

Daily Rhythmicity of Glycemia in Four Species of Domestic Animals under Various Feeding Regimes

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Abstract: Daily rhythmicity of physiological processes has been described for numerous variables in numerous species. A major source of this rhythmicity is a circadian pacemaker located in the mammalian hypothalamus, but very little is known about how the pacemaker generates the multiplicity of bodily rhythms. Research on rats has shown that the rhythm of blood glucose concentration is not a mere consequence of the rhythm of food ingestion, but is rather generated directly by the pace-

maker. In this study, we investigated the rhythm of blood glucose concentration in four different species of domestic animals under four different feeding regimes. Our results suggest that, as in rats, the rhythm of blood glucose concentration is not a mere consequence of the rhythm of food ingestion in sheep and cattle. In dogs and horses, however, the rhythmicity of blood glucose concentration seems to be contingent on the presence of a feeding regime.

Key words: cattle, circadian rhythm, dog, glucose, horse, sheep.

A regular pattern of daily oscillation in the levels of physiological variables in animals has been described for a multitude of variables, including locomotor activity, body temperature, heart rate, blood pressure, hormonal secretion, and urinary excretion [1, 2]. Extensive research has established that, in mammals, a circadian pacemaker located in the suprachiasmatic nucleus of the hypothalamus generates daily rhythmicity, which is modulated by environmental cycles of light and darkness, food availability, ambient temperature, and other factors [3, 4]. Very little is known, however, about how the hypothalamic pacemaker controls the multitude of daily rhythms in the body. It is very unlikely that the central clock generates each and every rhythm individually, but are most rhythms simply derived from a few clock-controlled rhythms?

Glucose concentration in the blood (glycemia) is an important physiological variable that has been shown to exhibit daily rhythmicity in animals fed on a regular schedule or ad libitum [5–9]. Because carbohydrates are a substantial part of the diet of most mammals, one would expect the daily rhythm of glycemia to be a direct result of the behavioral rhythm of food ingestion. Yet, a study in laboratory rats showed that the rhythm of blood glucose concentration persists in animals fasted for 36 h as well as in animals fed multiple isocaloric temporally equidistant meals [8]. Further investigation provided strong evidence

that the hypothalamic clock controls the daily rhythm of glycemia by direct action on the liver through the sympathetic nervous system [10]. To ascertain whether the daily rhythm of blood glucose concentration is independent of the rhythm of food ingestion in species other than the laboratory rat, we studied the daily oscillation of glycemia in dog, sheep, horse, and cattle under different feeding regimes. Use of these four species is valuable not only for comparative purposes in mammalian species varying greatly in size from 15 kg (dog) to 700 kg (cattle), but also for commercial purposes, because two of the species (dog and horse) are often exploited as athletes for human entertainment, and the other two (sheep and cattle) are exploited as sources of meat for human consumption.

METHODS

Animals. The subjects, which were all female, were 5 six-year-old bitches (*Canis familiaris*, Beagle breed), 5 three-year-old ewes (*Ovis aries*, Comisana breed), 5 seven-year-old mares (*Equus caballus*, English Thoroughbred breed), and 5 four-year-old cows (*Bos taurus*, Italian Brown breed).

The bitches were housed in individual indoor pens (140 × 200 cm) lined with wood shavings. Light timers were set to maintain a light-dark cycle with 12 h of light and 12 h of darkness each day (lights on at 07:00). Ambient tem-

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