Dietary Carbohydrate and Intellectual Performance

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It is well known (Cahill & Owen, 1968) that the human brain requires approximately 120g of sugar/day in order to function properly and that this is supplied by the blood sugar which in normal individuals is maintained between 70 and 150mg/100ml. Although blood sugar governs certain psychological and hormonal responses such as appetite (Bell et al., 1965) it is not known whether it affects intellectual performance. Moreover, certain rare food sugars such as mannose are metabolized by brain tissue whereas others such as maltose are not (Sloviter & Kamimoto, 1970), and some disorders of carbohydrate metabolism, such as galactosaemia, are characterized by mental retardation (Woolf, 1968).

As part of a general programme of research into the metabolic effects of the rare food sugars in relation to their chemical structure (Birch, 1969, 1971; Birch et al., 1973) the following results demonstrate some preliminary effects of mixtures of rare food sugars, in the form of glucose-syrup fractions, on intellectual performance.

The first experiment was done with male research students aged 22–26, divided into three groups of two subjects, who were fed low- or intermediate-molecular-weight fractions of glucose syrups obtained by a reverse osmosis procedure or saccharin as a control after an overnight fast. Rate of carbohydrate feeding was 1 g/kg body weight and immediately after consumption in the form of a slurry subjects were asked to complete an intelligence test consisting of 24 questions selected in random triads from the A. H. 6 SEM test available from the National Foundation for Educational Research. To compensate for the artificial conditions of the test subjects were allowed 2min 10s to answer each triad followed by 2min 50s rest before proceeding to the next triad. In this way each test lasted 40min and hence coincided with the sharpest rate of blood sugar rise after consumption of the carbohydrate. Tests were conducted once fortnightly on three occasions so that each group performed once after receiving each of the glucose-syrup fractions and once after receiving the saccharin (placebo). All subjects had been receiving glucose-syrup fractions at 90% of their entire calorie intake throughout the previous day.

The data in Table 1 show that the low-molecular-weight fraction of glucose syrup resulted in consistently lower scores than with the high-molecular-weight fraction although the results are only significant at the 10% level. Evidently these differences cannot be simply due to amounts of blood sugar because the placebo group scored nearly as high as the intermediate-molecular-weight fraction groups overall. Further, blood glucose increases, when determined on a subsequent day after consuming these carbohydrates, showed similar values for all subjects. Possibly the data in Table 1 reflect a metabolic effect of one or more rare food sugars on brain performance. Although most of the sugar reaching the bloodstream appears as glucose the hyperosmoticity of an ingested solution can cause oligosaccharides to be absorbed intact (Menzies, 1972a,b; Menzies & Seakins, 1972). Further, the greater hyperosmoticity of the low-molecular-weight fraction could

Table 1. Test scores of male research students consuming glucose syrup fractions or saccharin

Two male research students/group. Test scores (average/subject) out of 24, i.e. eight triads after consumption of glucose-syrup fraction (1g/kg) or isosweet saccharin.

<table>
<thead>
<tr>
<th>Group</th>
<th>Low fraction (average mol.wt. 290)</th>
<th>Intermediate fraction (average mol.wt. 1100)</th>
<th>Saccharin</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>17.5</td>
<td>18.0</td>
<td>15.5</td>
</tr>
<tr>
<td>B</td>
<td>15.5</td>
<td>18.5</td>
<td>18.0</td>
</tr>
<tr>
<td>C</td>
<td>12.5</td>
<td>16.5</td>
<td>17.5</td>
</tr>
</tbody>
</table>

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Table 2. Test scores of male sixth form science pupils consuming honey, whole glucose syrup or saccharin

Seven male pupils/group. Test scores (average/subject) out of 24, i.e. eight triads after consumption of honey or glucose syrup (90g) or isosweet saccharin

<table>
<thead>
<tr>
<th>Group</th>
<th>Honey (average mol.wt. 200)</th>
<th>Whole glucose syrup (average mol.wt. 390)</th>
<th>Saccharin</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>11.6</td>
<td>17.1</td>
<td>10.4</td>
</tr>
<tr>
<td>B</td>
<td>9.6</td>
<td>9.6</td>
<td>11.0</td>
</tr>
<tr>
<td>C</td>
<td>10.9</td>
<td>11.7</td>
<td>12.0</td>
</tr>
</tbody>
</table>

induce greater psychological stress owing to delayed gastric emptying; more recent work however, in *Macaca mulatta* suggests that gastric emptying of carbohydrate meals is equally determined by their chemical structure (White et al., 1973).

In a further experiment 21 male sixth form science pupils were tested in a similar way with 90g of either whole glucose syrup or honey, saccharin being used as a control. Again the low-molecular-weight (honey) group scored lowest although not significantly so (Table 2). In both experiments the greatest differences between test scores after consumption of high- or low-molecular-weight carbohydrates appeared at the first test sitting when subjects presumably experienced greatest stress owing to unfamiliarity with test conditions. Such effects of dietary carbohydrate may, for example, be manifested as lowered accident incidence over long periods (Brooke, 1973).


Menzies, I. S. (1972a) *Biochem. J.* 126, 19p

Menzies, I. S. (1972b) *Clin. Sci.* 42, 18p


New Aflatoxins from Cultures of *Aspergillus flavus*

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During our investigations of the various aflatoxins produced by *Aspergillus flavus* 91019b and two mutant strains produced in this laboratory (*A. flavus* 91019bi and 91019bi; Hall et al., 1970), the occurrence of several previously unidentified metabolites was observed during t.l.c. purification of the culture-fluid extracts, see Fig. 1.

The identity of the compounds designated $B_{1a}$ and $G_{2a}$ was confirmed by their spectral properties which were found to be identical with those published for aflatoxins $B_{1a}$.