking for 12 hours followed by boiling for 60 minutes. A fourth lot was left raw. Each of the samples was ground, made into slurry and force-fed to adult broilers that have been starved for 24 hours. Six broilers paired into three by weight were used for each sample. Each pair consisted of fed and unfed birds, which were left in individual cages with clean plastic trays underneath for 24 hours. After this, the droppings were collected quantitatively, dried, and combusted in bomb calorimeter. The three sample subjected to heat processing methods yielded true metabolizable energy (TME) values that were similar but significantly ($P < 0.05$) higher than the true metabolizable energy of the raw stock. The TME values of the samples were raw (1.05 Kcal), toasted (3.00Kcal), soaked-and-boiled (3.19 Kcal), and boiled (3.22 Kcal). These represent 22.83% and average of 70.32 % for the raw and heat-treated samples, respectively. The results show that heat treatment can be used as means of processing *Mucuna cochinchinensis* in order to improve its bioavailable energy.

Key words: *Mucuna cochinchinensis*, true metabolizable energy, heat treatments, alternative feedstuff

DESCRIPTION OF PROBLEM

Feed is the largest input cost in animal production and for many years accounted for 70-75 % of poultry production cost (1). Currently feed probably accounts for 55-60 % of poultry production costs, the reduction being associated with high interest rates and increased fuel costs. The biologically available energy component of feed is about 70 % of the cost. Consequently, biologically available energy accounts for approximately 40 % of the farm gate cost of poultry products. Reduction of bioavailable energy input costs, through the use of more accurate bioavailable energy values to estimate

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requirements and to formulate rations, offers the greatest potential for increasing production efficiency. In addition, improved diet formulation will increase the efficiency with which other nutrients are utilized, thereby leading to further cost reduction.

Mucuna cochinchinensis is presently a cheap and readily available feedstuff that could contribute both energy and protein to feed. Knowledge of its bioavailable energy will be important to assess its nutritive potential. Since it is still cheap, it will contribute low cost biologically available energy (and other nutrients) and thus reduce the cost of production of feeds.

The B-vitamins, which function as general metabolic catalysts, are needed in direct proportion to the total energy metabolism, or in direct proportion to the total calorie food intake (2). Kleiber (3) concluded that a ration is deficient in any food constituent whose addition increases the total efficiency to energy utilization. These statements imply that biologically available energy should be the baseline for establishing nutrient requirements.

A relationship between voluntary feed intake and dietary biologically available energy led Wardkentin *et al.* (4) to suggest that rats "eat for calories". Subsequently, Peterson *et al.* (5) showed that chicks attempt to eat to satisfy their energy requirements but are unsuccessful at low dietary concentrations (6, 7). Further demonstration of the relationship between feed consumption and energy intake was provided by Powell *et al.* (8) who showed that the feed intakes of hens decreased when a sucrose solution replaced the drinking water. The inverse relationship between feed intake and dietary biologically available energy concentration led Crampton (9) to suggest that energy be used as the common denominator in feed formulation.

These underscore determination of bioavailable energy of feedstuff as an important step in its evaluation as a potential feedstuff. Therefore, this work aims at determining the true metabolizable energy of *Mucuna cochinchinensis* seeds as a preliminary step towards its biological evaluation as a potential feedstuff.

MATERIALS AND METHODS

Processing of seeds

Seeds were bought from markets in Nsukka area of Enugu State and Igala area of Kogi State. They were divided into four lots, three of which were subjected to three locally adaptable processing methods in accordance with the recommendation of Ukachukwu and Obioha, (10). The processing methods were boiling, boiling with presoaking, and toasting. The fourth lot was left raw.

Laboratory analysis

The four feedstuff samples and resulting excreta from experimental birds were analysed for gross energy by employing the Parr Adiabatic Oxygen Bomb Calorimetry Technique.

Data Analysis

Generated data were tested for significance by the analysis of variance

(ANOVA) and where necessary, means were separated by the Duncan's multiple range test (11).

Experimental procedure

Details of the Sibbald (12) methods as modified by Wehner and Harrold (13) on feeding technique and Sibbald (14) on period of Starvation was used. Details of the procedure are given below.

Twenty-four adult broiler birds housed in individual cages with free access to water were starved for 24hr and placed in cages over clean trays. The birds were individually weighed, and there were three replicates per treatment. Birds were paired by weight and randomly assigned to fed or fasted treatments. The fasted birds served as the control. Each fed bird was force fed 25g of the feedstuff. The feedstuff was made into slurry by mixing 25g of very finely ground sample with water of about 5 times the volume of sample. The force-feeding was by means of a glass funnel with a rubber tube attachment. The tube was gently inserted into the crop via the oesophagus by rotatory movement. The slurry was poured into the funnel and worked down to the crop with the aid of a glass rod. The tube was withdrawn by reverse rotatory movement. After force-feeding, the birds were returned to their cages and the time recorded. Throughout the experiment all birds had free access to fresh water. Exactly 24hr after placement, the trays were removed. The excreta which accumulated on each tray during each 24hr period was collected quantitatively, oven dried at 60°C according to the recommendation of Sibbald (15), allowed to come to equilibrium with atmospheric moisture and weighed. Samples of the feedstuff and excreta are ground to pass through a 20 mesh sieve and stored in air-tight bottles for gross energy assays.

Equation for calculating the true metabolizable energy (TME) was as given by Sibbald (12).

$$\text{TME (kcal/g airdry)} = (\text{GE}_f \times \lambda) - \frac{(\text{Y}_{ef} - \text{Y}_{uf})}{\lambda}$$

Where

| | | |
|-----------------|---|--|
| GE _f | = | gross energy of the feedstuff (kcal/g) |
| Y _{ef} | = | energy voided as excreta by fed birds |
| Y _{uf} | = | energy voided as excreta unfed birds |
| λ | = | weight of feed stuffs fed (g) |

RESULTS AND DISCUSSION

The resulting true metabolizable energy (TME) values of the different treatments are summarized in Table 1. The mean TME values ranged between 1.05 and 3.22 Kcal/g sample. The boiled and soaked-and-boiled samples had the highest TME values while the lowest TME value was recorded for the raw sample. Ologhobo and Fetuga (16) had assessed the effect of processing on the energy values of limabean and they reported that processing

Table 1: Effect of Processing Methods on the True Metabolizable Energy (TME) of *Mucuna cochinchinensis* (Kcal/g)

| Treatments | GE | TME | TME as percent of GE |
|-------------------|--------------------|-------------------|----------------------|
| Raw | 4.60 ^a | 1.05 ^b | 22.83 |
| Toasted | 4.31 ^c | 3.00 ^a | 69.61 |
| Soaked-and-boiled | 4.53 ^b | 3.19 ^a | 70.42 |
| Boiled | 4.54 ^b | 3.22 ^a | 70.93 |
| SEM | 0.018 [*] | 0.13 [*] | * |

Means on the same column not followed by the same superscripts are statistically different from each other at ** ($P < 0.01$).

GE = Gross energy Kcal/g = Kilocalories per gramme

SEM = Standard error of means.

significantly ($P < 0.01$) influenced metabolizable energy (ME). Thus, the low mean TME value of 1.05 kcal/g for the raw beans could be as a result of anti-nutritional factors inhibiting the expression of the nutrients in the raw beans.

The mean TME values for boiled (3.22 Kcal/g), soaked-and-boiled (3.19 Kcal/g) and toasted (3.00 Kcal/g) beans are similar but significantly higher than the TME value of the raw beans. Kakade and Evans (17) had reported that the trypsin inhibitors of many legumes comprise up to 30-40% cysteine. They argued that if these legumes are properly processed to remove the toxic effect the trypsin inhibitor content could contribute significantly to the sulphur amino acids yield of the seeds. Metabolization of these amino acids would yield more energy. It therefore could be that the higher TME values of the boiled, soaked-and-boiled and toasted *Mucuna cochinchinensis* seeds were due to the processing treatments.

Ukachukwu and Obioha (10) had reported improvement in the nutritional value of *M. cochinchinensis* beans subjected to boiling, soaked-and-boiled and toasting as processing methods. They observed that the three processing methods significantly improved the nutritive value of the beans in terms of their proximate components (Table 2) and anti-nutritional factor constituents (Table 3). The improved chemical composition would definitely mean more available nutrients which when metabolized will yield more energy. They particularly reported that the processing methods significantly decreased the crude fibre content of the beans. This would affect the TME yield in two ways. Firstly, crude fibre is generally a less digestible nutrient component. Secondly, its presence in a feed or feedstuff would reduce the digestibility of other nutrients. On the other hand, reduced concentration of crude fibre in a feed or feedstuff will enhance utilization of other nutrients in the feed or feedstuff. So the reduced crude fibre caused by the processing methods employed by Ukachukwu and Obioha (10) would have meant yield of more biologically available energy.

Table 2:* Chemical Composition of *Mucuna cochinchinensis* as by various durations of different thermal treatments

| Nutrient Components | Treatments | | | | SEM |
|---------------------|--------------------|--------------------|--------------------|-----------------------------------|----------|
| | Raw | Boiling (90min) | Toasting (60min) | Boiling (presoaked, 12hr) (60min) | |
| CP,% | 30.06 ^a | 31.82 ^b | 31.95 ^a | 31.96 ^a | 0.018 ** |
| CF,% | 9.04 ^a | 7.57 ^c | 7.65 ^b | 7.60 ^b | 0.018 * |
| EE,% | 4.52 ^a | 3.93 ^c | 4.40 ^b | 3.97 ^c | 0.013 ** |
| Ash,% | 4.52 ^b | 3.93 ^c | 4.80 ^a | 3.91 ^c | 0.026 ** |
| NFE,% | 51.86 ^b | 52.69 ^a | 51.20 ^b | 52.56 ^a | 0.052 ** |
| GE,Kcal/g | 4.60 ^a | 4.54 ^b | 4.31 ^c | 4.53 ^b | 0.018 ** |

Means on the same row having different superscripts are statistically different from each other at * (P<0.05) ** (P<0.01)

% - Percentage; CP -Crude protein; CF -Crude fibre; EE - Ether extractive; NFE -Nitrogen-free extractive; GE - Gross energy; Kcal/g-Kilocalories per gramme; Min-minutes

@ Culled from Ukachukwu and Obioha (2000) (In Press)

Table 3:* Effect of various time durations of the different thermal treatments on the anti-nutritional factors of *M. cochinchinensis*

| Anti-nutritional Factors | Treatments | | | | SEM |
|--------------------------|-------------------|--------------------|--------------------|-----------------------------------|----------|
| | Raw | Boiling (90min) | Toasting (60min) | Boiling (presoaked, 12hr) (60min) | |
| Trypsin inhibitor (mg/g) | 7.47 ^a | 4.08 ^b | 4.48 ^b | 4.43 ^c | 0.026 * |
| Tannin (mg/g) | 5.54 ^a | 4.37 ^c | 4.44 ^a | 3.91 | 0.032 ** |
| Haemagglutinin (HU/g) | 4267 | 1067 | 2133 | 1067 | |
| Cyanide (mg/kg) | 40.0 ^a | 21.00 ^b | 33.00 ^b | 20.00 ^b | 1.033 * |

Means on the same row having different superscripts are significantly different from each other at* (P<0.05) and ** (P<0.01).

@ Culled from Ukachukwu and Obioha (2000) (in press)

SEM = standard error of mean; Mg = milligramme; G = gramme;

HU = haemagglutinating unit; Kg = Kilogramme; Min = minutes

CONCLUSION AND APPLICATIONS

It can therefore be concluded that:

1. Some locally adaptable heat processing methods can improve the bioavailability of the energy of *Mucuna cochinchinensis*.
2. The three heat processing methods used here, viz: toasting, boiling and soaking-and-boiling are equally effective and can result in up to 70 % efficiency of energy bioavailability of the test ingredient. Hence, any of the methods can be applied in the processing of *Mucuna cochinchinensis* for formulation into broiler diets.
3. It is suggested that further study on prolonging the heat treatment time

be carried out to investigate its effects on further improvement of the bioavailability of the energy of the test ingredient. Also, the cost effectiveness of each heat treatment should be investigated.

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