Dietary Mushrooms Reduce Blood Pressure in Spontaneously Hypertensive Rats (SHR)

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Summary The blood pressure of spontaneously hypertensive rats (SHR) were significantly reduced by Maitake feeding for 8 weeks period beginning at a time when the animals were 10 weeks of age with well-established high blood pressure. There was no difference in the plasma total and free cholesterol, triglyceride and phospholipid levels between the Maitake fed animals and the control. On the other hand, Shiitake mushroom did not reduce the blood pressure, but significantly lower the plasma free cholesterol, triglyceride and phospholipid in compared with the control. The results suggest that dietary Maitake mushroom reduce the blood pressure.

Key Words blood pressure, spontaneously hypertensive rat (SHR), mushroom, Shiitake, Maitake

The pathogenesis of the high blood pressure in the spontaneously hypertensive rat (SHR) is conditioned by hormonal and nutritional factors (1–4). We previously reported that dietary mushrooms effectively prevented the increase of blood pressure in young SHRs (5, 6). It is of interest to investigate what effect, if any, these mushrooms have on SHRs of established high blood pressure. Thus, this study was undertaken primarily to examine whether mushrooms were effective in reducing the blood pressure of SHR after the establishment of a definitely elevated blood pressure.

The experiment was conducted on male SHRs of the Okamoto strain (from Funabashi Farm) when the SHRs were 10 weeks of age because at this time their high blood pressure had become well established. The animals were divided into 3 groups (5 rats per group) by matching average blood pressure and body weights. The grouping of rats and the composition of diets were as reported previously (5). Fresh diet and 0.5% NaCl solution to drink were available ad libitum. The rats were kept under controlled experimental conditions and blood pressure was recorded as...
previously described (5). The average of 3 recordings of blood pressure was taken as the systolic pressure of the rat.

Animals were starved overnight and then sacrificed by ether anesthetization after an 8-week feeding period to obtain liver and blood from the abdominal aorta. Plasma total and free cholesterol, triglyceride and phospholipid levels were measured by using assay kits (Wako Pure Chemical Industries, Ltd., Osaka). The data were analyzed by Student’s t-test; where t-test was not possible, Cochran–Cox test was followed.

The mean changes and standard errors in blood pressure of rats over the 8-week period of mushroom diets are shown in Fig. 1. At 10 weeks of age, when the experiment was started the acutely rising blood pressure of the SHRs reaches a plateau with an established high blood pressure of about 201 mmHg and then rises at a much slower rate. By the fourth week after beginning the diets, the rats manifested a reduction in blood pressure. The Maitake mushroom diet caused a significant (p<0.05) reduction in blood pressure and remained significant throughout the experimental period.

In contrast to the marked differences in blood pressure, the control and Maitake groups of animals appeared to be identical in their rate of growth, general health and activity. The final body and tissue weights are shown in Table 1. There was no significant difference among the groups.

The plasma cholesterol, triglyceride, and phospholipid levels are shown in Table 2. The total cholesterol levels in the rats fed Shiitake mushroom did not differ significantly from that of the control, but the free cholesterol level was significantly lower (p<0.05) than that of the control, which confirmed the results of our previous

*Fig. 1. Systolic blood pressure changes in spontaneously hypertensive rats fed mushroom diets. Each point represents the mean ± SE for 5 rats. Significantly different from control, *p<0.05, **p<0.01.*
Table 1. Effect of mushrooms on final body and organ weights of SHRs.

<table>
<thead>
<tr>
<th></th>
<th>Body wt. (g)</th>
<th>Liver (g)</th>
<th>Kidney (g)</th>
<th>Heart (g)</th>
<th>Brain (g)</th>
<th>Thyroid (mg)</th>
<th>Pituitary (mg)</th>
<th>Adipose (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>361.8 ± 8.3</td>
<td>10.1 ± 0.7</td>
<td>2.3 ± 0.1</td>
<td>1.6 ± 0.11</td>
<td>1.8 ± 0.11</td>
<td>16.4 ± 0.7</td>
<td>10.3 ± 0.4</td>
<td>6.6 ± 0.2</td>
</tr>
<tr>
<td>Shiitake</td>
<td>345.8 ± 7.5</td>
<td>10.5 ± 0.3</td>
<td>2.3 ± 0.1</td>
<td>1.5 ± 0.08</td>
<td>1.8 ± 0.05</td>
<td>17.3 ± 0.9</td>
<td>8.7 ± 0.7</td>
<td>6.0 ± 0.2</td>
</tr>
<tr>
<td>Maitake</td>
<td>344.2 ± 7.1</td>
<td>9.9 ± 0.4</td>
<td>2.2 ± 0.07</td>
<td>1.4 ± 0.06</td>
<td>1.8 ± 0.08</td>
<td>16.3 ± 0.6</td>
<td>10.1 ± 0.2</td>
<td>6.8 ± 0.4</td>
</tr>
</tbody>
</table>

Each value represents mean ± SE for 5 rats.

Table 2. Effect of mushrooms on plasma cholesterol, triglyceride, and phospholipid levels in SHRs.

<table>
<thead>
<tr>
<th></th>
<th>Cholesterol</th>
<th>Triglyceride</th>
<th>Phospholipid</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total</td>
<td>Free</td>
<td>Ester ratio  (%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>52.6 ± 4.1</td>
<td>17.7 ± 2.3</td>
<td>66.3</td>
</tr>
<tr>
<td>Shiitake</td>
<td>35.7 ± 5.6</td>
<td>8.2 ± 1.3*</td>
<td>77.0</td>
</tr>
<tr>
<td>Maitake</td>
<td>41.7 ± 3.2</td>
<td>13.2 ± 1.2</td>
<td>68.4</td>
</tr>
</tbody>
</table>

Each value represents mean ± SE for 5 rats. Significantly different from control, *p < 0.05.

In this study, plasma triglyceride and phospholipid levels in the Shiitake-fed group were also significantly lower (p < 0.05) when compared with the control. On the other hand, in the Maitake group no significant differences in plasma total and free cholesterol, triglyceride and phospholipid levels were observed when compared with the control. The results indicate that the plasma lipid levels of the animals is not the important determinant factor for blood pressure in SHR. In the case of Maitake-fed rats, although the plasma lipid levels were not decreased, the blood pressure was significantly decreased, which is contrary to the results obtained from the Shiitake-fed animals.

The present results support the contention that the Maitake mushroom not only suppresses the developing hypertension, it also lowers the blood pressure. This reduction of high blood pressure and the suppression of hypertension may take place by the same mechanism or two different mechanisms. It seems unlikely that Maitake was a specific antagonist of the basic pathogenetic mechanism operative in SHR, since the hypertension was not completely arrested soon after the treatment. It is possible that Maitake feeding may initiate cardiac, neural, or humoral alterations causing a primary fall in transmural pressure which then signals a
secondary process leading to prevention of the vascular alterations which normally accompany hypertension and through this means acts to lower the blood pressure.

At this stage of our experiments we only can postulate that there may be no relationship between blood pressure control by mushrooms and the levels of lipids. These findings indicate that the genetically programmed spontaneous hypertension of SHR is not of inexorable direction but can be manipulated by dietary and nutritional conditions, as reported by Wright et al. (7). The hypertension can be accelerated by excessive salt ingestion or it can be arrested for the entire period of antihypertensive drug treatment (8). In accordance with our previous reports (5, 6), it is pertinent to emphasize that the dietary manipulation must be instituted as early as possible to cause the most effective inhibition of rising blood pressure. After the establishment of high blood pressure, the reduction of blood pressure is not as effective as in the early stage (Fig. 1 and Ref. 5). It appears that when the duration of the hypertension is uncontrolled, the hypertension proceeds to higher and higher levels by gradual increments. Thus, the genetic and environmental factors appear to interact in determining the rate of development of hypertension in SHR.

In conclusion, the present study strongly suggests that the blood pressure of SHR can be altered by varying the source of diet. Maitake diet ameliorates the hypertension. However, further research is necessary to elucidate the mechanisms by which Maitake exerts its physiological effects on blood pressure.

REFERENCES
