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APPLICATION OF NUCLEAR TECHNIQUE FOR DYNAMIC STUDY IN ANIMAL RESEARCH.

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Abstract

This paper discusses the basic principle used in study the dynamic of biological compound in vivo using radioisotope with particular reference to water requirement study on farm animals. Some results of the study using the technique are also presented.

Introduction.

Radioisotopes have been widely used in animal research. This is the result of the advancement of modern technology where equipments are available for accurately quantify radioactivity and produce compounds containing radioactive materials. One of the advantages of using nuclear technique in research is that it enable the measurement on the dynamic of certain chemicals or compounds to be carried out in vivo without disturbing the normal biological proccesses. Informations generated then allow the research scientists to understand better the mechanism controlling normal body function.

Concept of dynamic study.

Figure 1 shows the basic biological system which is formed by contineous turnover of metabolic pool. Under steady state condition, the flux rates are constant and the pool remains at a constant size despite the contineous flux. If a tracer having similar chemical and biological charecteristic to the metabolic pool is introduced and evenly distributed in the metabolic pool, the rate of the tracer disappearance from the pool is a first order process. Thus:

$$dC/dt = -kCo$$

and

$$\ln C = -kt + \ln Co$$

where C is the tracer concentration; Co is the tracer concentration at the time of injection determined by extrapolation of the curve; t is the time after tracer injection and k is the velocity constant for tracer disappearance.

The pool size is estimated by dividing the dose of the tracer injected with the concentration of the tracer just after injection (Co). Thus:

Pool = Dose/Co.

The pool can also be expressed as percentage of body weight and this value is called a space.

Space = Pool x 100 / bw.

The rate of tracer disappearance is equal to the turnover rate which is the fraction of the pool turned over per unit of time. It is also called flux rate.

Flux rate = pool x k.

Turnover rates are also expressed as half-life. The turnover rate (k) relates to the half-life (T) as follow:

$$k = \ln 2 / T.$$

$$= 0.693/T.$$

Measurement of water requirement.

Water requirement or water turnover rate in life animal can be measured using isotopic water. There are several assumptions to be made using this technique (2). The assumptions are: (a) the animal is in a steady of body composition; (b) total body water of the animal is in a single compartment and isotopic water is distributed rapidly and uniformly throughout the compartment; (c) isotopic hydrogen is not incorporated into other body constituents and the isotopic hydrogen is lost from the body only in the form of water; (d) the specific concentration of water loss from the body is equal to the specific concentration of total body water.

Water turnover rate is measured by administrating a known quantity of isotopic water (0.1 mCi/kg b.w) through intramuscullar injection to over night fasted animal. After administration of the isotopic water, an equilibrium period of at least 6 hrs is allowed before any sampling (3). During the equilibration period, the animal is not allowed to take any water and only fed with concentrate to reduce the animal body water turnover (4).

After equilibration, daily blood samples are taken for a period of 5 to 7 consecutive days. The water is isolated by precipition method with dioxane (1) and the activity of isotopic hydrogen is measured using liquid scintillation counter. Water turnover rate, total body water and half-life of body water are then calculated using the equation described earlier.

Some reported results.

The isotopic technique has been used to access the impact of management systems on animal production. Table 1 shows the results of water requirement study conducted using this technique on buffalo managed under different management systems. It indicates that the requirement of water by buffaloes varies with different management systems. Since the water requirement is related with heat balance, thus it can be concluded that buffaloes under open pasture experiance high heat load as compared to the condition under plantation.

Conclusion.

Nuclear technique is very useful to be used in dynamic study. In the case of water turnover rate study, the technique allows very little disturbance to the animal and the animal is free to access the drinking water contineously. The results obtained then reflect the actual water consumed by the animal.

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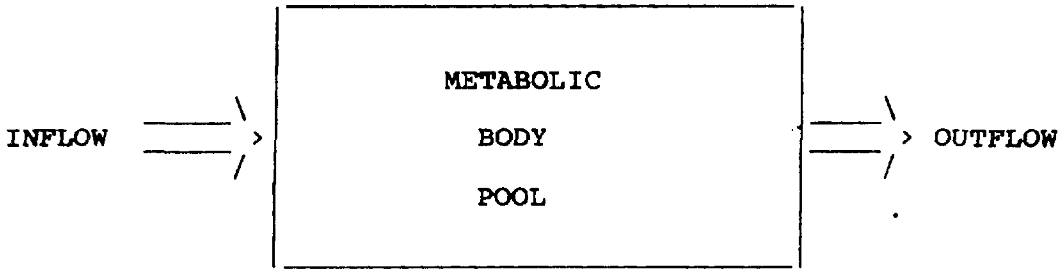

Figure 1. Single compartment steady state open system.

Table 1. Water turnover of buffaloes in open pasture and under plantation (5).

Parameter	Under plantation	Open pasture
max. temperature (°C)	31.5 (1.2)a	33.5 (1.5)b
min. humidity (%)	70 (9) a	62 (10)b
body weight (kg)	234 (10)a	237 (9)b
turnover rate (ml/d/kg$^{0.82}$)	418 (20)a	918 (30)b
half-life (d)	2.9 (0.5)a	1.8 (0.3)b
water space (% b.w)	65 (5)a	86 (10)b

( ) standard deviation
a b means values were significant at $p<0.05$.