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Antihypertensive Effect of Benifuuki Tea Containing *O*-Methylated EGCG

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Benifuuki is a tea cultivar with an antiallergic effect stronger than that of Yabukita tea, the most popular green tea cultivar consumed in Japan. The effective compound is (−)-epigallocatechin-3-*O*-(3-*O*-methyl)gallate (EGCG3″Me), an *O*-methylated derivative of EGCG. This study examined the antihypertensive effects of EGCG3″Me and Benifuuki tea. First, it was determined that EGCG3″Me has a significant inhibitory effect on the activity of angiotensin I-converting enzyme (ACE). Second, clinical trials showed that Benifuuki tea suppressed high blood pressure to a greater extent than green tea that did not contain EGCG3″Me after equal amounts of tea catechins were consumed for 8 weeks. The effect of Benifuuki tea on human hypertension is mainly the result of the strong inhibitory effect of EGCG3″Me on ACE activity, its high rate of absorption, and its stability in the blood.

KEYWORDS: Benifuuki tea; EGCG3″Me; antihypertension; angiotensin I-converting enzyme

INTRODUCTION

Benifuuki is a tea cultivar (*Camellia sinensis* L.) that was originally established by the National Institute of Vegetable and Tea Science, National Agriculture and Food Research Organization, Japan, and was registered for use as a black tea. Benifuuki is rich in epigallocatechin-3-*O*-(3-*O*-methyl)gallate (EGCG3″Me), which is not present in the Yabukita cultivar, the most popular green tea, which accounts for about 75% of green tea products consumed in Japan (*1*). EGCG3″Me has been reported to inhibit type I allergies to a greater extent than epigallocatechin gallate (EGCG), a major catechin of tea leaves (*2*). The main mechanism responsible for this antiallergic effect has been elucidated: EGCG3″Me strongly suppresses the release of histamine and leukotrienes from mast cells by preventing tyrosine phosphorylation of cellular proteins, phosphorylation of the myosin light chain, and expression of the high-affinity receptor for IgE (FcεRI) (*3*−*5*). Clinical studies have also shown that Benifuuki tea is useful for relieving some of the symptoms of Japanese cedar pollinosis (*6*) and atopic dermatitis (*7*).

Recently, Benifuuki extracts containing EGCG3″Me have been included in allergy prevention products in the form of candy, supplements, beverages, and cosmetics. Although Benifuuki was originally bred for use as a black tea, it has been used in the green tea form to maintain its EGCG3″Me content, which is destroyed in the fermentation process by which black tea is manufactured (*8*).

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Pharmacokinetics analysis confirmed that EGCG3″Me has a significantly higher absorption rate from the intestine and a lower disappearance rate from blood than EGCG (*9*). Therefore, although the amount of EGCG3″Me in Benifuuki tea is very small relative to that of EGCG, the blood concentrations of these two catechins after Benifuuki tea ingestion are almost identical. This is considered to be the main reason why Benifuuki has greater antiallergic activity than Yabukita.

Tea catechins have been widely studied with respect to bioregulatory activities such as antiallergic, anticarcinogenic, antimetastatic, antioxidative, antihypercholesterolemic, antidental-caries, and antibacterial effects and their amelioratory activities on intestinal flora (*10*−*15*). Ester-type tea catechins and theaflavins in black tea have an inhibitory effect on angiotensin I-converting enzyme (ACE) activity (*16*) and suppress high blood pressure in humans.

The renin−angiotensin pathway is one of the main mechanisms by which blood pressure is increased. In this pathway, ACE converts angiotensin I to angiotensin II, which increases blood pressure. More than 90% of hypertension patients are classified as having essential hypertension, which was thought to be mainly caused by an aberrant renin−angiotensin system. Therefore, we hypothesized that tea catechins would have a preventative or ameliorative effect on essential hypertension because of their inhibitory effect on ACE. It has also been reported that tea catechins decrease the risk of mild hypertension (*17*).

Although the inhibitory effect of EGCG on ACE has been described, that of EGCG3″Me has not been investigated. As EGCG3″Me has excellent absorption efficiency and stability in the body, Benifuuki, which contains EGCG3″Me, should have a stronger hypotensive effect than Yabukita if EGCG3″Me has a

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strong inhibitory effect on ACE. In this study, we examined the inhibitory effect of EGCG3″Me and Benifuuki on ACE in vitro and the hypotensive effect of Benifuuki in normal subjects with a slightly elevated blood pressure and mildly hypertensive patients.

MATERIALS AND METHODS

Materials. EGCG was purchased from Sigma-Aldrich Japan (Tokyo, Japan) and EGCG3″Me from Nagara Science (Gifu, Japan). Benifuuki extract and Yabukita extract used for assay of ACE inhibitory activity were prepared by incubating 5 g of leaves of Benifuuki and Yabukita with 100 g of water at 90 °C for 10 min, respectively. Benifuuki extract powder was purchased from Asahi Soft Drinks (Tokyo, Japan) and green tea extract powder, which does not contain EGCG3″Me, from San-Ei Gen FFI (catalog no. 16714; Osaka, Japan) for the clinical trial. ACE (EC 3.4.15.1, peptidyl-dipeptidase A from rabbit lung) was purchased from Sigma-Aldrich. Hippuryl-His-Leu solution was purchased from the Peptide Institute Inc. (Osaka, Japan) and used as the substrate for the enzyme reaction. Other reagents, which were all of special grade, were purchased from Wako Pure Chemical Industries (Osaka, Japan).

Measurement of the Amount of Catechins and Caffeine in Tea Extract. Tea samples were prepared for HPLC analysis as follows. Samples were immersed in 50% ethanol containing 1% H_3PO_4, disrupted using an ultrasonic apparatus for 30 min at 20 °C, and then filtered through a membrane filter (0.45 μm pore size). The HPLC assay was performed using a Shimadzu LC-10A pump coupled to an UV detector (SPD-M10Avp; Shimadzu, Kyoto, Japan) and a reverse-phase Wakopak Navi C18-5 column (4.6 mm i.d. × 150 mm; granule diameter, 5 μm; Wako Pure Chemical Industries).

Elution consisted of a 2−45 min linear gradient from 0 to 80% of solvent B and solvent A. Solvent A consisted of distilled water/phosphoric acid/acetonitrile (400:10:1 v/v), and solvent B consisted of methanol/solvent A (1:2 v/v). Samples were eluted at a flow rate of 1 mL/min at 40 °C. The detection wavelength was 272 nm. The amounts of catechins and caffeine in tea extracts were measured by comparing the peak area of each catechin in tea extract with that of a standard preparation that contained a fixed quantity of caffeine, strictinin, epicatechin (EC), catechin (C), EGCG, gallocatechin gallate (GCG), epicatechin gallate (ECG), catechin gallate (CG), EGCG3″Me, and gallocatechin-3-*O*-(3-*O*-methyl)gallate (GCG3″Me).

Assay for ACE Inhibitory Activity. The ACE inhibitory activity of tea catechins and tea extracts was measured according to the method of Horie (*18*). Aliquots (25 μL) of tea samples of various concentrations were preincubated with 4.7 mM hippuryl-His-Leu (50 μL) in 400 mM potassium phosphate buffer (pH 8.3) containing 600 mM NaCl at 37 °C for 10 min. Then, 0.025 U/mL of ACE (50 μL) was added, and the solution was incubated at 37 °C for 40 min. For the control and blank, distilled water was added instead of tea samples and ACE, respectively. To 25 μL of the reaction mixture were added 0.3 M NaOH (150 μL) and 10 μL of 2% *o*-phthalaldehyde in methanol. The solution was kept at room temperature for 10 min, after which 20 μL of 3 M HCl was added to stop the enzyme reaction. The amount of liberated His-Leu was determined by measuring the intensity of fluorescence generated after the addition of *o*-phthalaldehyde (excitation, 355 nm; emission, 460 nm) using a 1420 ARVO (TM) Multilabel Counter (Perkin-Elmer, Inc., Boston, MA).

The inhibition rate was calculated as [100 − (sample − blank)/(control − blank)] × 100, where sample is the fluorescence intensity of the test sample in the presence of the reaction mixture, blank is the fluorescence intensity of tea test sample in the absence of ACE, and control is the fluorescence intensity of buffer in the absence of the test sample.

Analysis of ACE Assay Data. Statistical analysis was performed using SPSS 13.0J for Windows (SPSS Japan Inc., Tokyo, Japan). All results are expressed as the mean ± SD. Differences in continuous variables between the two samples were analyzed by two-way analysis of variance (ANOVA) followed by Dunnett's multiple-comparison test. A value of $P < 0.05$ was considered to be statistically significant.

Clinical Trials. *Open-Label Study*. We selected 10 subjects who were classified as being normal but had slightly high blood pressure or mild hypertension according to the Japanese Society of Hypertension Guidelines for the Management of Hypertension (2004) and who were not taking antihypertensive medication, nutritional supplements, or Japanese FOSHU (foods for specified health use).

The study protocol was approved by the Institutional Review Board of the National Institute of Vegetable and Tea Science (NIVTS) for Human Research and was carried out in accordance with the Declaration of Helsinki. Written informed consent was obtained from all participants before study participation in accordance with the guidelines of the Hara-Doi hospital research ethics committee.

All subjects prepared Benifuuki tea from a tea bag containing 2 g of Benifuuki leaves by steeping a tea bag and dunking it up and down several times in freshly boiling water of >200 mL for 1 min and drank it containing 25 mg of EGCG3″Me twice daily after breakfast and lunch for 8 weeks.

Blood pressure was measured before the study commenced and every 4 weeks during the study by using an electric sphygmomanometer (CH-485E; Citizen Watch Co., Ltd., Tokyo, Japan). We measured blood pressure until the differences of several values reached within 5 mmHg and got the averages of two consecutive dates with subjects sitting down at rest. Blood, urine, and anthropometric parameters were measured only before the study.

Statistical analyses were performed using SPSS 13.0J for Windows (SPSS Japan Inc., Tokyo, Japan). Results are expressed as the mean ± SD. A paired *t* test was used to compare the changes in blood pressure, blood, urine, and anthropometric parameters during the test period. Statistical significance was assessed at the 5% level.

Double-Blind and Intergroup Study. We selected subjects as described for the open-label study. All subjects signed informed consent forms prior to the study in accordance with the guidelines of the Hara-Doi hospital research ethics committee.

In the double-blind study, we compared the decrease in patients' blood pressure between Benifuuki tea (BT), green tea (GT), and dextrin (C), which is the placebo for tea ingestion. Subjects were randomly assigned to BT, GT, or C treatments and instructed to take four capsules twice daily after breakfast and lunch for 8 weeks. The BT and GT capsules contained spray-dried BT and GT powder from hot water extracts, respectively. The total amounts of tea catechins in these capsules were almost identical. However, only the BT capsule contained 20 mg of EGCG3″Me and 5 mg of GCG3″Me, which is epimerized from EGCG3″Me during the process of extraction and spray-drying. Incidentally, GCG3″Me has a stronger antiallergic effect than EGCG3″Me (*19*). During the test period, subjects were asked to refrain from taking medicines or FOSHU to decrease blood pressure, to refrain from drinking green tea, and to keep the dietary habit as usual.

Blood pressure was measured before the study and every 4 weeks during the study in the same way as in the open-label study. Blood and urine samples were collected before and after the test period, and an examination was conducted by a doctor after the test period to check for side effects. The following clinical chemistry analyses were conducted: urea nitrogen, creatinine, uric acid, electrolytes (Na, K, Cl, Ca, and Mg), GOT, GPT, ALP, g-GTP, LDH, total bilirubin, total protein, albumin, HbA1c, total cholesterol, HDL-cholesterol, triglycerides, white blood cell count, red blood cell count, hemoglobin level, hematocrit, MCV, MCH, MCHC, and blood platelet count in peripheral blood and protein, pH, sugar, occult blood, Na, K, Cl, and creatinine in urine. The intake of the capsules during the study period was checked using daily reports.

Statistical analysis was performed using SPSS 13.0J for Windows (SPSS Japan Inc.). All results are expressed as the mean ± SD. Differences between groups were assessed using analysis of variance (ANOVA) and Tukey's test. Changes within groups in blood and urine parameters and blood pressure between weeks 0 and 8 were analyzed using the unpaired *t* test. Statistical significance was assessed at the 5% level.

RESULTS

In Vitro ACE Inhibitory Activity. Figure 1 shows the structures of EGCG and EGCG3″Me examined in this study. In the first experiment, EGCG3″Me or EGCG was added to the ACE reaction mixture at a concentration of 0.0213, 0.107, 0.426, or 1.04 mM. Both catechins inhibited ACE activity

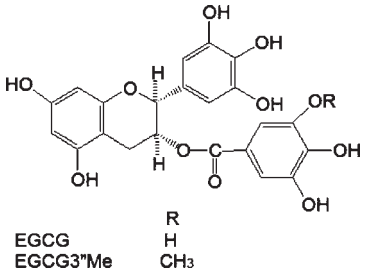

Figure 1. Chemical structures of EGCG and EGCG-3-*O*-(3-*O*-methyl)-gallate.

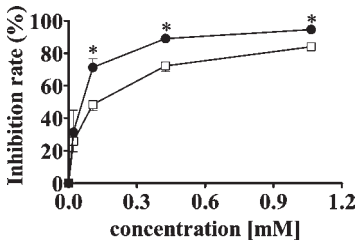

Figure 2. Effect of EGCG3″Me (●) and EGCG (□) on inhibition of ACE activity. Data are expressed as the mean ± SD (n = 3). Differences were analyzed by a two-way analysis of variance followed by Dunnett's multiple-comparison test and were significant between EGCG3″Me and EGCG. ∗, P < 0.05 versus EGCG.

Table 1. Composition of the Extract Used To Measure ACE Inhibitory Activity

	'Benifuuki' extract	'Yabukita' extract
catechin	87	90
epicatechin	210	239
gallocatechin	296	175
epigallocatechin	508	446
catechin gallate	43	34
epicatechin gallate	250	440
gallocatechin gallate	265	182
epigallocatechin gallate	844	1182
gallocatechin-3-*O*-(3-*O*-methyl)gallate	48	nd[a]
epicatechin-3-*O*-(3-*O*-methyl)gallate	47	nd
epigallocatechin-3-*O*-(3-*O*-methyl)gallate	189	nd
total amount of tea catechins	2788	2789
caffeine	112	140

[a] nd, not detected.

dose-dependently. However, EGCG3″Me inhibited ACE activity to a greater extent (P = 0.048) than EGCG (**Figure 2**).

Furthermore, in the second experiment, Benifuuki extract, which contains EGCG3″Me, or Yabukita extract, which does not contain EGCG3″Me (**Table 1**), was added at a concentration of 0.056, 0.28, 1.12, or 2.79 mg/mL. At each concentration, the total amounts of tea catechins in the two types of tea extracts were almost identical, but the amounts of individual catechins were slightly different. Benifuuki had a stronger inhibitory effect on ACE activity than Yabukita (**Figure 3**), but the difference was not significant.

Clinical Studies. *Open-Label Study*. The catechin composition of tea leaves contained in the tea bag is shown in **Table 2**, and the characteristics of subjects are shown in **Table 3**. As shown in **Figure 4**, mean systolic blood pressure decreased significantly (from 133.1 ± 2.8 to 124.5 ± 3.2 mmHg) over the 8 week study period, particularly in subjects whose initial systolic blood

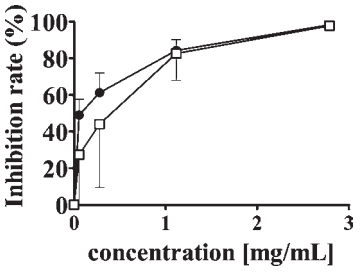

Figure 3. Inhibitory effect of Benifuuki extract (●) and Yabukita extract (□) on ACE activity. Data are expressed as the mean ± SD (n = 4).

Table 2. Catechin and Caffeine Contents of Benifuuki Leaves Used in the Open-Label Study[a]

	%
epicatechin	1.51
epigallocatechin	3.51
epicatechin gallate	1.81
epigallocatechin gallate	6.33
epigallocatechin-3-*O*-(3-*O*-methyl)gallate	1.72
caffeine	2.4

[a] All subjects drank Benifuuki tea twice daily after breakfast and lunch by brewing a tea bag containing 2 g of Benifuuki leaves in hot water.

Table 3. Characteristics of Subjects Enrolled in the Open-Label Study[a]

no. of subjects	10
age (years)	40.8 ± 8.4
height (cm)	168.6 ± 9.2
weight (kg)	74.6 ± 15.0
pulse rate (/min)	71.5 ± 3.7
systolic blood pressure (mmHg)	133.1 ± 8.8
diastolic blood pressure (mmHg)	89.9 ± 6.2

[a] Each value represents the mean ± SD.

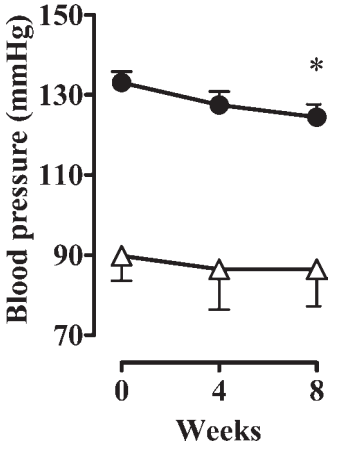

Figure 4. Changes in systolic (●) and diastolic (△) blood pressure in subjects consuming Benifuuki tea. Each point represents the mean ± SD. ∗, significantly different from blood pressure during the preintervention (week 0) (P < 0.05).

pressure was high. On the other hand, there was no notable change in blood or urine parameters during the intervention period.

Double-Blind and Intergroup Study. The contents of the capsules are shown in **Table 4**, and the characteristics of subjects are shown in **Table 5**. As one person in the BT group withdrew from the study for personal reasons, a total of 29 subjects were

Table 4. Composition of Capsules Used in the Double-Blind and Intergroup Study[a]

	BT group (mg)	GT group (mg)
catechin	10.5	10.5
epicatechin	21.0	27.9
gallocatechin	30.9	21.4
epigallocatechin	53.6	55.6
catechin gallate	4.3	3.1
epicatechin gallate	25.4	42.5
gallocatechin gallate	27.8	13.0
epigallocatechin gallate	87.1	116.4
gallocatechin-3-*O*-(*O*-methyl)gallate	5.0	nd
epigallocatechin-3-*O*-(3-*O*-methyl)gallate	20.0	nd
total amount of tea catechins	285.6	290.5
caffeine	57.6	67.2

[a] The subjects ingested four capsules twice daily. nd, not detected.

Table 5. Characteristics of the Subjects Enrolled in the Double-Blind and Intergroup Study[a]

	BT group	GT group	C group
no. of subjects	9	10	10
age (years)	45.6 ± 12.8	48.0 ± 8.5	47.5 ± 12.1
height (cm)	161.9 ± 3.4	163.5 ± 7.1	164.8 ± 11.6
body weight (kg)	66.5 ± 9.2	63.2 ± 8.7	65.4 ± 11.9
pulse rate (/min)	68.7 ± 7.1	69.2 ± 6.4	71.6 ± 11.7
systolic blood pressure (mmHg)	140.8 ± 10.2	138.7 ± 10.6	139.1 ± 7.9
diastolic blood pressure (mmHg)	91.0 ± 5.9	93.6 ± 3.8	92.4 ± 4.9

[a] Each value represents the mean ± SD. There were no significant differences among groups.

randomly assigned to three groups with similar age, sex, diastolic blood pressure, and systolic blood pressure. There were no differences in the ratio of males/females among groups.

As shown in **Figure 5**, the decrease in diastolic blood pressure of the BT group after 8 weeks of treatment (from 91.0 ± 5.9 to 87.6 ± 9.3 mmHg) tended ($P = 0.103$) to be greater than that of the GT group (from 93.6 ± 3.8 to 95.5 ± 7.5 mmHg). In the BT group, systolic blood pressure had decreased by the end of the intervention period (from 140.8 ± 10.2 to 133.3 ± 12.8 mmHg, $P = 0.102$). The decrease in diastolic blood pressure in the GT group was significant between the preintervention measurement and week 4, but returned to preintervention values after the 8 week treatment period. In group C (placebo treatment), systolic and diastolic blood pressure ($P = 0.389$ and $P = 0.599$, respectively) remained unchanged throughout the 8 week treatment period. These results indicate that the ingestion of the placebo sample did not affect blood pressure. Some blood biochemical parameters changed significantly between baseline and week 8.

DISCUSSION

In this study, we showed that EGCG3″Me has a stronger ACE inhibitory activity than EGCG.

Hara et al. (*16*) reported that EGCG has the strongest ACE inhibitory activity among major tea catechins on the grounds that EGCG and ECG containing a gallate moiety have much stronger ACE inhibitory activity than EC or EGC and that EGCG of pyrogallol type catechins has a much stronger ACE inhibitory activity than ECG of the catechol type catechins.

Our results and those of Hara indicate that EGCG3″Me has the strongest ACE inhibitory activity of the known nonpolymerized tea catechins. Hara attributed the strong inhibitory effect of EGCG on ACE to molecular structural interaction with the active site of ACE, but the mechanism responsible for the stronger inhibitory effect of EGCG3″Me on ACE activity is not clear and warrants elucidation.

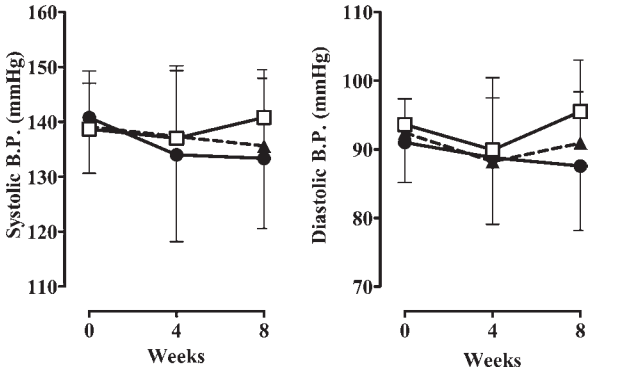

Figure 5. Changes in blood pressure in subjects consuming Benifuuki extract powder (●), green tea extract powder (□), or placebo (▲). Each point represents the mean ± SD. Statistical analyses were conducted using two-way analysis of variance followed by Dunnett's multiple-comparison test.

Benifuuki extract had stronger ACE inhibitory activity than Yabukita extract, but the difference was not significant ($P = 0.16$). In addition to EGCG3″Me, Benifuuki extract contains several types of catechins that have ACE inhibitory activity and are also present in Yabukita extract. That EGCG3″Me constitutes only 7% of the total catechins in Benifuuki extract may be why it did not have as strong an inhibitory effect on ACE activity as pure EGCG3″Me.

The ACE inhibitory activity of the Benifuuki extract was compared with that of a reconstituted mixture that contained eight types of pure catechins in the same amounts as in Benifuuki extract. The ACE inhibition activity of the mixture was 60% of that of Benifuuki extract (data not shown). This shows that substances other than catechins contribute to the ACE inhibitory activity of Benifuuki extract.

There was no significant difference between Benifuuki extract and Yabukita extract in ACE inhibitory activity in vitro. However, Oritani et al. (*20*) reported that when Benifuuki extract was administered orally to mice, the plasma EGCG3″Me concentration was 70% of that of EGCG after 3 h, even though the EGCG3″Me content was equivalent to 23% of the EGCG content. This shows that absorption of EGCG3″Me is much better than that of EGCG and indicates that its bioavailability is 3 times higher than that of EGCG when equal amounts of EGCG3″Me and EGCG are administered orally to mice. Sano (*9*) also reported that when the same amounts of EGCG3″Me or EGCG were administered orally to mice, EGCG3″Me was very stable in plasma and the concentration of free EGCG3″Me was 9 times that of EGCG.

The blood pressure of spontaneously hypertensive rats treated with Benifuuki increased more slowly than that of mice treated with green tea (data not shown), probably because of the high absorption rate and stability of EGCG3″Me in plasma and its strong inhibitory effect on ACE activity. Clinical trials have confirmed that EGCG3″Me is absorbed 6 times more quickly than EGCG in humans and that it disappears more slowly from the blood than EGCG (*21*).

On the basis of these results, we hypothesized that Benifuuki would have a beneficial effect on hypertension in vivo and conducted two clinical investigations, an open-label study with Benifuuki tea only and a double-blind comparative study with Benifuuki tea, green tea, and a placebo (dextrin).

In the open-label study, the Benifuuki tea treatment gradually decreased systolic blood pressure from the preintervention level, and the difference was significant by the end of the intervention 8 weeks later. In the double-blind study, the diastolic blood pressure of the BT group decreased to a greater extent ($P = 0.103$) than that of the GT group. In the BT group, systolic blood pressure was strongly suppressed by the end of the intervention and was lower than that at the start of the trial ($P = 0.102$). From these results, it was concluded that high blood pressure was suppressed more efficiently in the BT group than in the GT group.

Some blood biochemistry values (MCH and MCHC) changed significantly between the beginning and the end of the study. However, as these changes were observed in both the BT and GT groups and were within reference ranges, we concluded that they were the result of a substance common to green teas.

The safety of Benifuuki has been confirmed in that there are no differences in parameters for blood and urine analyses, pathological examination, or subjective symptoms before and after clinical trials involving long-term treatment (*6*).

One mechanism responsible for the antiallergic effect of Benifuuki is inhibition by EGCG3″Me of phosphorylation of the myosin light chain (MLC) of mast cells (*22*). Phosphorylation and dephosphorylation of the MLC plays an important role in the regulation of blood pressure by inducing vascular smooth muscle contraction and relaxation, respectively. Therefore, we hypothesized that EGCG3″Me would decrease blood pressure by inhibiting the phosphorylation of MLC. In addition, EGCG3″Me and other catechins could combine with angiotensin-I and some receptors related to hypertension and have an effect on decreasing blood pressure in vivo. In the clinical study, we observed that Benifuuki and EGCG3″Me decreased blood pressure by inhibiting ACE, but inhibition of phosphorylation of MLC and combination with proteins may also be involved.

As green tea contains many substances, it is unlikely that a single substance is responsible for its many beneficial effects. However, in as far as the greater inhibitory effect of Benifuuki on hypertension than green tea is concerned, EGCG3″Me is probably the main substance responsible because large amounts are present in Benifuuki but not in green tea, it has a high absorption rate, and it has a strong inhibitory effect on ACE activity and MLC phosphorylation.

The catechin content of green tea depends on the time of harvest and the position of the leaves on the tree. The EGCG3″Me content is highest in fully mature leaves of the second or third crop and in the lowest leaves of the tea tree (*23*). We are currently developing a device to measure EGCG3″Me content more easily than current methods so that we can identify the harvesting time at which the level of EGCG3″Me in tea leaves is greatest. Dissemination of our data on the antihypertensive effect of Benifuuki may increase demand for it, reduce its price, and contribute to the health and well-being of people.

ABBREVIATIONS USED

ACE, angiotensin I-converting enzyme; EGCG, epigallocatechin gallate; EGCG3″Me, (−)-epigallocatechin-3-*O*-(3-*O*-methyl)-gallate; HPLC, high-performance liquid chromatograph; BT, Benifuuki tea; GT, green tea; GOT, glutamic oxaloacetic transaminase; GPT, glutamic pyruvic transaminase; ALP, alkaline phosphatase; γ-GTP, γ-guanosine triphosphate; LDH, lactate dehydrogenase; HbA1c, hemoglobin A1c; HDL-cholesterol, high-density lipoprotein; MCV, mean corpuscular volume; MCH, mean corpuscular hemoglobin; MCHC, mean corpuscular hemoglobin concentration; MLC, myosin light chain.

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