A METHOD FOR MEASURING ENERGY EFFICIENCY OF INDIVIDUAL LAYING HENS

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One hundred and seven Dekalb DK hens, 44 weeks of age were fed a diet that contained 15.5% protein and 2890 Kcal ME/kg. The birds were individually kept in wire cages equipped with two 946 cc plastic containers used as feed cups for each hen. Birds were weighed at the beginning and the end of the three-week experiment in order to calculate the change in body weight. Total feed consumption was recorded for each hen during the experimental period and was used to calculate the ME intake. Egg production and egg weight were recorded daily in order to calculate the egg mass (g/day).

A multiple linear regression equation describing the relationship between body weight (W), change in body weight (G) and egg mass (E) was derived to predict the metabolizable energy intake (MEP). The equation is: $MEP = 0.142\ W + 3.41\ G + 1.58\ E$.

The relative efficiency ratio (RER) is defined as: predicted ME intake/actual ME intake x 100 and was calculated for each hen. The results showed that 93.5% of the hens had RER values ranging between 90 and 110%. The effect of body weight on RER showed that the heavy hens had higher RER values than the light ones.

The laying hen requires energy for body maintenance, weight gain and formation of eggs. A number of regression equations have been developed by using this factor to predict the daily intake of feed or more precisely energy intake of the laying hen. Firstly, two equations were used to predict feed intake

(Byerly, 1941, and Brody, 1945). Later, Combs (1962) formulated an equation to predict the daily energy intake of the hen from Byerly's equation by multiplying by the estimated metabolizable energy content of the diet used by Byerly.

There have been many other regression equations developed for predicting the daily energy intake of the laying hen. McDonald (1978) reviewed the data used for these equations and concluded that many factors were influencing the accuracy of the prediction of the equations. These factors were, assumptions and methodology, seasonal effects, housing effects, management, genetics and nutrition. There were considerable differences between the equations for the different experiments (Table 1). However, a highly significant equation could be developed for each experiment.

This experiment was conducted to determine the variability of energy utilization among a flock of hens. An equation was developed for the prediction of the entire flock and this was used to predict the intake of the individual hen. The actual intake was measured and the relative efficiency of the hens calculated from these values.

EXPERIMENTAL PROCEDURE

one-hundred and seven individually caged DeKalb DK hens were used in this experiment. They were maintained in individual cages and were given a corn-soybean meal diet (Table 2) formulated to meet their daily nutritional requirements as suggested by Harms (1981). Each cage was equipped with individual feed cups as described by Roland et al. (1971). The hens were individually weighed at the beginning and the end of the three-week experiment. These weights were used to calculate the daily change in body weight. Egg production was recorded daily. All eggs were collected and weighed daily during the experimental period. Egg production and egg weights were used to calculate daily egg mass. Two cups were placed in front of hens, therefore, they had sufficient feed for one-week. The feed was weighed at the beginning and the end of each week. The ME intake was calculated by multiplying feed intake by ME content of the diet. A multiple linear regression equation was developed describing the relationship between body weight (W), daily change in body weight (G) and daily egg mass (E) to predict the metabolizable energy intake (MEP). The relative efficiency ratio (RER) was calculated for each hen by dividing the predicted ME intake by the actual ME intake and multiplying by 100. The general linear model procedure (SAS, 1979) was used for all analysis.

RESULTS AND DISCUSSION

The multiple linear regression equation describing the relationship between body weight (W), change in body weight (G) and egg mass (E) and the metabolizable energy intake (MEP) is:

$$MEP = 0.142\ W + 3.41\ G + 1.58\ E$$

This equation is different from those mentioned by McDonald (1978) using data for breeds ranged from light bodies layers to meat breeders, in cages or floor pens, controlled environment or open pens.

The relative efficiency ratios (RER) for the individual hens ranged from 70 to 120% (Figure 1). One hundred hens or 93.5% of the hens had RER values ranging from 85 to 115%. Seventy-four percent of the hens had RER values ranging from 90 to 110%.

As each equation gave its own prediction to a high degree of accuracy, the possibility exists that individual strain equations are very narrow in their capability of prediction and should only be used for their own particular strain, and not all strains with a similar body weight.

The relationship between the average body weight and the RER values was plotted (Figure 2). This distribution indicates that the RER values increased as the body weight of the hen increased. Maybe the reason is that the heavy hens tends to lay a bigger eggs and accordingly a bigger egg mass (Table 3)

The correlation coefficient of average body weight and RER values was found to be 0.96.

These data indicated that a considerable difference in RER values can be measured between individual hens within a flock. Further studies will be conducted to determine whether this measurements can be used for comparison of different genetics stock and for measuring inheritance of feed efficiency.

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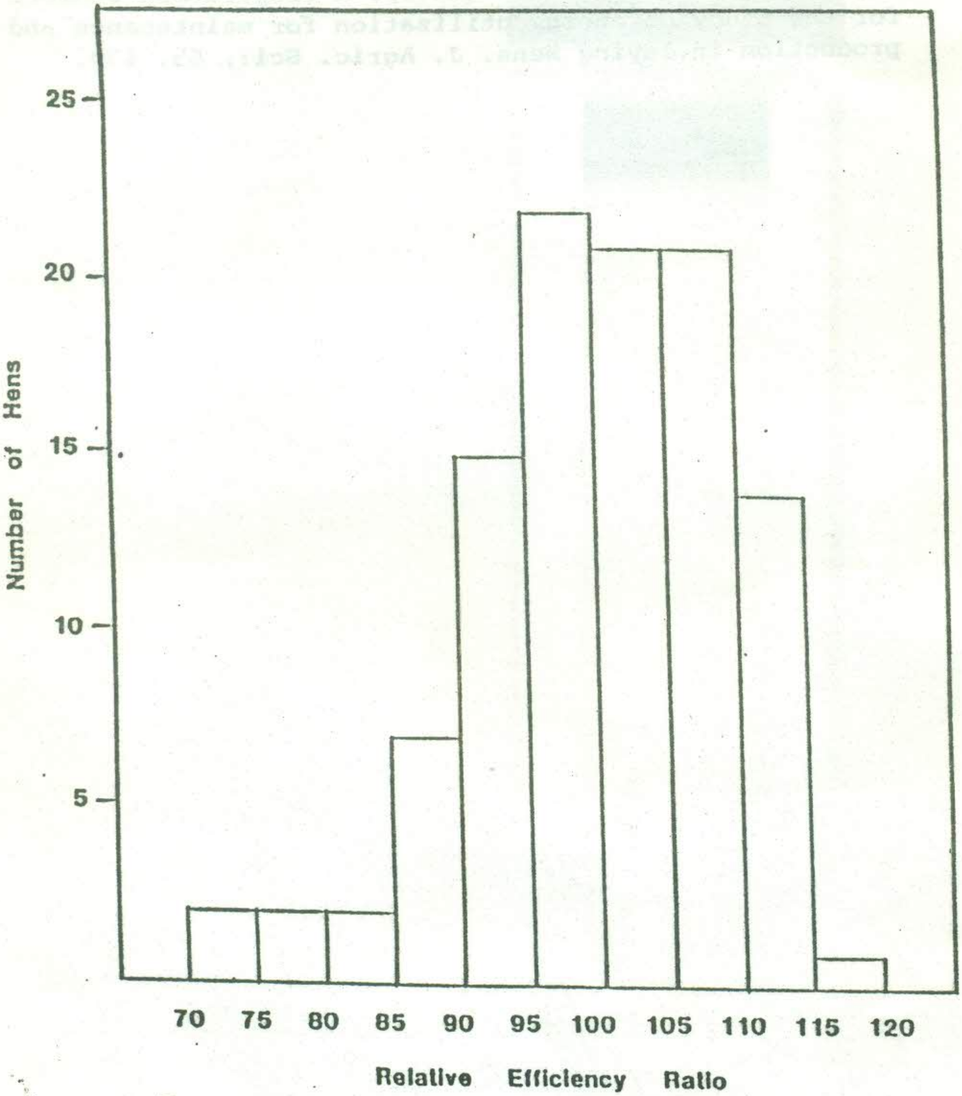

Figure 1: Number of hens at various relative efficiency ratios

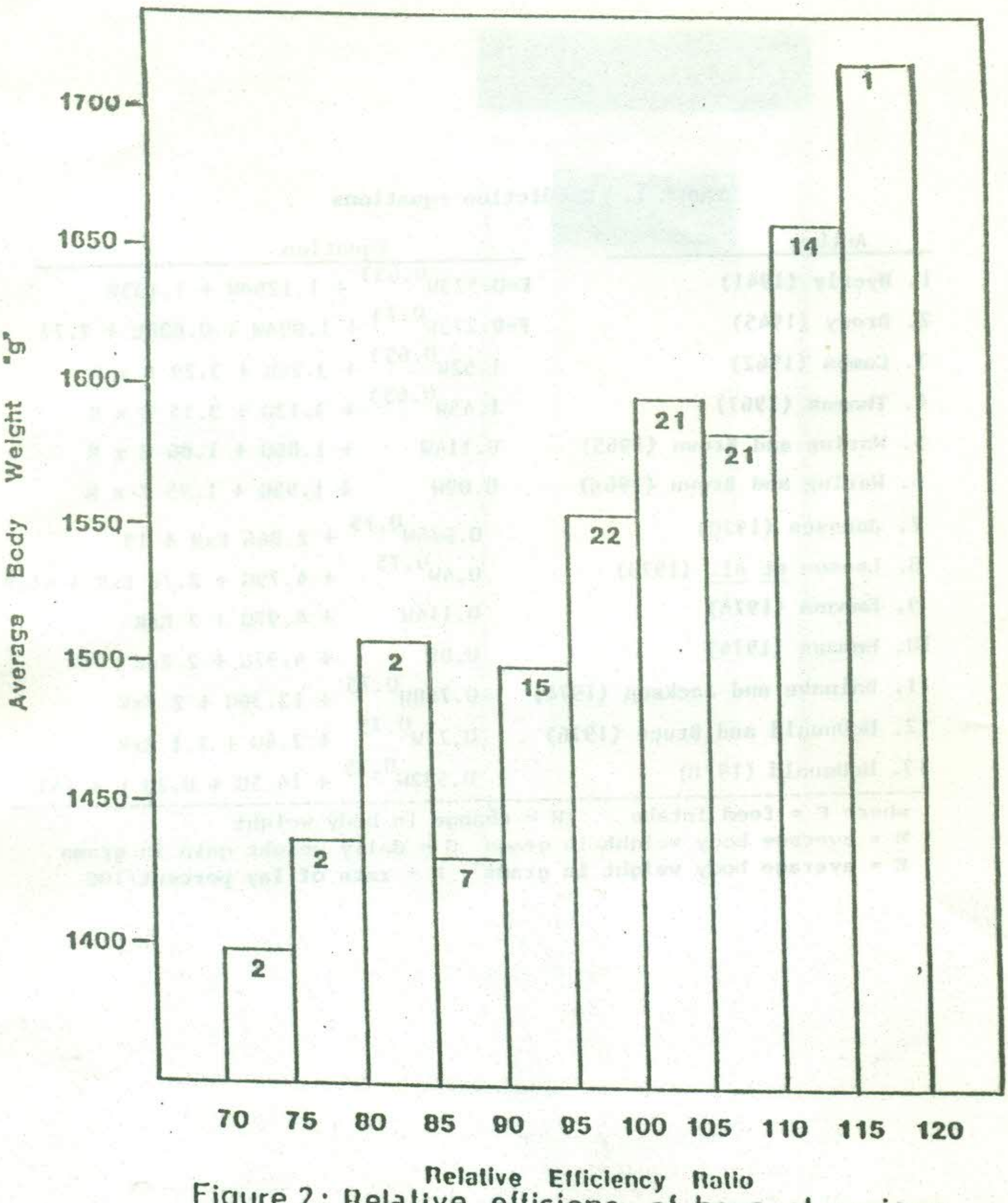

Figure 2: Relative efficiency of hens at various average body weights.

TABLE 1. Prediction equations

Author	Equation
1. Byerly (1941)	$F=0.523W^{0.653} + 1.126\Delta W + 1.135E$
2. Brody (1945)	$F=0.273W^{0.73} + 1.09\Delta W + 0.688E + 7.77$
3. Combs (1962)	$1.52W^{0.653} + 3.26G + 3.29\ E \times R$
4. Thomas (1967)	$1.45W^{0.653} + 3.13G + 3.15\ E \times R$
5. Waring and Brown (1965)	$0.114W + 1.86G + 1.86\ E \times R$
6. Waring and Brown (1965)	$0.09W + 1.95G + 1.95\ E \times R$
7. Janssen (1970)	$0.676W^{0.75} + 2.866\ ExR + 19$
8. Leeson _et al._ (1973)	$0.4W^{0.75} + 4.79G + 2.76\ ExR + 64.8$
9. Emmans (1974)	$0.114W + 4.97G + 2\ ExR$
10. Emmans (1974)	$0.09 + 4.97G + 2\ ExR$
11. Balnave and Jackson (1974)	$0.748W^{0.75} + 13.36G + 2\ ExR$
12. McDonald and Bruce (1976)	$0.71W^{0.75} + 2.4G + 2.1\ ExR$
13. McDonald (1978)	$0.532W^{0.75} + 14.5G + 0.20\ E + 147$

where F = feed intake W = change in body weight
W = average body weight in grams G = daily weight gain in grams
E = average body weight in grams R = rate of lay percent/100

TABLE 2. Composition of the diet

Ingredient	%
Yellow corn	70.7
Soybean meal 48.5%	19.0
Limestone	8.1
Dicalcium phos. 22-18 5%	1.2
Vit. and Minerals mix *	0.5
Salt	0.4
DL-Methionine	0.1
Crude protein	15.5
ME Kcal/kg	2890

*Vitamin and minerals mix. provided the following per kilogram diet: Vit. A, 6600 IU, Vit. D_3, 2200 IU, menadione, dimethyl-pyrimidinol bisulfite, 2.2 mg, riboflavin, 4.4 mg, pantothenic acid, 13.2 mg, niacin, 39.6 mg, Choline chloride, 499.4 mg, Vit. B_{12}, 22 mcg, ethoxyquin, 0.0125%, Mn, 60 mg, Fe, 50 mg, Zn, 35 mg, Cu, 6 mg. I, 1.1 mg, Co, 0.198 mg.

TABLE 3. Average body weight, average feed intake and egg mass of the various RER categories.

RER %	No. of hens	Av. Body Wt. ±SE gm.	Av. Feed intake ±SE gm	Egg mass gm/day
70-74.9	2	1398±105.81	76.8±4.10	42.0
75-79.9	2	1438±105.81	80.7±4.10	39.0
80-84.9	2	1509±105.81	87.8±4.10	52.7
85-89.9	7	1443±56.56	91.7±2.19	51.2
90-94.9	15	1501±38.63	96.2±1.50	51.2
95-99.9	22	1554±31.90	98.2±1.24	52.4
100-104.9	21	1595±32.65	101.6±1.27	51.1
105-109.9	21	1584±32.65	105.6±1.27	52.7
110-114.9	14	1660±39.99	111.1±1.55	53.8
115-119.9	1	1707±149.6	116.6±5.80	52.7

طريقة لقياس كفاءة الاستفادة من الطاقة فى الدجاج البياض

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أستخدم فى هذه الدراسة ١٠٧ دجاجة بياضة من نوع دى كالب عمرها ٤٤ أسبوعا غذيت على عليقة بها ١٥٫٥ ٪ بروتين ، ٢٨٩٠ كيلو كالورى طاقة ممثلة لمدة ثلاثة أسابيع . وقد تم وضع الدجاج فى أقفاص فردية كل منها مجهز بكوبين من البلاستيك تستعمل كغذايات لكل دجاجة . وقد تم وزن كل دجاجة أسبوعيا لحساب معدل التغيير فى الوزن الحى . أيضا تم تسجيل معدل أستهلاك الغذاء وأستخدم لحساب كمية الطاقة الممثلة المتناولة الفعلية . كما تم تسجيل معدل أنتاج البيض لكل دجاجة ووزن كل بيضة يوميا وذلك لحساب كتلة البيض الناتجة يوميا بالجرام.

ومن البيانات السابقة أستخرجت معادلة أنحدار خطى متعدد تحدد العلاقة بين وزن الجسم (W) ومعدل التغيير فى وزن الجسم (G) وكتلة البيض (E) وبين الطاقة الممثلة المتوقع تناولها (MEP) والمعادلة هى :

$$MEP = 0.142\ W + 3.41\ G + 1.58\ E$$

هذا وقد حسب معدل الاستفادة النسبية (RER) لكل دجاجة والذى يعرف بأنه الطاقة الممثلة المتوقع أستهلاكها / الطاقة الممثلة المتناولة فعلا × ١٠٠.

وقد أظهرت النتائج أن ٩٢٫٥ ٪ من الدجاج تراوح معدل الاستفادة النسبية له بين ٨٥ ، ١١٥ ٪ كما تراوح معدل الاستفادة النسبية بين ٩٠ ، ١١٠ ٪ لـ ٧٤ ٪ من الدجاج .

وأظهرت الدراسة أيضا أن هناك علاقة بين وزن الجسم ومعدل الاستفادة النسبية حيث حقق الدجاج الاكبر وزنا معدل أستفادة أعلى من الدجاج الاخف وزنا .