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PJBS

ISSN 1028-8880

Pakistan Journal of Biological Sciences

ANSInet
Asian Network for Scientific Information
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan

Pakistan Journal of Biological Sciences 8 (10): 1392-1396, 2005
ISSN 1028-8880

The Effect of Fasting Birds Period on the Metabolic Plus Endogenous Energy Losses for True Metabolisable Energy Values of Feedstuffs

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Abstract: An experiment was made to study the effect of the duration of the excreta collection period on the True Metabolizable Energy (TME) values of cereals as wheat, maize and barley and wheat bran. The experiment was performed with 48 mature Cornish and Rhode Island Red (RIR) cockerel strains, under standard conditions. Droppings voided during the experimental period were collected and assayed for gross energy and nitrogen. The results showed that the rate of excretion of EEL (32.71% for Cornish and 17.82% for RIR) and nitrogen (40.26% for Cornish and 22.80% for RIR) voided by adult birds of two strains decreases during the period of fasting bird (12 to 72 h). The effect of fasting period (12, 24, 48 and 72 h) on the TME values obtained of barley, wheat and maize 18.98, 6.24 and 16.32% for Cornish and 12.78, 7.82 and 8.31% for RIR birds, were significantly due to be reduced respectively. The finding of this study proves those 48 h fasting birds of two strains are suitable for routine of excreta collection time on estimates of metabolic plus endogenous energy losses for true metabolisable energy values for cereals such as wheat, wheat bran, maize and barley.

Key words: Metabolic and Endogenous Energy Losses (EEL), TME, excreta collection period of birds

INTRODUCTION

The excreta of poultry contain energy, which is not derived directly from the diet. The metabolic Fecal Energy (FEm) is the energy of digestive juices bile and abraded intestinal mucosa. The Endogenous Urinary energy (UEe) results from the degradation of tissues and production of catabolites during body maintenance. These energy losses are of particular importance in the measurement of available dietary energy[1]. When body fat is catabolized to supply energy for body maintenance, the waste products are carbon dioxide and water, however, when protein is degraded, energy containing nitrogenous, primarily uric acid, is voided. Thus, the excreta of a fat bird may be less than that of a lean bird during a fast. Variability of TME data is increased if some birds which catabolize more protein than others do. Reduction of tissue catabolism, by elimination of fasting is a possible. Dietary nitrogen retained in the body, if catabolized is excreted as energy containing compounds such as uric acid (36.5 kJ g^{-1} which is the energy of uric acid nitrogen). Waring and Brown[2] found uric acid nitrogen to account for from 49 to 51% of the total urinary nitrogen. Shires *et al.*[3] found the nitrogen correction to reduce TME values measured with chicks and adult cockerels by 6 and 8%, respectively and produced evidence of reduced variability. Edmundson[4,5] suggested that metabolic plus endogenous loss is characteristic of the bird. Sibbald and Price[6] confirmed that metabolic plus endogenous loss (FEm+UEe) is a characteristic of the bird. Sibbald[7] reported the importance of using a uniform population in TME and similar bioassay so that the estimates of metabolic plus endogenous loss (FEm+UEe) reveal significant age and genotype differences. Yaghobfar[8,9] reported sex and genotype also affected Endogenous Energy Losses (EEL) of birds and cockerels had significantly greater EEL than females. Also, who argue that there was no significant difference between the data obtained for EEL from the unfed birds and the intercept from regression analysis so, the figure from regression analysis could be used for calculating TME value of maize.

There is a belief that FEm + UEe loss varies with the nature and quantity of feed ingested. Hallsworth and Coates[10] showed intestinal mucosa increased with the intake of dietary fiber. The addition of wheat bran to a diet had no effect on the rate of renewal of intestinal epithelium[11]. Shires *et al.*[12] concluded that the protein, but not cellulose, content of the diet affected the FEm+UEe loss during a subsequent fast.

Both excreta energy (FE+UE) and excreta nitrogen (FN+UN) varied among time periods and among birds and appeared to be related to metabolic body size. Sibbald[13] suggested fasted birds are able to provide acceptable measurements of metabolic plus endogenous energy losses (FEm+UEe). Sibbald[14] observed that the quantity of gross energy excreted daily by adult roosters during a fast decreased with the duration of starvation. However, the extension of the period of starvation from 24 to 96 h, by intervals of 24 h, had no significant effect on the TME value of a laying hen diet. Macleod[15] reported that turkeys had greater endogenous energy and nitrogen losses than broilers and that difference in TME yield to turkeys and broilers were in opposite directions for wheat meal and soya bean meal. Originally the preliminary fast was for 21 h and the experimental period was 24 h[16], subsequently, times were changed to 24 and 48 h, respectively[17] or two 48 h periods[18]. It was the purpose of this study to investigate the suitability of using fasted adult cockerel to estimate the metabolic plus Endogenous Energy Losses (EEL) and nitrogenous losses, of the initial fasting period in the two strains. Therefore, determine the metabolizable energy content of four major cereal ingredients, such as maize, wheat, wheat bran and barley.

MATERIALS AND METHODS

The experiments were conducted with 48 mature Cornish and Rhode Island Red (RIR) cockerel strains. The cockerels were individually housed in metabolic cages in a temperature-controlled room (26°C) with 14 h of light per day. Each cage was fitted with an individual feeder and a nipple drinker. An aluminium tray was placed under each cage to allow droppings to be collected quantitatively. In the experiment, modified plastic bags were fitted to the birds for the collection of droppings. Of the 48 birds of two strains, 24 birds were allocated to the 12, 24, 48 and 72 h fasting to allow measurement of endogenous and metabolic energy and nitrogen loss. In each of the fasting treatment groups, six birds were given maize, barley, wheat and wheat brain. The birds were precision feeding 35 g of the assigned feedstuffs and metabolizable energy values were calculated[19]. After precision feeding, bags were immediately attached to each bird. The samples of droppings voided during the 48 h immediately after feeding were collected and frozen. Before analysis, the frozen samples were removed from the freezer, taken out of the bags and placed in an oven, to be dried at 90°C overnight. Samples of the ground feedstuffs and excreta were assayed for gross energy by means of adiabatic oxygen bomb calorimeter and nitrogen concentrations in the feedstuffs and excreta samples were determined by the Kjeldahl procedure[20].

RESULTS

The result of experiment indicated that, except for 12 h there were not significantly differences between the amount of EEL obtained of two strains during of excreta collection time at 24 to 72 h ($p>0.05$), respectively (Table 1). However, data shown that amount of the EEL obtained of Cornish strain (46.10 to 78.53 kJ g^{-1}) were higher than those of the RIR strain (40.54 to 49.33 kJ g^{-1}) at differences excreta collection time. Nitrogen excitation derived by fasting birds, also except for 12 h there were not significant differences between two strains ($p>0.05$). The data shown that amounts of nitrogen excreta obtained of the Cornish strain (0.316 to 0.838 g) there were higher than those of the RIR strain (0.237 to 0.317 g) respectively. The output of EEL and nitrogen values per unit of time decreased with the duration of fasting birds. Consequently, when duration of fasting birds was longer tended to have a less excretion of endogenous and nitrogenous losses (Table 1).

The endogenous energy loss values from two fasting strain birds at different time excreta collection were affected on the amount of TME and TMEn values derived of barley. However despite the amount of TME values obtained from barley (11.17±1.21, 11.38±0.54, 11.42±1.80, 11.63±1.50, 11.84±1.63 and 12.59±1.84 kJ g^{-1}) were not significantly differences for 12, 24 and 48 h of fasting time excreta collocation of birds ($p>0.05$). But, when two strain bird were fasting for 72 h, amount of TME values (9.96±1.09 and 10.20±1.34 kJ g^{-1}) for barley significantly reduced ($p<0.05$). Otherwise, amount of TMEn values obtained from barley (11.09±1.55, 11.88±2 12.42±0.92 and 13.93±1.09 kJ g^{-1}) were significantly increased on the 12 and 24 h fasting time excreta collection for two strain birds ($p<0.05$). However, despite on the difference of time excreta collection (48 and 72 h) amounts of TMEn values (12.47±1.17, 13.89±1.2 and 14.14±1.13 kJ g^{-1}) derived from barley were not significantly differences ($p>0.05$). However, the results of the experiment indicated that there were not significant differences between two strains (Cornish and RIR) for amount of the TME values from barley on the different time of excreta collection respectively ($p>0.05$). But, amount of the TMEn values derived of two strains (Cornish and RIR), were not significantly different from barley except for 12 h fasting (Table 2).

At different times of fasting excreta collection 12, 24, 48 and 72 h amount of the TME and TMEn values derived of wheat were not significantly differences for Cornish birds ($p>0.05$), except TMEn values were significantly increased on the 12 and 24 h fasting birds. However, amount of TME and TMEn values of wheat were not significantly differences for RIR birds ($p>0.05$). Table 2 indicate that there were significant ($p<0.50$) differences between the two strains (Cornish and RIR) with respect to the values for TME and TMEn values obtained with wheat diets.

Table 1: The effect of excreta collection time on the endogenous plus metabolic energy (EEL) and nitrogen losses of fasted adult cockerels

	12 h	24 h	48 h	72 h
EEL (kJ)				
Cornish strain	78.53±28.95^{a}	53.72±20.88^{b}	46.10±17.57^{b}	52.84±15.48^{b}
RIR strain	49.33±14.98^{b}	48.07±16.94^{b}	41.30±11.00^{b}	40.54±14.27^{b}
Nitrogen (g)				
Cornish strain	0.838±0.36^{a}	0.529±0.34^{b}	0.366±0.19^{b-d}	0.316±0.12^{b-d}
RIR strain	0.317±0.26^{b-d}	0.397±0.27^{bc}	0.258±0.14^{b-d}	0.237±0.1

Mean values within a column with different superscripts letter(s) are significantly different ($p<0.05$)

Table 2: The effect of differences strains and excreta collection time of fasting on the amount of TME and TMEn values of cereals (kJ g^{-1})

	12 h		24 h		48 h		72 h	
	TME	TMEn	TME	TMEn	TME	TMEn	TME	TMEn
Barley								
Cornish	12.59±1.84^{c}	11.88±2^{c-e}	11.84±1.63^{c-e}	13.93±1.09^{a}	11.63±1.50^{c-e}	13.89±1.21^{ab}	10.20±1.34^{fg}	14.14±1.13^{a}
RIR	11.42±1.80^{c-f}	11.09±1.55^{e-g}	11.38±0.54^{c-f}	12.42±0.92^{cd}	11.17±1.21^{d-g}	12.47±1.17^{cd}	9.96±1.09^{g}	12.47±1.21^{cd}
Wheat								
Cornish	12.93±3.76^{be}	12.26±3.76^{c}	12.26±3.85^{c}	13.93±3.01^{b}	12.09±3.55^{c}	13.89±2.90^{b}	10.83±3.68^{c}	14.10±3.05^{b}
RIR	16.61±1.13^{a}	16.32±1.34^{a}	16.57±1.0^{a}	17.11±0.63^{a}	16.40±0.88^{a}	17.15±0.42^{a}	15.31±0.83^{ab}	17.15±0.42^{a}
Maize								
Cornish	13.60±1.84^{b-d}	12.88±1.80^{c-g}	12.88±1.59^{cd}	13.34±1.55^{b-f}	12.68±1.80^{d-g}	13.30±1.67^{b-f}	11.38±0.50^{g}	13.55±1.6^{b-e}
RIR	14.68±2.0^{ab}	14.35±1.88^{a-c}	14.64±2.00^{ab}	15.23±1.00^{ab}	13.46±0.43^{a-c}	15.31±1.00^{a}	13.30±1.80^{b-f}	15.31±.1.05^{a}
Wheat bran								
Cornish	9.83±1.92	8.66±1.59	8.91±2.05	8.58±1.63	8.62±1.76	8.49±1.46	8.87±2.00	8.78±1.55
RIR	9.24±2.42	8.83±2.34	9.20±2.51	9.41±2.30	8.95±2.55	9.50±2.13	8.91±2.59	9.50±2.21

Mean values within a column with different superscripts letter(s) are significantly different ($p<0.05$)

Table 3: Effect of strains on the metabolized energy content of cereals[1]

	AME (kJ g^{-1})		AMEn (kJ g^{-1})	
	Cornish strain	RIR strain	Cornish strain	RIR strain
Barley	10.20±1.34^{b}	9.96±1.09^{b}	12.88±1.00^{a}	11.50±1.13^{ab}
Wheat	10.63±3.68^{c}	15.31±0.83^{ab}	13.01±2.93^{a-c}	16.27±0.54^{a}
Wheat bran	6.90±1.67	7.45±2.47	7.28±1.38	8.28±2.13
Maize	11.38±1.76^{b}	13.30±1.80^{a}	12.38±1.59^{ab}	14.39±1.00

Mean values within a column with different superscripts letters are significantly different ($p<0.05$), [1]Mean±SE means for two strains

The TME and TMEn values obtained of maize on the 12, 24 and 48 h were not significantly different for Cornish birds ($p>0.05$), but on the 72 h was significant decreased (11.38±0.50 kJ g^{-1}) contrast 12 and 24 h of fasting birds ($p<0.05$). Therefore, those had not significant differences for amount of TMEn derived of maize for Cornish birds ($p>0.05$). However, amount of TME and TMEn values obtained of maize were no significantly differences on the different time excreta collection (12 to 72 h) from RIR birds ($p>0.05$). The effect of the strains on the amount of TME and TMEn values on the 12 and 72 h excreta collection time of fasting were not significant, but they showed significant different for TME and TMEn values obtained of maize on the 48 h birds fasting ($p<0.05$).

The data of experiment shown that there were not significantly differences between two strains (Cornish and RIR) therefore, excreta collection time of fasting on the 12 to 72 h had not effect on the TME and TMEn values derived of wheat bran ($p> 0.05$).

The data indicated that AMEn for cereals (barley, maize wheat and wheat bran) there were not significantly differences between two strain birds respectively ($p>0.05$). Also, AME values derived from barley (10.20±1.34 and 9.96±1.09 kJ g^{-1}) and wheat bran (6.90±01.67 and 7.45±2.47 kJ g^{-1}) were not significantly differences. But the amount of AME values obtained of maize (11.38±1.76 and 13.30±1.8 kJ g^{-1}) and wheat (10.63±3.68 and 15.31±0.83 kJ g^{-1}) had significant differences between two strain birds, respectively (Table 3).

DISCUSSION

The metabolic plus endogenous and nitrogenous excretions of birds, under conditions of fasting, vary both in quantity and composition. Metabolic body weight, body composition, genotype, age and physiological state contribute to the variability. The FEm is the energy of that portion of the faces other than the feed residues and is present as abraded intestinal mucosa, bile and digestive fluids. The UEe is that of portion of the urinary energy not of direct feed origin. The correction for EEL (FEm+UEe) has several important effects. Under conditions of the experiment, the rate of excretion of EEL and nitrogen voided by adult birds of two strains were decreases during the period of fasting[14]. After, 12 to 72 h fasted birds the EEL excretion to be 32.71% for Cornish and 17.82% for RIR birds and amount of nitrogen excretion to be 40.26% for Cornish and 22.80% for RIR birds, there decreases respectively. The observed EEL and nitrogen excretion data of experiment show that the loss during

12 to 48 h period (EEL 41.29% for Cornish and 16.28% for RIR; nitrogenous 62.3% for cornish and 25.23% for RIR birds), after fasting is greater than that from 24 to 72 h fasted birds. The EEL and nitrogenous varies among birds, but there is evidence that it is the characteristic of the birds[6]. The data of this report indicate that EEL and nitrogen excretion may also be the characteristic of the birds. There was a high level of variation in EEL and nitrogenous among excreta collection times which points to the need to measure EEL must be included in each bioassay. Therefore, in experiments in which estimates of EEL are required, it is necessary to make direct measurements.

The maintenance cost of birds varies according to its metabolic size, its physiological function and the environment in which it is kept. It is reasonable to assume that these factors also affect the EEL production. The measurement of TME controls at least partially, the effects of these variables and causes the data to be more accurate and reproducible. The results of this experiment shows that the effect of fasting period birds (12 to 72 h) on the TME values obtained of cereal as barley (Cornish 18.98% and RIR 12.78%), wheat (Cornish 6.24% and RIR 7.82%) and maize (Cornish 16.32% and RIR 8.31%) were significantly due to be reduced. In contrast fasting birds 12 to 48 h there those cause to slightly reduction (1.26 to 8.31%) and were not statistically significant from two strains.

There is a belief that EEL and nitrogen excretion varies with the nature of feedstuffs[6]. However, this study provides no evidence of differences in either energy or nitrogen excretion associated with feedstuffs composition. Cereal composition as wheat, barley, wheat bran and maize had no effects on the amount of the metabolizable energy values. Indeed, the addition of wheat bran as a source of fiber had no effect on the rate of intestinal epithelium removal of birds[11,7].

The original suggestion of 24 h[21,14] is known to be too short and all data collected on this basis should be ignored because of the uncertainty involved. Farrell[22] recommends 32 h and Sibbald[19] 48 h for routine use. Fisher and McNAB[23] comparing data from 48 h and 72 h collections time and they argue that the longer the collection period the higher the endogenous and exogenous energy ratio and greater the relative importance of error in the correction for EEL. The findings of this study prove those 48 h fasting birds of two strains and for cereals as wheat, barley, wheat bran and maize for routine are suitable for duration times of driving EEL from birds.

Sibbald[11] dose not recommends N correction in the negative control birds for the calculation of TMEn. Mutzar and Slinger[24] followed this recommendation but the Poultry Research Center Group and Shires[3] believe this to be incorrect. The result of this experiment indicated that nitrogen variation of fasted birds depended on the types of strain. Therefore, amount of nitrogen execration on the 12 to 48 h and 12 to 72 h for fasting birds were significantly reduced from Cornish birds, but this condition was not significantly different for RIR birds. However, nitrogen obtained of negative control birds shown that affect of nitrogen correction in the TMEn values were differences for feedstuffs. Thus, amount of TMEn values obtained of Cornish bird from barley and wheat was significantly increased (12 to 14.14%), but TMEn values for maize and wheat bran did not significantly varied. However, TMEn values derived of RIR bird from wheat, maize and wheat bran were not significantly increased except barley. This experiment confirms that the nitrogen correction in the negative control birds for the calculation of TMEn dependent on the strains, age and feedstuffs compassion.

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