THE GLUCOSE TOLERANCE OF THE WEST AFRICAN DWARF GOATS

S. G. NAIR AND S. N. SHETTY

Department of Veterinary Physiology and Pharmacology,
University of Nigeria, Nsukka, Nigeria

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Summary: Glucose tolerance tests conducted on 4 adult goats and 3 kids, injecting glucose intravenously (0.5 g/kg body weight), showed that the former required 180 min and the latter 45 min after injection, to restore blood glucose to normal.

For the adult goats, the turnover rate (K) was 0.38±0.03/hr, turnover time (Tr) 2.64±0.18 hr and half-time (T½) 11.24±7.73 min for glucose clearance while for the kids, these were 1.59±0.12/hr, 0.64±0.04 hr and 28.05±4.36 min respectively. The higher glucose clearance in the kids than in the adults may be attributed to a more efficient insulin response and to greater glucose utilization than in the former. The dwarf goats appear to differ substantially from the cows in their homeostatic responses to induced hyperglycemia.

Key words: goats glucose tolerance kids

INTRODUCTION

In ruminants, the central role played by acetate in their overall energy metabolism, relegate glucose to a secondary place in this respect. From the results of glucose tolerance tests conducted on normal and diabetic cows (8), Kaneko (7) concluded that the glucose tolerance of the cow is comparable to that of other animals, eventhough earlier studies indicated a decreased glucose tolerance in cows (4) and sheep (5, 11, 15). Hale and King (3) investigated the influence of ration on glucose tolerance of lambs. Edwards (2) compared glucose tolerance of new-born and 2-4 weeks old calves. Lend (9) reviewed studies on glucose entry rate and pool size in ruminants using isotope tracer techniques.

In goats, requirement for digestible nutrients per 100 lb body weight is twice as that of cow or sheep and it is endowed with a proportionate appetite (10). The paucity of available information on glucose tolerance of goats prompted this study. The investigation was conducted on the dwarf (short-legged) goats of West Africa, a breed that has attracted scant attention from physiologists.
MATERIALS AND METHODS

West African dwarf goats, 3 females aged about 9-12 months, a one year buck and 3 kids (1 male and 1 female aged 41 days each, and 1 female aged 33 days), maintained in the University Farm, formed the experimental animals. All the animals were healthy and in good nutritional status. The kids were on mothers milk and were also fed concentrates and leaves. They were consuming appreciable quantity of leaves. Adult ruminants need not be fasted before glucose tolerance tests (7). However, concentrates were withdrawn from the ration of adult goats and kids 24 hr before the experiment, but leaves were provided ad libitum. The kids were separated from their mothers 3 hr before the test.

Two separate experiments were conducted using the same animals. In experiment 1, the animals were weighed individually and then administered intravenously (i.v.) a 50% solution of glucose (7) at the rate of 1 ml/kg body weight, taking about 3-5 min for the injection. Blood samples were collected from the animals before (basal), immediately after ('0' time) and at 1 hr after administration of glucose. Thereafter, blood samples were collected at 30 min intervals up to 3 hr. All the blood samples were analysed for glucose.

The experiment 2 was conducted to evaluate half-time (T 1/2 ) and other biokinetics of glucose clearance. This was carried out 1 month after the first experiment in the case of adult goats and 15 days in the case of kids. The experiment was conducted in an exactly similar manner as before, except that the blood samples were collected before (basal) and immediately after ('0' time) i.v. administration of glucose and thereafter, at 15 min intervals up to 1 hr.

Blood was collected from the jugular vein using sodium fluoride as anticoagulant (10 mg/ml blood). The protein-free blood filtrate was prepared by the method of Somogyi Schaffer-Hartman (13) using zinc sulphate for precipitating proteins. The filtrate by this method contains only glucose as reducing substance and hence, the estimates were the true glucose values. The filtrate was assayed for glucose by the method of Folin and Wu (13).

In the statistical analysis, Students t and Anova tests (14) were conducted. To determine the half-time (T 1/2 ) semilogarithmic plots of the blood glucose at different time intervals after i.v. administration of glucose in adults and kids were made. The formulae for calculating the biokinetics were adopted from Mixner and Lennon (12).
RESULTS AND DISCUSSION

Table I gives the blood glucose of the adult goats and kids in experiment 1, just before (basal), immediately after (‘0’ time) and at different time intervals from 60 min to 180 min postglucose administration (PGA) i.v. (0.5 g/kg body weight).

The basal blood glucose in adult goats (54.36±1.36 mg%) in this study compare with that reported (45-60 mg%) for goats (7). The higher blood glucose in the kids (80.94±2.57 mg%) than in the adults (P<0.01) is expected as young ruminants and adult non-ruminants have similar blood glucose levels (1).

**TABLE I:** Glucose tolerance in kids and adult goats in experiment 1.

<table>
<thead>
<tr>
<th>Goat/Sex</th>
<th>Blood glucose (mg%)</th>
<th>Basal</th>
<th>0’time</th>
<th>60</th>
<th>90</th>
<th>120</th>
<th>150</th>
<th>180</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kid/M</td>
<td></td>
<td>77.81</td>
<td>273.63</td>
<td>73.95</td>
<td>70.83</td>
<td>75.52</td>
<td>68.61</td>
<td>84.86</td>
</tr>
<tr>
<td>Kid/F</td>
<td></td>
<td>78.85</td>
<td>236.46</td>
<td>64.87</td>
<td>79.17</td>
<td>75.52</td>
<td>72.92</td>
<td>71.11</td>
</tr>
<tr>
<td>Kid/F</td>
<td></td>
<td>86.15</td>
<td>210.07</td>
<td>71.24</td>
<td>76.92</td>
<td>69.40</td>
<td>85.13</td>
<td>76.77</td>
</tr>
<tr>
<td>Mean</td>
<td></td>
<td>80.94</td>
<td>240.05</td>
<td>70.02</td>
<td>75.64</td>
<td>73.48</td>
<td>75.56</td>
<td>77.58</td>
</tr>
<tr>
<td>SEM</td>
<td></td>
<td>2.57</td>
<td>18.46</td>
<td>2.69</td>
<td>2.49</td>
<td>2.04</td>
<td>4.97</td>
<td>3.99</td>
</tr>
<tr>
<td>Adult/M</td>
<td></td>
<td>54.05</td>
<td>275.67</td>
<td>135.17</td>
<td>118.92</td>
<td>89.19</td>
<td>88.59</td>
<td>67.57</td>
</tr>
<tr>
<td>Adult/F</td>
<td></td>
<td>51.19</td>
<td>259.52</td>
<td>114.29</td>
<td>86.90</td>
<td>72.61</td>
<td>54.76</td>
<td>53.67</td>
</tr>
<tr>
<td>Adult/F</td>
<td></td>
<td>57.81</td>
<td>260.42</td>
<td>131.77</td>
<td>101.56</td>
<td>85.42</td>
<td>82.67</td>
<td>69.44</td>
</tr>
<tr>
<td>Mean</td>
<td></td>
<td>54.36</td>
<td>274.29</td>
<td>134.17</td>
<td>104.82</td>
<td>77.73</td>
<td>72.05</td>
<td>61.24</td>
</tr>
<tr>
<td>SEM</td>
<td></td>
<td>1.36</td>
<td>9.81</td>
<td>4.67</td>
<td>6.98</td>
<td>5.90</td>
<td>8.08</td>
<td>4.24</td>
</tr>
</tbody>
</table>

*P<0.05 and **P<0.01 compared to basal level.

The increment in blood glucose immediately PGA was more or less to the same magnitude in adults (274.29±9.81 mg%) and kids (240.04±18.46 mg%). In adults, eventhough the blood glucose steadily decreased during the experimental period, hyperglycemia persisted at 150 min (P<0.05); the basal blood glucose was restored only 180 min PGA. In the kids, at 60 min PGA, the blood glucose (70.02±2.69 mg%) was below the basal level (P<0.05) Evidently, they were able to dispose off the excess load of glucose in a much shorter time than the adults. During the remaining period of study, the blood glucose in the kids showed a tendency to stabilize.
Fig. 1 is a semilogarithmic plot of blood glucose response to the test dose of glucose (0.5 g/kg body weight) in adult and kids in experiment 2. The faster rate at which the kids were able to clear the glucose increment PGA compared to adults is demonstrated by the steeper slope of the graph for kids. In this experiment, at 45 min, PGA, the blood glucose in kids (73.79±6.19 mg%) returned to the basal level (75.82±1.93 mg%). At 60 min PGA they exhibited hypoglycemia (58.98±3.05 mg%, P<0.01 compared to basal level).

![Glucose Tolerance in Goats](image)

Fig. 1: Semilogarithmic plot of the blood glucose response to a test dose of glucose in kids and adult goats during the first hr after intravenous injection.

- a: Basal glucose.
- b: 'O' time glucose.

Each point represents the group mean.

In non-ruminants like the dog, the time taken for blood glucose to return to normal, PGA is only 60-90 min (7). The much longer duration (180 min) required for this by
the adult goats as well as the substantial difference in the glucose clearance time between
the adults (180 min) and kids (45 min). In this study, agree with the observation of others
(6,11) in similar studies in sheep that injected glucose is removed from the blood stream
in the adults at a much slower rate than in non-ruminants or in very young lambs.

Table II presents the data for glucose biokinetics for the goats in this study. The
kids exhibited a higher turnover rate (K), and a much shorter turnover time (Tt) and T1/2
compared to the adults (P<0.01) in all cases. This taken along with their ability to
restore basal glucose level within 45 min PGA compared to the 180 min for this in the
adults and the hypoglycemia that follows at 60 min PGA suggest a more efficient insulin
response to hyperglycemia in the kids. Jarrett et al. (6) using isotope dilution technique
found that young lambs have a much higher glucose utilization than the adults.

TABLE II: Biokinetics of glucose tolerance in kids and adult goats in experiment 2.

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Kids</th>
<th>Adults</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of animals</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Body weight, kg</td>
<td>2.67±0.17 a</td>
<td>12.00±1.47</td>
</tr>
<tr>
<td>Basal glucose, mg%</td>
<td>75.82±1.93</td>
<td>55.26±2.90**</td>
</tr>
<tr>
<td>Turnover rate, K, per hr</td>
<td>1.69±0.12</td>
<td>0.38±0.03**</td>
</tr>
<tr>
<td>Turnover time, Tt, hr</td>
<td>0.64±0.04</td>
<td>2.64±0.18**</td>
</tr>
<tr>
<td>Half-time, T1/2, min</td>
<td>26.05±4.36</td>
<td>110.24±7.73**</td>
</tr>
</tbody>
</table>

a Mean ± SEM

**P<0.01 compared to kids.

Kaneko and Rhode (8) in glucose tolerance studies conducted on normal cows
got a turnover rate (K) of 1.39-1.02/hr, turnover time (Tt) of 0.72-0.98 hr and T1/2 of
0.50-0.68 hr. The adult goats in this study exhibited a much lower K (0.38±0.03/hr),
and very high Tt (2.64±0.18 hr) and T1/2 (110.24±7.73 min). Presumably, goats
and cows, though ruminants, exhibit outstanding differences in their homeostatic responses
to induced hyperglycemia. The high roughage and low concentrate content of the ration
of the experimental goats might have contributed, to some measure, to the low glucose
tolerance of these animals. Hale and King (3) demonstrated that grain fed lambs had
much higher glucose tolerance than hay fed lambs.

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REFERENCES


