

RESEARCH NOTE

THE LIKELY EFFICIENCY OF PRENATAL ENERGY UTILIZATION

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When analysing experiments involving the quantification of animal growth and efficiency of feed utilization (Parks, 1970; 1972; 1973; 1975a; 1975b; Meissner, Roux & Hofmeyr, 1975; Roux, 1976; Meissner, 1977, Kemm, 1980; Scholtz & Roux, 1980) the cumulative energy intake is required, since the mass of an animal at any stage is a function of the total amount of feed consumed up to that stage. In evaluating the relationship between cumulative feed intake and body mass at birth, for example, the energy input to achieve birth mass is not known and methods are required to estimate this.

A solution to this problem is to estimate the energy content of the animal body at birth e.g. by the use of a regression equation relating birth mass and body energy, and to correct this value for prenatal efficiency as follows: $100\% \div \text{prenatal efficiency} \times \text{body energy at birth} = \text{total energy input for birth mass}$. Estimates of the prenatal efficiency of energy utilization are therefore needed to solve this equation. In mammals these estimates are difficult to obtain because the maternal organism undergoes profound metabolic changes, so that the heat increment of gestation is by no means the heat production of the embryo and foetus. Furthermore, the embryo, or foetus constitutes only a small part of the mother whose metabolism is measured, so that measurement error may be of the same magnitude as the embryonic contribution. The situation is further complicated if the mother is young and growing (Brody, 1945).

According to Brody (1945) the bird embryo is particularly suited for prenatal growth efficiency investigation. This is because in the case of eggs the nature of the nutrients is known, and eggs are conveniently isolated from complicating environments. The gross energetic efficiency of growth of the bird up to the time of hatching can be obtained by estimating the combustion values of (1) the egg, (2) the newly-hatched bird, and (3) the unused part of the egg, such as the left-over yolk and membranes.

Efficiency figures available from published literature vary from 85 percent for newborn lambs (Kielanowski,

1965) to 62 percent for chicks, 65 percent for silkworms, 59 percent for the sea urchin and 51 percent for frogs (Brody, 1945). Brody (1945) favoured an efficiency value between 60 and 65 percent. This study was intended to investigate whether the efficiency figures for the largest living bird (the ostrich) would correspond to the range of values given by Brody (1945). The question arises from Brody's (1945) conclusion that, in general, prenatal efficiency does not vary with size or incubation time.

Four dozen ostrich eggs were obtained of which 10 were used to estimate the combustion value of the egg by adiabatic bomb calorimeter, and 38 were hatched in an incubator. Of the latter 30 were infertile, 6 died during incubation, while only 2 eggs hatched. In spite of this small number the analyses were carried out in an attempt to confirm Brody's generalization of the independence of efficiency from incubation time and species.

The 10 eggs used to estimate the combustion value of the ostrich egg had an average ln mass (g) of $6,9991 \pm 0,1209$ and an average ln energy content (KJ) of $8,8776 \pm 0,1178$. A linear regression analysis with egg mass as the independent and energy content as the dependent variable yielded a slope (b) of 0,7601 and a ln intercept (a) of 3,5577 with $Sy.x$ and r as 0,0781 and 0,9802 respectively. The masses of the 2 hatched eggs were known and their energy content was estimated by linear regression procedures. The combustion values of the different components of the 2 hatched eggs are indicated in Table 1.

From Table 1 the average gross efficiency is:

$$\frac{4618}{4618 + 2513} \times 100 = 64,8\%$$

and the average energy loss is:

$$\frac{2513}{4618 + 2513} \times 100 = 35,2\%$$

Table 1

Combustion values of the 2 hatched eggs

	Egg 1	Egg 2	Mean
Mass of unhatched egg	1018 g	1308 g	1163 g
Estimated combustion value of egg	6682KJ (100%) 6,563KJ/g	8585KJ (100%) 6,563KJ/g	7633KJ (100%) 6,563KJ/g
Combustion value of hatched egg	4399KJ (65,8%) 4,321KJ/g	4838KJ (56,4%) 3,699KJ/g	4618KJ (60,5%) 4,010KJ/g
Combustion value of unused material	219KJ (3,3%) 0,215KJ/g	784KJ (9,1%) 0,600KJ/g	502KJ (6,6%) 0,408KJ/g
Energy lost during incubation (subtraction)	2064KJ (30,9%) 2,028KJ/g	2962KJ (34,5%) 2,265KJ/g	2513KJ (32,9%) 2,147KJ/g

This estimate of 64,8 percent for prenatal efficiency is in good agreement with Brody's preferred values, and his conclusion that the size of an egg and the incubation time have no influence on the prenatal efficiency of energy utilization.

It seems therefore that an approximate value of 60 - 65 percent, or for convenience 2/3, for prenatal efficiency may be acceptable for all animals. The prenatal energy

intake can thus be estimated using this efficiency figure. An estimate of prenatal energy intake, even if it is not very accurate, is preferred to one of zero, as the contribution of prenatal intake to the cumulative intake during a growth experiment decreases rapidly with time, so that errors of moderate size soon become relatively small and unimportant. For example, a value of 85 percent instead of 65 percent in the rat, induced a difference of only 3 percent at weaning (21 days of age).

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