Bioassay Procedure of Energy Sources for Poultry Feed And Estimation of Available Energy of Cassava Meal

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In the evaluation of nutritive value of energy sources for poultry feed such as cereals, potatoes and fats, availability of energy in the sample is important first of all. Secondly, toxicity or any other detrimental effects of the sample should be tested carefully. Finally, nutritive value of minor nutrients in the sample, such as protein, minerals and vitamins, should be evaluated.

Biological assay is one of the most convenient procedures to evaluate the nutritive value of the sample, since over-all evaluation can be made simultaneously on availability of energy and other nutrients, toxicity, palatability and so on.

Body weight gain of chicks can be shown as functions of dietary energy and protein levels under certain conditions[4]. When dietary protein level is kept constant, curvelinear relation will be obtained between chick's gain (y) and dietary energy level (x), which may be approximately linear within a certain narrow range of dietary energy level as described by equation 1,

$$y = a + bx \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

where, a and b are constants. From this equation, energy level of unknown diet will be estimated from the y of the chicks fed the diet. This is the principle of bioassay of energy level.

Procedure of bioassay

The bioassay described here was devised to adopt for starting chicks from 0 to 4 weeks of age[5),6)]. The composition of experimental diets is shown in Table 1. The diets with signs of SO-0, SO-5 and SO-10 were standard diets, which contained 0, 5 and 10% of soy-

Table 1. Composition of diet

Ingredients	Standard diet			Test diet		
	SO-0	SO-5	SO-10	C-10	C-20	C-32
Yellow corn	32.5%	32.5%	32.5%	26.1%	14.3%	—%
Cassava meal	—	—	—	10.0	20.0	32.3
Fish meal	5.0	5.0	5.0	5.5	6.7	8.2
Soybean oil	—	5.0	10.0	5.9	6.5	7.0
Corn starch	10.0	5.0	—	—	—	—
Defatted rice bran	20.2	20.2	20.2	20.2	20.2	20.2
Soybean meal	27.6	27.6	27.6	27.6	27.6	27.6
DL-methionine	0.1	0.1	0.1	0.1	0.1	0.1
Mineral mixture	4.1	4.1	4.1	4.1	4.1	4.1
Vitamin mixture	0.5	0.5	0.5	0.5	0.5	0.5

bean oil in place of corn starch, respectively.

The content of the rest of the ingredients was exactly the same, so that all of the 3 diets contained the same amount of well-balanced protein, minerals and vitamins and graded level of energy. The diets with signs of C-10, C-20 and C-32 were test diets, which contained 10, 20 and 32% of cassava meal, respectively. The content of yellow corn, fish meal and soybean oil was adjusted so that dietary protein level was kept constant at 23%.

Total digestible nutrients abbreviated as TDN was used in this experiment to indicate dietary energy level, since TDN has been commonly used in this country. TDN values of 3 standard diets, SO-0, SO-5 and SO-10, were 60.6, 67.3 and 74.0%, respectively. If necessary, TDN level can be exchanged with nitrogen-corrected metabolizable energy by the following equation 2[7],

$$y = 4.249x - 0.0537 \quad \ldots\ldots\ldots\ldots \quad (2)$$

where, x is dietary TDN level (g/g) and y metabolizable energy (kcal/g).

One-day-old White Leghorn male chicks were separated into groups of 15 chicks each with an uniform average body weight. Each of the standard or test diet was fed to duplicated lots for 4 weeks, except the C-32 diet containing autoclaved cassava meal, which was fed to one lot. The chicks were reared in an electrically-heated battery brooder with free access of feed and water.

Evaluation of available energy of cassava meal

Average body weight gain and feed intake for 4 weeks are summarized in Table 2. Equation 3 was found fit to describe the relationship between the growth response of the chicks on the standard diets and the dietary TDN level,

$$y = 3.396x + 5.82 \quad \ldots\ldots\ldots\ldots \quad (3)$$

where, y is the average body weight gain for 4 weeks (g) and x is the dietary TDN level (%). The relationship is shown in Fig. 1.

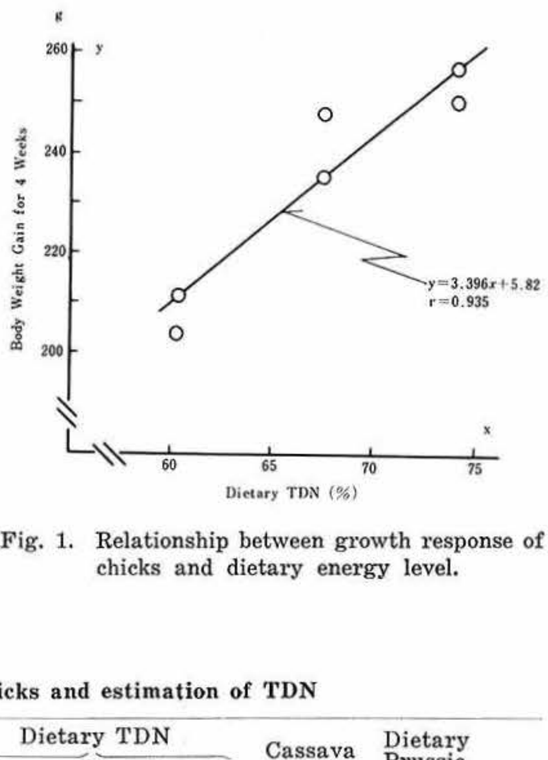

Fig. 1. Relationship between growth response of chicks and dietary energy level.

Table 2. Growth response of chicks and estimation of TDN

Diet	For 4 weeks		Dietary TDN		Cassava TDN	Dietary Prussic acid
	Weight gain	Feed intake	Mean	95% fiducial limit		
SO-0	208 g	498 g	60.6%	%	%	—ppm
SO-5	242	489	67.3			—
SO-10	253	486	74.0			—
C-10	234	487	67.2	60.4−73.9	67	3.6
C-20	207	468	59.3	45.6−66.6	28	7.2
C-32(water soaked)	240	511	69.0	62.8−76.4	75	±
C-32(autoclaved)	228	491	65.4	55.7−73.7	64	

TDN level of the test diet was estimated by substituting y in equation 3 with the body weight gain of the chicks on the diet and solving the equation for x. Similarly, 95% fiducial limits could be calculated by solving the equation for x,

$$y = a + bx \pm t_{(\alpha, n-2)} s_{y,x} \sqrt{1/n + 1/p + (x-\bar{x})^2/S_{xx}} \quad \cdots\cdots\cdots\cdots\cdots (4)$$

where, x is energy level of the test diet, y average body weight gain on x; a and b are constants; $t_{|(\alpha, n-2)}$ is t-value at $\alpha\%$ level with n-2 degrees of freedom; $s_{y.x}$ is deviation from regression; n and p are number of lots on the standard and test diets, respectively; and $\bar{x}$ and S_{xx} are mean and sum of squares of x on the standard diets, respectively.

TDN of cassava meal itself could be calculated from TDN of the diet subtracting TDN value of the ingredients other than cassava meal.

Nutritive value of cassava meal

As shown in Table 2, the chicks on the diet containing 10% of cassava meal grew normally with good appetite, suggesting that cassava meal at this level could be utilized well by the chicks. On the other hand, cassava meal at the dietary level of 20% retarded growth rate, suggesting the toxic effect of raw cassava meal at this level. Both of soaking the meal in water overnight and autoclaving the meal at 120°C for 1 hour were effective to remove the toxic material.

The cassava meal contained 36 ppm of prussic acid, which was suspected of causing growth retardation at the dietary level higher than 3.6 ppm. Water soaking and autoclaving were effective to remove prussic acid.

Summarizing the data of the other two estimations[8] with those presented in Table 2, the cassava meal contained 70% of TDN in average and could be used as energy source at the dietary level less than 10%. The cassava meal tested was obtained from Thailand, of which the chemical composition is given in Table 3. The conclusions mentioned here are agreeable with those reported by Vogt et al.[1,2,3].

Table 3. Chemical composition of cassava meal

Moisture	13.5%
Crude protein	2.0
Crude fat	0.4
Nitrogen-free extracts	76.9
Crude fiber	2.9
Crude ash	4.3
Prussic acid	36*

* ppm

Merit of bioassay

Biological assay technique has many merits, that is, behavior and health of the chicks can be observed during the estimation of caloric value of the sample, feed intake indicating palatability to the sample can be determined and other techniques, such as digestion trial and carcass analysis can be combined with bioassay if necessary. The evaluation of nutritive value of the sample can be made using all the information available collectively.

It should be kept in mind that any growth-promoting or growth-depressing effect over the effect of caloric value of the sample is estimated as available energy. Low TDN of cassava meal estimated from the data on C-20 diet is one of the typical examples. Fiducial limits as shown in Table 2 may help one suspect the existence of such a special effect of the sample. An estimate of TDN or caloric value widely different from the fiducial limits corresponding to gross energy of the sample suggests possible growth-promoting or depressing-effect of the sample.

Relatively wide fiducial interval of the estimate by bioassay should be compared with that estimated by physical or chemical assay procedure. The interval can be made narrow, if the number of lots on the standard and test diets, shown as n and p, respectively, in equation (4), be large, and suspected caloric value of the test diet, shown as x in equation (4), be made as close to $\bar{x}$ as possible.

The bioassay procedure described here is further refined, so that the caloric value of a sample of such a small amount less than 50 g can be evaluated biologically[9].

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