Comparison of Carbohydrate Digestion between Japanese and Polish Healthy Subjects

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Abstract We have revealed that light environment affects digestion and absorption of dietary carbohydrates in the gastrointestinal tract. This experimental result supposes that the efficiency of carbohydrate absorption may differ among people who live in different latitudes, such as Japanese and Polish people, at the same calendar season. In order to prove this hypothesis, we have been comparing the efficiency of carbohydrate absorption using the breath hydrogen test in Japan and Poland. Here, we report the comparison of the result obtained in the summer of 2004 as the following; (1) Orocecal transit time (OCTT) for indigestible trisaccharide of Japanese subjects was significantly longer than that in Poland (p=0.043). (2) On the ingestion of minestrone, the amount of unabsorbed carbohydrate of Japanese subjects (which was estimated as trisaccharide equivalent) was significantly larger than that of Polish subjects (p=0.006). J Physiol Anthropol Appl Human Sci 24(4): 507–509, 2005 http://www.jstage.jst.go.jp/browse/jpa
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Introduction

During the course of our investigation on the effects of environmental factors on human gastrointestinal activity, we have found the effects of light intensity on carbohydrate absorption as the followings.

(1) Daytime dim-light caused delay and/or malabsorption of dietary carbohydrate in the evening meal (Lee et al., 2001).

(2) Daytime dim-light suppressed the digestion of the evening meal resulting in less absorption of dietary carbohydrates and less gastro myoelectric activity (Sone et al., 2003).

(3) Evening time dim light exerted a better effect on carbohydrate absorption in the evening meal comparing to bright light (Hirota et al., 2003).

These results could be related to and explained by the effects of light exposure on the tone of the autonomic nervous system and resulting change in the gastrointestinal activity including salivary secretion (Nishimura et al., 2003; Kanikowska et al., 2002). These results prompted us to compare the seasonal change in the efficiency of dietary carbohydrate absorption in Japan and Poland on the assumption that human digestive activity varies according to the seasonal light environment, then the changing pattern should be different in the two countries because of the different daytime length at the same calendar seasons.

In this paper, we report the comparison of orocecal transit times and the efficiency of carbohydrate absorption of the two test meal samples at the summer of 2004.

Method

Twenty-six healthy Japanese females, aged from 19 to 23 years, and ten (3 females and 7 males) Polish subjects, aged from 18 to 30, were volunteered as paid participants. All participants were non-smoker and they were required to report antibiotic therapy anytime in the survey (Gilat et al., 1978). All female subjects were examined for breath hydrogen test in the follicular phase of their menstrual cycles because the menstrual cycle could affect the gastrointestinal activity (Wald et al., 1981). Each subject gave written informed consent for this experiment. Breath hydrogen tests were conducted on July and August of 2004 in both countries. Figure 1 shows the experimental protocol; Subject took commercially available ready-to-eat minestrone containing 72 g carbohydrate on the first day and 200 ml of indigestive trisaccharide water solution (containing 6 g of lactosucrose) on the second day at 9:10.
Subjects’ end-alveolar breath samples were collected into commercially available airtight collection bags every 20 minutes from 08:50 and hydrogen concentration was measured by gas chromatography (Breath Gas Analyzer model TGA-2000, TERAMECS, Kyoto, Japan). Because it has been shown that there is a rough linear correlation between breath hydrogen excretion rate and the quantity of unabsorbed carbohydrate (Fritz et al., 1985), the area under the hydrogen concentration vs. time curve (AUC) was used to represent hydrogen excretion due to the fermentation of unabsorbed carbohydrate by microflora in the cecum. AUC was calculated according to the trapezoidal rule (Rumessen et al., 1989) and expressed in ppm·hr. We defined the AUC values corresponding to the morning test meal as the area under curve for 3 hours from the point of time when we observed the first rise in breath hydrogen level over 5 ppm above individual base line value followed by its two more consecutive rise (* Fig. 1), at which the head of meal reached to the cecum. Therefore, the time length between 9:10 and this point of time was defined as orocecal transit time (OCTT; min). The amount of undigested carbohydrate of minestrone (UCM) was evaluated as “trisaccharide equivalent (g)” that was calculated by the following equation; $6 \frac{g}{H_11003}$($AUC$ for minestrone/$AUC$ for lactosucrose).

All data were expressed in terms of mean±standard deviation (SD). Independent samples $t$ test was applied to the statistic comparison of OCTT and UCM. A $p$ value <0.05 was considered to be statistically significant.
Results

Table 1 shows the summary of the comparison of OCTT, AUC and UCM between Japanese and Polish subjects at the summer of 2004.

Statistic analysis showed significant differences in OCTT and AUC for lactosucrose, and USM between Japanese and Polish subjects in the summer season. Figures 2 and 3 show these results of significant difference, respectively.

Discussion

In this experiment, we found that OCTT for lactosucrose (indigestible trisaccharide) had significant difference, where OCTT of Japanese subjects was significantly longer than that of Polish subjects, while OCTT for minestrone (ordinal meal) had no significant difference between Japanese subjects and Polish subjects. It is generally accepted that soluble unabsorbable oligosaccharides are not retained in the stomach before entry into the small intestine (Kondo et al., 1994), therefore the significantly longer OCTT for lactosucrose in Japanese subjects indicates that it takes longer time for the trisaccharide to pass through the small intestine in Japanese subjects than in Polish subjects.

This result might reflect the fact that anatomically the length of small intestine of Japanese is longer than that of Polish people (generally speaking, people who usually eat fiber-rich diet, Japanese, have longer intestine than people who usually eat meat, European people). But, we can’t rule out that different light environment of the two countries, daytime and night time, affect motility of the small intestine in the morning.

Concerning the efficiency of digestion of dietary carbohydrate in morning meal, we found that the amount of undigested carbohydrate of minestrone (UCM) in Japanese subjects were significantly larger than that of Polish subjects. This result indicates that the efficiency of digestion and absorption of dietary carbohydrate in the morning in Japanese subjects is less than that of Polish subjects. As we described in the introduction section, we know that dim condition during the daytime affects the digestion of evening meal causing delay of dietary carbohydrate in the evening meal. In addition, bright-light condition in the evening resulted in less digestive activity during the evening time. Therefore, we can suspect that longer daytime as well as dimmer night light condition in Poland comparing to those in Japan could affect on morning digestive activity of Polish subjects giving better absorption of dietary carbohydrate in the morning meal.

Here, we postulate possible explanation for our present results. However, in order to explain these results, we have to await further examination of breath gas analysis on Polish subjects during a whole year and to compare seasonal change in UCM. In addition, we have to carry out further experiment to know the effect of light intensity during daytime and night time on digestive system in the following morning.

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References


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