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Short Communication:

FACE-MASK TECHNIQUE AS A METHOD FOR ESTIMATION OF HEAT PRODUCTION IN CATTLE

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Since the early 1960s, there has been substantial research to doubt the accuracy and usefulness of prediction of feed requirements based on chemical analysis and a calculated metabolisable energy value of a feed. This has led to the establishment of calorimetry technology in nutrition research. The technology is used to measure the heat production of animals to develop systems of feed evaluation. It is also used to determine energy requirements by farm animals based on nett energy.

Due to the high costs in constructing the calorimetry or respiratory chambers for animals, most of the developing countries have not ventured into this field of research. This problem can be partially overcome by using the face-mask technique. Such technique simulates the open circuit respiratory chamber to measure the respiratory gaseous exchange of the experimental animals.

A face mask basically has two or more single-way breathing valves to separate the inhaled and exhaled air. When attached to the animal, the face mask allows the animal to breathe normally and the exhaled air to be collected simultaneously via a collecting tube attached to the outlet valve. The exhaled air can then be trapped into a Douglas bag or pass directly into a gas meter to determine its ventilated rate (litres per minute).

A sample of the exhaled air is collected into a gas bag and later analysed for its oxygen content. The temperature of the exhaled air and the atmospheric pressure are also measured so that the ventilated rate is adjusted to volume at Standard Temperature and Pressure (STP). The diagramatic presentation of the measuring system is shown in *Figure 1.*

Heat production can be calculated using McLEAN'S (1972) equation. In his equation, heat production (kJ) = 20.46 VX, where V is the volume of the exhaled air measured per unit time at STP and X is the difference between the O_2 concentration of inhaled and exhaled air.

However, the face mask when in use restricts feeding. It, therefore, cannot be used for continuous measurements of the respiration air of the experimental animals as can be done if respiration chambers were used. In addition, heat production changes from time to time, according to the various activities (resting, feeding, *etc.*) of the animals. The accuracy of using the face-mask technique in estimating heat production, therefore, depends on the ability of the researcher to collect respiration air samples which will accurately measure the heat productions at different times throughout the day.

A study was conducted to determine the optimum duration, time and frequency of gas sampling so that the daily heat production of the experimental animals can be accurately estimated. The results showed that there were no significant differences among the heat production data estimated from the different sampling durations studied (one to ten minutes). However, considering all the factors and practical experiences learnt from the study, it is suggested that a

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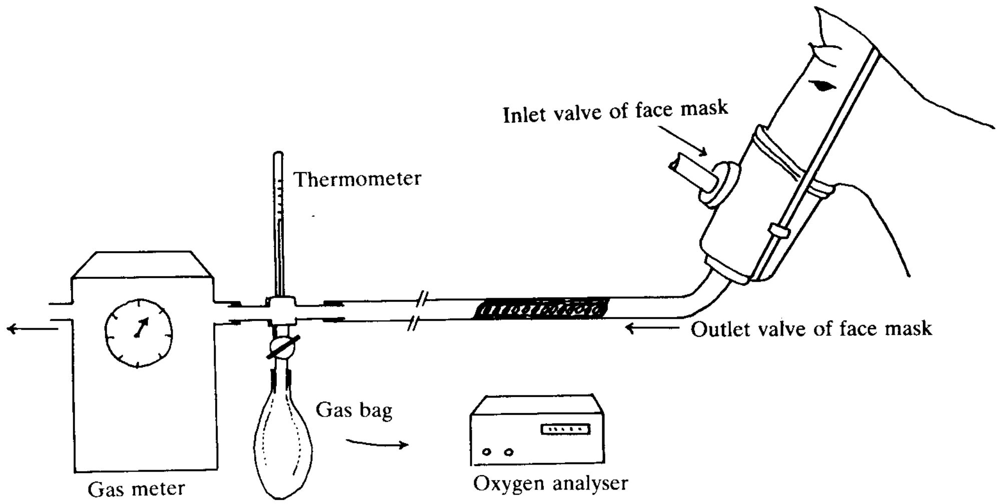

Figure 1. The diagramatic presentation of the measuring systems for heat production by the face-mask technique

Table 1. Heat production of Kedah-Kelantan bulls fed with cut Guinea grass estimated at different sampling times

Sampling time	Heat production (kJ/kg $W^{0.75}$/h) of 3 bulls			
	No. 1	No. 2	No. 3	Average
0300 h	13.43	11.38	7.36	10.72
0900 h	12.38	12.72	10.38	11.83
1200 h	14.77	14.27	13.31	14.17
1500 h	12.68	13.22	12.43	12.78
1900 h	10.84	11.55	10.79	11.06
2300 h	11.34	13.81	12.49	12.53
Average	12.57	12.83	11.13	12.18

sampling duration of six minutes (one-tenth of an hour) is most appropriate. If shorter sampling durations are used, a short interval of about one minute should be given to allow the animal to accept the face mask before sampling began. Training the experimental animals to accept the face mask before the experiment is necessary.

The results also suggested that heat production of animal differs from time to time, although the difference was insignificant ($P<0.05$) *(Table 1)*. Neverthe-less, the heat production values followed the general observation that the values were higher during and immediately after feeding (1200h and 1500 h) than before feeding (SHIBATA and MUKAI, 1979). The higher heat production values obtained during and immediately after feeding were mainly due to heat increment as a result of feeding activities. Therefore, under similar experimental conditions, respiratory air samples are best collected at least once before (0800 h) and once during or immediately after feeding (1500 h) to note the effect of heat increment as a result of feeding activities.

There are no known published local data to make comparison with. However, the overall heat production data estimated in this study although were slightly lower, the data were comparable to those estimated elsewhere *(Table 2)*. The differences could be due to diet, sex, breed and physiological stages of the animals in the different studies.

The results of this study suggested that the face-mask technique can be used to

Table 2. Comparative estimates of the heat production of cattle

Breed (diet)	Heat production (kJ/kg $W^{0.75}$/h)	Source
Kedah-Kelantan bull (grass at maintenance)	12.17	Present study
Dry Holstein cow (unknown diet)	14.73	HASHIZUME, MUSUBUCHI, HAMADA, ABE, CHIBA and YOKOTA (1963)
Holstein dry cow (Italian ryegrass hay)		SHIBATA and MUKAI (1979)
Before feeding	15.06	
After feeding	18.41	
Overall mean	19.44	Agricultural Research Council (1980)
Dairy heifer (concentrate mixture)	19.73	SHIBATA, MUKAI and KUME (1981)

estimate heat production of cattle in places where the more sophisticated animal respiratory chambers are not available. With slight modifications to the face mask, the same technique can also be adopted for buffaloes, sheep and goats.

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REFERENCES

Agricultural Research Council (1980). The nutrient requirements of ruminant livestock. Commonwealth Agricultural Board, Slough.

HASHIZUME, T., MUSUBUCHI, T., HAMADA, T. ABE, M., CHIBA, H. and YOKOTA, C. (1963). Studies of energy metabolism in cattle. I. Influence of temperature on the resting metabolism of dry Holstein cows. *Bull. Nat. Inst. Anim. Ind.* ***2***, 61–8.

MCLEAN, J.A. (1972). On the calculation of heat production from open-circuit calorimetric measurements. *Br. J. Nutr.* ***27***, 579–600.

SHIBATA, M. and MUKAI, A. (1979). The effect of environmental temperature on the relationship between ruminal volatile fatty acids and heat production of dry cows. *Jap. J. Zootech. Sci.* ***50***, 265–70.

SHIBATA, M. MUKAI, A. and KUME, S. (1981). Estimation of energy expenditure in dairy heifers walking on the level and gradients. *Bull. Kyushu Natl. Agric. Exp. Stn.* ***21***, 589–607.

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