Diurnal Variation of the Chicken Plasma Glucose

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It is well known that the blood glucose levels of many mammals are higher in the daytime. In chickens, TWIEST and SMITH\(^1\) and SMITH\(^2\) showed that the blood glucose levels were higher during hours of light. RAHEJA\(^3\) failed to observe the diurnal variation in his experiment.

The present paper reports the diurnal variation of the chicken plasma glucose levels and feed intake under normal light and dark conditions.

**Materials and Methods**

(Experiment 1)

Fifteen White Leghorn cockerels were given ad lib the commercial mash feed at 9:00-9:30 in the morning every day. The diurnal variation of feed intake was estimated by weighing the feeder every hour during the light period and every three hours during dark period. Artificial illumination (5:30-17:30) was synchronized with the time of natural dawn and dusk. The blood samples were collected from the branchial vein on alternative days. The plasma glucose values were determined by the SOMOGYI-NELSON method\(^4\).

(Experiment 2)

The time of feeding and the start of lighting were altered in order to observe the changes of the plasma glucose levels as shown below. The glucose values in these experiments were determined by o-toluidine method\(^5\).

(a) Feeds were given one and half hours later than the usual feeding time accustomed to be fed in one case, or otherwise feeds were not given.

(b) Artificial illumination was turned on at 5:30 A.M., about one hour earlier than the natural dawn (6:30) in the season of this experiment, though the cockerels were not given feed until collecting samples.

**Results**

(Experiment 1)

The diurnal variation of the feed intake in the present experiment was shown in Fig. 1. Cockerels took apparently much feed within one hour after feeding (about 20 g). After the maximal peak of the feed intake, the hourly feed consumption decreased and became steady in the daytime (below 10 g). At night they took little and from the start of the light period to the feeding time they took slightly.
The diurnal variation of plasma glucose levels was given also in Fig. 1. The plasma glucose levels at night were low, being below 220 mg/dl, and at dawn (5:30) it was 223 mg/dl. One hour after dawn (6:30) the glucose level increased to 247 mg/dl (p<0.01), and just before the feeding time (9:00) it was 240 mg/dl. One hour after feeding (10:30) it increased to 260 mg/dl (p<0.01), and two hours (11:30) it increased more (p<0.01) and reached the maximal level, 274 mg/dl. Three hours after feeding (12:30) the glucose level declined to 252 mg/dl (p<0.01), and in the afternoon (15:00) to 257 mg/dl. In the evening (17:30) the glucose level decreased to 236 mg/dl (p<0.01), one hour after dusk (18:30) it decreased further to 227 mg/dl.

The plasma glucose levels estimated during the light period were clearly higher than those of the dark period (p<0.001). The glucose levels of the postfeeding time were definitely higher than those of the prefeeding time during the light period (p<0.05), especially two hours after feeding the level was higher than each of the other times (p<0.01).

(Experiment 2)

(a) Effects of delay of the feeding time and fasting (Fig. 2)

When the feeding time was delayed one and half hours, the appearance of the maximal peak of the glucose level was also delayed one and half hours. When the feeder was taken off at 9:00 and no feed was given, within two hours the glucose level decreased significantly (p<0.01), and thereafter it decreased more.

(b) Effect of one hour advancement of the start of lighting.

Both at the time of natural dawn (6:30) and one hour before it (5:30), the glucose
level of 7 birds were similarly low; 224 and 217 mg/dl. Lighting up one hour earlier (5:30) than natural dawn, the glucose level one hour after lighting (6:30) increased to 238 mg/dl and was higher than those of the natural group (p<0.05).

Discussion

The cockerels had a diurnal variation of taking mash feed. They ate much in the morning, immediately after feeding. The mash feed consumed would be digested and absorbed in a few hours6). In the present experiment the peak of the blood glucose level appeared two hours after feeding, and that peak similarly delayed when the feeding time was delayed one and half hours. Therefore the peak of the blood glucose level after feeding was a dietary hyperglycemia.

Three hours after feeding the plasma glucose level returned to normal level and thereafter became in steady state, which was assumed to be the standard level in the fed and light time.

Woods7) showed that rats with regular feeding schedule got the circadian rhythm of insulin secretion. When the cockerels were given no feed at the usual feeding time, the glucose level dropped off much only within two hours. It will be because the cockerels had a rhythm like the rats7) that the insulin secretion increased two or three hours after the usual feeding time in spite of fasting.

Twiest and Smith1) reported that the blood glucose levels during the light period were higher than the dark period. We could observe a similar difference and this phenomenon seemed to be related to a light-dark cycle, since one hour earlier lighting increased the glucose level quickly. Smith2) reported similar changes by alteration of lighting schedule. Raheja3) failed to observe the diurnal variation of the glucose levels in his experiment. It was thought to be a problem that he collected all samples in the light time from the cockerels which seemed to behave actively.

The light-dark difference of the blood glucose levels must be considered to be in interaction to the variation of bird’s physiological function, system phase8). Berman and Meltzer9) showed that the metabolic rate (oxygen consumption and heat production) of the
fowl decreased in the night.

In the evening, not yet dark, the glucose level decreased than those of the daytime. At that time the cockerels squatted down and plunged their head into plumage, supposed to be asleep. Therefore it seems that the low glucose levels in the evening as well as during the dark period reflect sleeping or inactivity, and reversely the high glucose levels during the light period reflect awakening or activity.

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**Literature**