Note

Effects of Mannooligosaccharides from Coffee Mannan on Blood Pressure in Dahl-Salt-Sensitive Rats

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Summary Dahl salt-sensitive (Dahl-S) rats, serving as a model of hereditary hypertension, were used to examine the effect of mannooligosaccharides (MOS) on blood pressure. Dahl-S rats were induced to develop hypertension by administering them with a 1.25% salt solution ad libitum. In a 10-wk experimental period, the Dahl-S control and MOS groups developed and maintained significantly higher blood pressure than the Dahl salt-resistant normal control group. The MOS group showed a significantly lower blood pressure than the Dahl-S control group after 5-wk of treatment (p<0.05). In addition, the serum aldosterone level of the MOS group significantly decreased (p<0.05). The findings of this study using a model of hypertensive rats suggest that MOS are able to suppress an elevation in blood pressure.

Key Words mannooligosaccharides, blood pressure, hypertension, serum aldosterone

We successfully extracted mannooligosaccharides (MOS) from spent coffee grounds (1). Previous studies have confirmed that MOS have a beneficial effect on the large bowel function by improving the intestinal microflora (1–3). Recently, our studies revealed that MOS reduce body fat by inhibiting fat absorption (4–6). Further investigations have been undertaken to explore the potential functionality of MOS.

Indigestible oligosaccharides have been reported to reduce blood pressure. Fructooligosaccharide intake has been reported to decrease diastolic blood pressure in hyperlipidemic patients (7). Soybean oligosaccharide intake was shown to decrease diastolic blood pressure in healthy men (8). MOS from coffee are indigestible oligosaccharides (2) and are expected to control blood pressure. However, until now, no study regarding the effect of MOS on blood pressure control has been conducted.

In the present study, we examined the effect of MOS on blood pressure in Dahl salt-sensitive rats (Dahl-S), serving as a model of hereditary hypertension.

Materials and Methods

Preparation of MOS MOS were prepared as described in a previous study (9). Spent coffee grounds were hydrolyzed in a reactor that was kept at 220°C. The hydrolyzed product was decolorized with activated carbon powder and desalted with a cation and anion exchange resin. Monosaccharides were eliminated using active carbon chromatography with a stepwise gradient of water and 10.0% (v/v) ethanol. The purified solution was concentrated in a rotary evaporator and lyophilized. The MOS mixture [mannose, 0.4%; dp (degree of polymerization) 2, 19%; dp3, 27%; dp4, 21%; dp5, 17%; and dp6 or more, 14%] was used for the animal tests.

Animals. Five-week-old male Dahl-S and salt-resistant (Dahl-R) rats were purchased from Kyudo Co., Ltd. (Kumamoto, Japan). To ensure proper quarantine, the rats were placed in care for 7 d after delivery and acclimated to the new environment for 14 d. The rats were fed water containing 1.25% NaCl to induce hypertension. Only animals with no abnormalities in their overall physical state were used in this experiment.

Care conditions. The animals were placed in a movable rack made of stainless steel. The room was kept at a temperature of 23±1°C, a humidity of 55±5%, and under a 12-h alternating light/dark cycle (artificial lighting: 7 am to 7 pm). During this preliminary period, the rats had free access to the powdered diet (CE-2; CLEA Japan, Inc., Tokyo, Japan).

Test methods. The experimental design of this study was approved by the Animal Experiment Committee of the Prefectural University of Kumamoto. After the preliminary period, 10 Dahl-S rats were divided into 2 groups (n=5 per group) according to their weight. Five Dahl-R rats were used as normal controls. The animals were fed the experimental diet and water containing 1.25% NaCl (salt water) ad libitum for 10 wk. The
experimental diet was the powdered CE-2 diet (CLEA Japan, Inc.), which contained 30% (w/w) corn oil. In the MOS group, MOS were given three times a day by oral administration (900 mg/animal/d). In the normal control and the control groups, water was administered instead of MOS. Body weight was measured once a week, and the total food and salt water intakes were measured every day. The animals were deprived of diet for more than 18 h, starting in the evening of the day before the end of the test period; however, they still had access to water containing 1.25% NaCl. After the rats were etherized, blood samples were drawn from the abdominal artery.

Measurement of blood pressure and serum aldosterone. Systolic blood pressure (SBP) in the rat caudal artery was measured via the tail cuff method. After the rats were warmed for 5 min in a room with an ambient temperature of 37°C and fixed in place with a holder, SBP was measured using an MK-1030 non-invasive blood pressure monitor for rats (Muromachi Kikai Co., Tokyo, Japan). Five SBP measurements were taken when the rats remained motionless, and the average of the readings was entered as the measured data. Blood pressure was measured once a week. The serum aldosterone level was measured in the blood sample collected at the end of the experiment with an Aldosterone EIA Kit (Cayman Co., USA).

Statistical methods. The data obtained are expressed as mean±SE. A one-way ANOVA and multiple-range test (Fisher's protected least-significant difference test) were used to test the significant differences between the groups; significance was set at p<0.05. All statistical analyses were performed using the Excel Statistics Software package (OMS Publishing, Tokyo, Japan).

Results and Discussion
The results of the experiment on body weight are shown in Fig. 1. An increase in body weight was observed in all the groups throughout the experiment. Dahl-S rats (the control and MOS groups) had a growth curve similar to that of the Dahl-R rats. No significant difference in body weight change was observed between the control and MOS groups.

The average intakes of food and salt water by the rats are shown in Fig. 2. No significant difference in food or salt water intakes was observed between the control and MOS groups (Fig. 2A and B).

The SBP curve is shown in Fig. 3. Compared with the normal group, the control and MOS groups had a significantly elevated blood pressure, which confirmed the fact that a higher blood pressure was induced by salt intake. The SBP of the control group was 135.0±5.3 mmHg before the experiment and gradually rose to 203.4±4.9 mmHg by the end of the experiment. On the
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other hand, the MOS group began to show a lower SBP in the 5th week of the experiment compared with the control group. This trend continued throughout the remainder of the experiment, and the SBP in the 10th week (185.0±4.4 mmHg) was significantly lower than that of the control group (p<0.05).

The results for serum aldosterone levels are shown in Fig. 4. The control group had a significantly higher serum aldosterone level than the normal group. However, the serum aldosterone level in the MOS group was significantly lower than that in the control group (p<0.05).

Indigestible oligosaccharide intake has been reported to reduce blood pressure (7, 8). In the present study, the effects of MOS on the blood pressure of the Dahl rats were investigated. Dahl-S rats are characterized by a moderate increase in blood pressure when fed a low-salt diet (10). In the present experiment, the Dahl rats were given 1.25% NaCl solution ad libitum, which elevated blood pressure. Before the start of the experiment, blood pressure of the control group was significantly higher than that of the normal group. Moreover, the control group remained hypertensive throughout the experiment, with blood pressure increasing gradually over time.

On the other hand, inhibition of blood pressure elevation was evident in the MOS group. In the 5th week of MOS administration, blood pressure was lower than that of the control group. This trend continued throughout the experiment. Various increases in blood pressure could be induced in Dahl rats, depending on the amount of salt consumed (11). However, in the present study, there was no difference in the average daily salt intake of the control and MOS groups. Therefore, it was assumed that both the groups were predisposed to have a similar increase in blood pressure.

The renin-angiotensin system (RAS) is one of the blood pressure-elevating mechanisms of the body. Renin is secreted from the kidneys and triggers a cascade of enzyme reactions, which in turn results in the secretion of aldosterone, a blood pressure booster (12, 13). In this experiment, the serum aldosterone level of the MOS group was significantly lower than that of the control group. Therefore, it is assumed that this is one of the reasons why MOS are able to inhibit an elevation in blood pressure. Although renin was not monitored in this experiment, MOS might have intervened in some parts of the regulatory system and reduced the increase in blood pressure (14), given that the RAS controls the secretion of aldosterone.

This study suggests that MOS are able to suppress an elevation in blood pressure. Further study to clarify the mechanism of MOS on blood pressure control is required.

REFERENCES


