INGESTION OF A GLUCOSE SYRUP DRINK DURING LONG DISTANCE CANOEING

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Abstract

The use of a drink containing glucose syrup and mineral salts has been compared with a placebo in a group of eight long-distance canoeists under simulated race conditions. The findings suggest that maintenance of blood glucose above fasting level during severe exercise prevents both a deterioration of performance and prolonged post-exercise exhaustion. There was no evidence to suggest that the benefits were psychological in nature.

Introduction

In severe exercise the requirement for respiratory fuel increases (Down, 1968; Saltin and Hermansen, 1967, and Thomas, 1970) (1, 2, 3) and adipose tissue triglyceride is mobilized to provide an alternative fuel to glucose, when levels of the latter are low, as shown by the rise in blood glycerol and plasma free fatty acids (F.F.A.). The increase in concentration of F.F.A. results in an increased rate of ketone body formation; during exercise these are utilized as fuel and therefore do not accumulate, but, on cessation of work, ketone bodies tend to accumulate and continue at an elevated level, causing the condition of "post-exercise ketosis" (Johnson, Walton, Krebs and Williamson, 1969) (4).

When glucose is made available during exercise, fat mobilization is greatly reduced (Havel, Naimark and Borchgrevink, 1963 and Carlson, Havel, Ekelund and Holmgren, 1963) (5, 6) whilst pre-exercise glucose ingestion results in a rise in the respiratory quotient indicating a preference for glucose as a metabolic fuel (Issekutz, Berkhead and Rodahl, 1963) (7).

Thomas (3) has stated that, to some extent, performance is governed by the ability of the performer to avoid or delay hypoglycaemia, a view supported by Bannister (8) who listed hypoglycaemia among the chief dangers of marathon racing.

For many years sportsmen have used glucose supplements, often in the form of dextrose monohydrate tablets, but whilst these may be convenient, many have found that they present problems of nausea, and particularly during an event, a neurosympathetic inhibition of salivation. To overcome these, a logical development is a drink in which the

carbohydrate used is glucose syrup, a partial hydrolysate of starch (Wood, 1970) (9). Glucose syrup has the advantage of being much less sweet than table-sugar or dextrose, and the absence of cloying sweetness, when compared in isocaloric concentration, assists palatability and acceptance, allowing it to be used freely. Recently, a glucose syrup drink for sportsmen has been formulated containing 46% w/v glucose syrup, with added mineral salts to replace salt losses caused by sweating, 250 ml of the drink providing 355 kilo-calories. Glucose syrup is speedily absorbed (Bennett and Dodds, 1925; Dodds, Fairweather, Miller and Rose, 1959) (10, 11) and utilized (Butterfield, Sargent and Whichelow, 1964) (12) when taken orally. The rate of absorption from isolated rat intestine has been studied by Chain and his co-workers (Chain, Mansford and Pocchiari, 1960) (13) who found that both glucose syrup and dextrose were absorbed about twice as fast as sucrose and fructose and that the non-dextrose constituents of glucose syrup were absorbed without prior breakdown to dextrose.

The initial testing of this drink was performed in the laboratory and gymnasium using a cycle ergometer (Brooke, Davies and Green, 1972) (14) and a treadmill (Green and Thomas, 1972) (15). Both series of trials were designed to simulate competitive events and extremely encouraging results were obtained, but it seemed possible that field trials might provide better motivation.

The first sport studied was canoeing, where weather and water conditions had to be taken into account.

Methods

Ten canoeists (9 male, 1 female) aged 17 to 38 years were tested on two occasions; they were divided into two groups for each test, one group receiving the glucose syrup drink (Treatment T₁) and the second, (Treatment T₂), a placebo which was identical in all respects but without carbohydrate (less than 1 kcal per 250 ml). The products were presented to the participants in plain bottles to prevent identification. On the second occasion those subjects who had used the glucose syrup drink for the first test were given placebo and vice versa. The trials were carried out between 10.00 and 14.00 hours on warm, dry days and consisted of five laps of approximately 2.5 miles each; both the air temperature and the level of the river were similar on each day.

Capillary blood samples were taken at the end of each lap and after the subjects had rested for 30 minutes at the end of the trial. 250 ml of the drink were given 30 minutes before the start of the exercise, with a further 250 ml after three laps had been completed. Performance was measured by recording the lap times for each participant. The blood samples were deproteinized immediately after collection, mixed well, deep frozen and transported to the laboratory for analysis within 3 hours of collection. The glucose was determined by means of an automated glucose oxidase procedure (Sokoloff) (16).

Results and Discussion

The original ten participants were reduced to eight during the trials by illness or non-attendance; the values for these eight are shown in the succeeding tables.

When given the glucose syrup drink, the mean blood glucose value was raised from the mean fasting level by 27 mg per 100 ml after the first lap, 18 mg per 100 ml after the second and 12 mg per 100 ml prior to being given the second drink on completion of lap 3. Again the level rose by an average of 21 mg per 100 ml after the fourth lap and 20 mg per 100 ml after lap 5. In contrast, when given placebo, there was a regular fall from the mean fasting value at the end of each lap, with the exception of lap 1 when a small rise was recorded, and on completion of the five laps, the mean value was 20 mg per 100 ml below the initial level (Table 1).

TABLE 1

Blood Glucose (mg per 100 ml); expressed as mean differences from fasting levels (glucose = 78; placebo = 83).

CANOE	CLASS	K1 and K2	K1 Only
LAP 1	T ₁	+27	+35
	T ₂	+3	+4
LAP 2	T ₁	+18	+17
	T ₂	-12	-13
LAP 3	T ₁	+12	-1
	T ₂	-14	-20
LAP 4	T ₁	+21	+21
	T ₂	-14	-18
LAP 5	T ₁	+20	+25
	T ₂	-20	-23
Resting	T ₁	+26	+30
	T ₂	-17	-20

Key T₁ = Glucose syrup drink
 T₂ = Placebo drink
 K1 = Single seat canoe
 K2 = Two-man canoe

These data clearly demonstrate that ingestion of the glucose syrup drink enabled fasted subjects to maintain relatively high levels of blood glucose when undergoing strenuous exercise, whereas, using placebo, a continuous fall in the level occurred with each succeeding lap.

Individually, some quite remarkable losses were noted. Resting samples, 30 minutes post-exercise show that the use of the glucose syrup drink has prevented a fall below the fasting level, thus avoiding mild hypoglycaemia and possible ketosis. In addition, those subjects using the glucose drink on any one occasion were obviously less distressed and exhausted than their counterparts using the placebo, who frequently had to be helped to lift the canoe from the water!

The performance of the volunteers, measured by mean lap-times, is shown in Table II.

TABLE II

Mean Lap-Times (in minutes and seconds)

CANOE	CLASS	K1 and K2	K1 Only
LAP 1	T ₁	29.05	31.40
	T ₂	28.19	30.08
LAP 2	T ₁	28.49	30.52
	T ₂	27.23	30.30
LAP 3	T ₁	29.01	31.14
	T ₂	29.33	32.02
LAP 4	T ₁	30.38	32.49
	T ₂	30.39	32.52
LAP 5	T ₁	29.23	30.16
	T ₂	31.33	34.35

The mean values for the complete group i.e. K1 and K2 classes, demonstrate that when using the glucose syrup drink, the canoeists were able to return a reasonably consistent lap time, but when using placebo, there was a gradual worsening of performance, with the exception of lap 2. Unfortunately, the true effect is masked to some extent by the fact that four of the volunteers participated in K2 canoes i.e. two-man kayaks.

As the glucose syrup drink and placebo were

distributed alternately on each occasion, it resulted in each crew having one member taking the drink while his companion received placebo and inevitably the times recorded for both members of the crew were virtually identical, despite the difference in drinks being used. If the times of those four participants who used K2 canoes are excluded, then a clearer picture emerges (Tables II and III).

TABLE III

K1 Class Performance
Mean difference from 1st lap time (in seconds)

	GLUCOSE SYRUP DRINK (T ₁)	PLACEBO (T ₂)
LAP 1	-	-
LAP 2	-48	+22
LAP 3	-26	+114
LAP 4	+69	+164
LAP 5	-84	+267

The results show that the canoeists were able to sustain their performance and to improve upon the first lap-times in three of the four succeeding laps, whereas, using the placebo, lap-times grew progressively longer. The latter effect demonstrates that the improvement in performance is in no way due to the 'psychological effect' of taking a drink. The improvement in performance of the individual K1 canoeists when using the glucose syrup drink, indicated by the decrease in lap time (negative values), is further demonstrated in Table IV.

TABLE IV

Individual K1 Performances
Lap-time differences between treatments T₁ & T₂ (in minutes and seconds)

SUBJECT	A	G	H	K
LAP 1	-1.30	-1.25	+9.13	-0.11
LAP 2	+0.42	-0.30	-1.17	+2.36
LAP 3	-1.00	-0.55	-4.36	+3.20
LAP 4	-0.22	-0.19	-0.27	+0.56
LAP 5	-7.37	-2.24	-4.30	-2.48
Total Difference	-9.47	-5.33	-1.37	+3.53

Despite the performance of Subject K, the lap time improved on more occasions when the glucose drink was used than when the placebo was taken and all of the participants were capable of a sprint finish when the former was consumed (see Lap 5 times).

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