Amelioratory Effect of Barley Tea Drinking on Blood Fluidity

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Summary Effects of barley tea drinking on blood fluidity were evaluated by measuring the passage time of whole blood with a microchannel array flow analyzer (MC-FAN). The ingestion of barley tea in 250 mL amounts decreased the passage time of whole blood, but this did not occur with the ingestion of the same volume of water. 2, 3, 5-Trimethyl pyrazine at the same level as in barley tea also caused a significantly decreased time of blood passage in vitro. This suggests that alkylpyrazines may serve as factors affecting the blood fluidity in barley tea drinking.

Key Words barley tea, blood fluidity, pyrazine, thrombocyte

Barley tea is one of the most popular beverages in Japan to relieve the thirst, but few reports have been made about its physiological functions except the protective effect against gastric stress ulcer (1) and the antioxidative activity of its containing catechol (2). On the assumption that the circulatory system might be affected after the ingestion of barley tea, we investigated the effect of barley tea on blood fluidity with the MC-FAN instrument, which had been confirmed to be reliable, quantitative, and reproducible to assess blood rheology by Kikuchi et al. (3).

Experimental Subjects. Eight male subjects ranging in age from 25 to 52 y participated in the in vivo study and 8 male subjects ranging in age from 26 to 48 y provided blood for the in vitro study. Both groups were informed according to the Helsinki Declaration.

Materials. Plastic bottled barley tea, green tea, and oolong tea were obtained from a wholesale market in Tochigi, Japan. Pyrazine and 2,3,5-trimethylpyrazine were purchased from Wako Pure Chemicals (Osaka, Japan).

Measurement of blood fluidity. The measurement of blood fluidity with an MC-FAN instrument was the same as described by Kikuchi (4). Blood (5 mL) was donated by each subject via venepuncture of the antecubital vein with a syringe coated with a few drops of heparin solution (1,000 units/mL). The passage time for 100 µL of whole blood to flow through the microchannel array Bloody 6-7 (channel width 7 µm, length 30 µm, depth 4.5 µm, number 8736 in parallel; Hitachi Haramachi Electronics, Hitachi, Japan) was measured under a reduced pressure of 20 cmH₂O high.

Time schedule for in vivo study. The venous blood was gathered before breakfast from each donor, who immediately drank 250 mL of barley tea or water. One hour later, the venous blood was once again collected.

Tea samples for in vitro study. Commercially available tea samples were filtrated thorough an ultrafiltration membrane (Type LCC, Nihon Millipore; Tokyo, Japan) with cutoff molecular weight of about 5,000. A 50 µL of the ultrafiltrate was added to 100 µL of saline. Pyrazine or 2,3,5-trimethylpyrazine was diluted with saline to an appropriate concentration. Five microliters of each sample solution was added to 500 µL of blood, followed by measurement of the blood passage time.

Statistics. Data were obtained as means±SE (n=8). The blood passage times before tea drinking and 1 h after drinking were analyzed by the paired t-test following ANOVA (in vivo experiment). In an in vitro experiment, the passage time of blood mixed with its one-tenth volume of sample solution was compared by the paired t-test with that of the control (blood mixed with saline). The difference between both groups was considered significant at p<0.05.

Results In vivo study

Figure 1 compares the blood passage time before and 1 h after the ingestion of barley tea (a) or water (b). There was a significant difference in blood passage time between before and after barley tea drinking in contrast to no difference between before and after water drinking.

In vitro study

The passage time of blood containing 1% (v/v) ultrafiltrate of saline, barley tea, green tea, or oolong tea were 50.5±3.04, 47.3±2.41, 50.6±2.92, or 51.1±2.80 (s/100 µL). The coexistence of barley tea tended to decrease the blood fluidity in some extent, but green tea and oolong tea were almost equal in blood fluidity to saline. In this connection, the effects of an addition of pyrazine and 2,3,5-trimethylpyrazine at varied concentrations on the blood passage time were examined. As shown in Fig. 2 (a, b), the addition of pyrazine solution
a) Barley tea

Fig. 1. Blood fluidity before and 1 h after the feeding of barley tea (a) or water (b). The passage time for 100 µL of whole blood of each subject (closed circle) and the mean value (column) before and 1 h after the feeding of 250 mL of barley tea (a) or water (b) were shown. The passage time of whole blood was corrected by the passage time of saline determined just before the blood measurement to that expected when the saline passage time had been 12 s. Significantly different at * p<0.05.

b) Water

Fig. 2. Effects of pyrazine (a) and 2,3,5-trimethylpyrazine (b) on blood fluidity in vitro. The passage time of whole blood added with 1% (v/v) of saline (S; open column) or of each concentration (0.1, 1, 10 ppm) of pyrazine solution (solid column) was expressed as mean ± SE (n=8). The passage time of whole blood was corrected as written in the legend to Fig. 1. Significantly different from paired saline at * p<0.05, ** p<0.01.

at 0.1, 1.0, or 10 µg/mL had no effect on the blood fluidity, but an addition of 2,3,5-trimethylpyrazine solutions brought about a reduction in the blood passage time.

Discussion

To elucidate a new physiological function of barley tea, we assessed its drinking effect on the blood fluidity with an MC-FAN instrument. Barley tea significantly reduced the blood passage time at 1 h after its ingestion despite the ineffectiveness of water drinking. This implied that barley tea was superior to water in blood fluidity. Because the addition of barley tea tended to shorten the blood passage time, the low molecular substances it contained were considered to be possibly responsible for the amelioratory effect of barley tea on blood fluidity.
Pyrazine and its related compounds, which are important flavor constituents of a variety of roasted foods (5), have been reported to attenuate blood platelet aggregation (6) and to exert vasodilating activity (7). In China, incidentally, tetramethylpyrazine has been used as a remedy for thrombosis (8). Igarashi et al. (6) showed that pyrazine having three methyl substituents exerted the strongest anticoagulative effect among the pyrazines containing methyl substituent. In the present experiment, an addition of 2,3,5-trimethylpyrazine to the blood brought about a slight reduction in the passage time at the same concentration as in commercial barley tea, in which 2,3,5-trimethylpyrazine, total alkylpyrazine, and pyrazine were present at 0.1, 0.8, and 0.2 µg/mL, respectively. Therefore, the drinks containing many alkylpyrazines, such as coffee and roasted tea, may exert a similar or greater effect on barley tea.

Yamamoto and Kikuchi reported that roasted tea was ineffective to ameliorate blood fluidity with an MC-FAN instrument (9). They pointed out that coexistent caffeine in roasted tea might prolong the passage time. We have not elucidated the effects of the oral administration of 2,3,5-trimethylpyrazine on blood fluidity. The dose of pyrazines in in vitro study with platelet-rich plasma (6) or in a clinical trial in China (8) was about 100 times higher than that used in this study. Furthermore, the maximum level of 2-(allylthio)pyrazine in canine serum after an oral administration of 10 mg/kg has been reported to be about 1 µg/mL (10). Thus other ingredients in barley tea or the indirect effects of barley tea, such as psychological relaxation, might contribute to a reduction of the blood passage time. Arterial thrombosis is a multicellular event involving not only platelets, but also erythrocytes, leukocytes, and their interaction (11), the MC-FAN system being not necessarily representative of blood fluidity. Tetramethylpyrazine has been reported to inhibit platelet aggregation via the attenuation of intracellular ionized calcium mobilization (8), and several pyrazine derivatives have been suggested to inhibit calcium influx via Na+/Ca2+ exchange or through the epithelial cation channels (12). Calcium channel blockers increase erythrocyte deformability (13) and ameliorate blood fluidity (14). It thus seems quite likely that some pyrazine derivatives such as 2,3,5-trimethylpyrazine serve as factors ameliorating blood fluidity.

The faster the blood stream, the lower the blood pressure becomes. Furthermore, a reduction in share stress on endothelial cells may suppress the accentuation of arteriosclerosis. Thus a lowering of blood fluidity may accelerate the attack of lifestyle-related circulatory diseases, or vice versa. Thiosulfimates of onion and n-3 polyunsaturated fatty acids of fishes have been shown to ameliorate blood fluidity (15, 16) and to prevent cardiovascular diseases (17, 18). The muneural of Japanese apricot (19), histamine of brewed rice vinegar (20), and low molecular ingredients in black tea, Pu’er tea, and well-fermented oolong tea (9) have been shown to measurably improve blood fluidity with the MC-FAN system. These foods and barley tea may also serve to lower the risk of lifestyle-related circulatory diseases. The duration of the effective period and the optimum requirement of barley tea remain to be further elucidated.

REFERENCES


