A Note on Estimation of Urinary Energy from Nitrogen Content of Urine in Early Weaned Calves up to 6 Months of Age

Junjiro SEKINE, Masaaki HANADA*,
Shigeru MORITA**, Toshio MOROOKA,
Seiji KONDO, Masahiko OKUBO and
Yasushi ASAHIDA

Faculty of Agriculture, Hokkaido University,
Sapporo-shi 060

* Konsen Agric. Exp. Sta., Nakashibetsu-cho 086-11

** College of Dairying, Ebetsu-shi 069-01

(Received December 18, 1985)

Key words: urinary energy, urinary nitrogen, calves

The energy of the urine corresponds to 3 to 4% of gross energy ingested¹⁻⁴⁾. This means that the amount of energy lost in the urine is not so small as to be ignored in energy balance trials. Thus, it must be determined in the measurement of metabolizable energy. It has been shown that the proportion of urine energy to gross energy ingested stays at a fairly constant level, irrespective of age and body size¹⁾. It used to be assumed that urine was substantially an aqueous solution of urea, until RUBNER⁵⁾ first demonstrated the energy value of excretory products as a unit per gram of nitrogen in the urine.

Lyophilization of the urine has been generally applied to determine the energy value of the urine for minimizing the loss of nitrogen from the urine. As moisture occupies the greatest part of the urine, lyophilization requires several hours to obtain urinary solids. Thus, the purpose of the present study was to estimate the energy value of the urine (UE) from the nitrogen content of the urine (UN) using results obtained in energy balance trials reported elsewhere⁶⁻⁹⁾.

Materials and Methods

A total of 255 sets of observations used for regression analyses were obtained from energy balance trials carried out using 64 growing castrated male calves⁸⁻⁹⁾ weaned at

6ヵ月齢までの子牛の尿中エネルギー含量の推定: 関根純二郎・花田正明¹⁾・森田 茂²⁾・諸岡敏生・近藤誠司・大久保正彦・朝日田康司 (北海道大学農学部 札幌市 060, 道立根釧農業試験場 中標津町 086-11¹⁾ 酪農学園大学江別市 069-11²⁾)

6 week of age. In addition, 18 sets of observations were obtained from fasting trials done with 18 castrated male calves.

Energy balance trials were carried out in the same manner as reported elsewhere⁶⁻⁹⁾ at ages from 7 to 25 weeks. Methods for collection and determination of nitrogen and energy were the same as reported elsewhere⁷⁾.

Statistical analyses were done by the methods described by SNEDECOR¹⁰⁾ and STEEL and TORRIE¹¹⁾.

Results and Discussion

Table 1 shows means and ranges of UE and UN in urine of castrated male calves and those at fasting used for regression analyses. From regression analyses of two variables, a highly significant regression equation ($P < 0.01$) was obtained for castrated male calves, as shown in table 1. Standard error of the estimates averaged about 1.1% of the mean energy content of the urine. The energy content of urine was calculated to be 68 kJ/g of UN. This value was a little higher than that reported for lambs¹²⁾. The value, however, was about three times higher than the energy value for urea-nitrogen (22.8 kJ/g), which shows that not all nitrogen in urine is excreted as urea but also in such other nitrogenous compounds as hippuric acid, gluconates and other detoxication products, as pointed out by BLAXTER¹³⁾. No partition of nitrogenous compounds, however, was made in the present study.

The urinary energy was estimated by applying the equation shown in table 1 to the results for steers at the age of 1 to 3 years reported by ARMSBY and FRIES¹⁴⁾. The difference between the values thus estimated for urinary energy and the measured ones is considered to be due to an error in estimation. When the difference was regressed on the nitrogen content in urine, there was no significant correlation between them, suggesting that the nitrogen content of the urine did not cause any bias in estimation of UE. Then, regression analysis was done using the estimated (Est.) and measured (Meas.) values of urinary energy. The following significant ($P < 0.01$) regression

Table 1. Means and ranges of energy and nitrogen contents of urine for castrated male calves and regression equations

	No. of observations	Mean	Range	
			Min.	Max.
Energy content of urine (UE)			kJ/ml	
Castrated male calves	255	0.432	0.038	0.987
Fasting male calves	18	0.425	0.071	0.879
Nitrogen content of urine (UN)			mg/ml	
Castrated male calves	255	6.04	0.91	15.78
Fasting male calves	18	9.92	2.52	21.71
Regression equation			r	s. e.
Castrated male calves	UE=0.068 (±0.002) UN+0.021		0.924	±0.005
Fasting male calves	UE=0.036 (±0.006) UN+0.068		0.853	±0.038

equation was obtained:

Meas. = 0.93 (± 0.11) Est. + 0.06, $r = 0.898^{**}$, s.e. = ± 0.04 .

The regression equation shows a tendency to overestimate the energy value of urine when it is estimated from the nitrogen content in urine.

The regression coefficient, however, shows considerably close agreement between the estimates and the measured values. The coefficient of determination was calculated to be 0.81, which well speculates the relationship between the estimated and the measured values¹⁰⁾. Thus, the equation was concluded to be useful for the prediction of urinary energy values for growing calves. The results of application of observations reported by ARMSBY and FRIES¹⁴⁾ for the equation also suggest that the equation may be applied to urinary energy prediction for steers.

Results obtained from fasting appeared to differ from those observed under feeding conditions. Thus, analysis was separately made. A significant regression equation ($P < 0.01$) was obtained as shown in table 1.

ARMSBY¹⁸⁾ postulated the correction of metabolizable energy value by multiplying the value of 7.45 kcal to the nitrogen retention using the urinary energy value obtained from the experiment on dogs reported by RUBNER⁵⁾. The factor is now widely used for the determination of nitrogen corrected metabolizable energy for ruminants because of the absence of specific observations reported for ruminants¹⁸⁾.

Under fasting conditions, the body stores of fat and protein are utilized to maintain the homeostasis of the body. Thus, the nitrogen appearing in the urine corresponds to the nitrogen mobilized from the body tissue. The regression coefficient shows that the urine of a growing calf contained energy of 36 kJ/g of nitrogen, which appears to be a little higher than the correction factor postulated by ARMSBY¹⁸⁾ when the factor is converted from kcal to kJ, or 31 kJ/g of nitrogen retained.

References

- 1) BLAXTER, K. L., J. L. CLAPPERTON and F. W. WAINMAN, *J. agric. Sci., Camb.*, **67**: 67-75. 1966.
- 2) WEBSTER, A. J. F., J. S. SMITH and G. S. MOLLISON, *Anim. Prod.*, **24**: 237-244. 1977.
- 3) VERMOREL, M., J. C. BOUVIER and Y. GEAY, *Energy Metabolism*. (MOUNT, L. E., ed.) EAAP Pub. No. **26**: 49-53. Butterworths. London. 1980.
- 4) BLAXTER, K. L. and F. W. WAINMAN, *J. agric. Sci., Camb.*, **57**: 419-425. 1961.
- 5) RUBNER, M., *Zeit. Biol.*, **21**: 250-334. 1885.
- 6) SEKINE, J., S. MORITA, T. MOROOKA, M. OKUBO and Y. ASAHIDA, *Proc. 3rd AAAP*, **2**: 860-862. 1985.
- 7) SEKINE, J., S. MORITA, T. MOROOKA, S. KONDO, M. OKUBO and Y. ASAHIDA, *Jpn. J. Zootech. Sci.*, **56**: 787-791. 1985 (In Japanese).
- 8) SEKINE, J., S. MORITA, T. MOROOKA, S. KONDO, M. OKUBO and Y. ASAHIDA, *Jpn. J. Zootech. Sci.*, **56**: 920-924. 1985 (In Japanese).
- 9) SEKINE, J., S. MORITA, T. MOROOKA, S. KONDO, M. OKUBO and Y. ASAHIDA, *Jpn. J. Zootech. Sci.*, **57**: 126-130. 1986 (In Japanese).
- 10) SNEDECOR, G. W., *Statistical Methods*, 5th ed., 122-159. 438. Iowa State Univ. Press. Ames. 1956.
- 11) STEEL, R. G. D. and J. H. TORRIE, *Principles and Procedures of Statistics*. 305-331 McGraw-Hill Book Co., New York. 1960.

Prediction of Urinary Energy for Calves

- 12) ASAHIDA, Y. and Y. HIROSE, Jap. Jour. Sheep Sci., **2**: 12-14. 1965.
- 13) BLAXTER, K. L., The Energy Metabolism of Ruminants. 228. and 231. Hutchinson and Co. Ltd., London. 1962.
- 14) ARMSBY, H. P. and J. A. FRIES, U.S. D. A. Res. Bull. No. **128**: 1-245. 1911.
- 15) ARMSBY, H. P., The Principles of Animal Nutrition. 2nd. ed. 275. John Wiley and Sons. New York. 1906.
- 16) MAYNARD, L. A., J. K. LOOSLI, H. F. HINTZ and R. G. WARNER, Animal Nutrition. 7th ed. 196. McGraw-Hill Book Co., New York. 1979.