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A blend of sesame oil and rice bran oil lowers blood pressure and improves the lipid profile in mild-to-moderate hypertensive patients

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KEYWORDS:
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Blend of sesame oil and rice bran oil;
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Lipid profile

BACKGROUND: Sesame oil and rice bran oil are known for their unsaturated fatty acids and antioxidants contents and have been reported to reduce the cardiovascular risk.

OBJECTIVE: To determine the effect of a blend of 20% unrefined cold-pressed lignans-rich sesame oil and 80% physically refined γ-oryzanol–rich rice bran oil (Vivo) as cooking oil in mild-to-moderate hypertensive patients.

METHODS: In this prospective, open-label dietary approach, 300 hypertensive patients and 100 normotensives were divided into groups as: (1) normotensives treated with sesame oil blend, (2) hypertensives treated with sesame oil blend, (3) hypertensives treated with nifedipine, a calcium channel blocker (20 mg/d), and (4) hypertensives receiving the combination of sesame oil blend and nifedipine (20 mg/d). Sesame oil blend was supplied to respective groups, and they were instructed to use it as the only cooking oil for 60 days. Resting blood pressure was measured at days 0, 15, 30, 45, and 60, whereas the fasting lipid profile was measured at days 0 and 60.

RESULTS: Significant reduction in blood pressure (systolic, diastolic, and mean arterial) from days 0 to 15, 30, 45, and 60 were observed in hypertensives treated with sesame oil blend alone ($P < .001$), nifedipine alone ($P < .001$), and combination of sesame oil blend and nifedipine ($P < .001$). Sesame oil blend with nifedipine-treated group showed greatest reduction in blood pressure. Total cholesterol, low-density lipoprotein cholesterol, triglycerides, and non–high-density lipoprotein cholesterol levels reduced, whereas high-density lipoprotein cholesterol levels increased significantly only in hypertensives treated with sesame oil blend alone and the combination of sesame oil blend and nifedipine ($P < .001$).

CONCLUSION: We demonstrate for the first time that using a blend of sesame oil and rice bran oil as cooking oil showed a significant antihypertensive and lipid-lowering action and had noteworthy additive effect with antihypertensive medication.

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Introduction

Hypertension is a graded, consistent, and independent risk factor for cardiovascular diseases (CVDs). The association of hypertension with CV morbidity and mortality is well established. Traditionally, the ultimate goal of the antihypertensive therapy is to reduce overall CV risk and thus its morbidity and mortality rates. Numerous clinical trials have shown that lowering blood pressure reduces CV risk by 20% to 25% for myocardial infarction, 35% to 40% for stroke, and by 50% for heart failure.[1,2] Nutritional intervention studies focusing on the prevention of hypertension offer advantages over current pharmacologic treatments, which are associated with several adverse side effects.[3] Nutrition-based approaches are recommended as first line of treatment to control blood pressure in hypertensive patients.[4] Interventions that reduce total dietary saturated fat intake can effectively control systolic blood pressure (SBP) and diastolic blood pressure (DBP).[5–7] Observational studies suggest that dietary saturated fat is positively associated with high blood pressure, whereas diets enriched with polyunsaturated fat protect against induced blood pressure elevation.[8–11] There is substantial evidence for a protective effect of dietary unsaturated fatty acids in the prevention of heart diseases,[12] particularly in high-risk populations.[13] It is well established that a diet low in saturated fat and rich in unsaturated fat can lower blood pressure.[14] Earlier studies have reported that elevated blood pressure could be controlled with monounsaturated fatty acids and polyunsaturated fatty acids intake.[15–17]

We recently reported that using sesame oil as cooking oil (rich in unsaturated fatty acids, antioxidant lignans, sesamin, sesamol and sesamolin, and vitamin E) lowered blood pressure,[18–20] blood sugar,[21] and cholesterol in hypertensive, diabetic-hypertensive, and type 2 diabetes mellitus (T2DM) patients.[22] Furthermore, the use of sesame oil showed additive effects with antihypertensive and antidiabetic medications for better improvement of blood pressure and hyperglycemia in these patients. The antioxidant lignans, monounsaturated fatty acids, polyunsaturated fatty acids, and vitamin E in sesame oil have collective effect in the control of hypertension, hyperglycemia, and elevated blood lipids. It has been reported that sesamin possesses Ca^{2+} antagonistic vasorelaxing activity,[23] which is a noticeable property of sesame oil for its blood pressure–lowering efficacy.

Rice bran oil that is extracted from the germ and inner husk of rice is another edible oil, which offers several unique properties that make it very interesting as a specialty cooking oil, and it has been shown to reduce total cholesterol (TC) and triglycerides (TGs) and increase the proportion of high-density lipoprotein cholesterol (HDL-C) in T2DM and hyperlipidemic patients.[24,25] Rice bran oil is a rich source of unsaturated fatty acids and antioxidant γ-oryzanol, known to be a mixture of steryl and other triterpenyl esters of ferulic acids.[26] γ-oryzanol has its own individual effect to decrease serum TC by inhibiting lipid absorption from intestine in both human and animal models.[27–29]

The vast majority of data on the benefits of sesame oil and rice bran oil on CVD have been obtained when given individually.[18–20,24,25] However, no study has been conducted so far to examine the combined effect of blending these 2 oils as cooking oil in hypertensive patients. Keeping in view the continuing controversy regarding the nonpharmacologic management of hypertension, a comparison of antihypertensive medication and a blend of sesame oil and rice bran oil (20% cold pressed unrefined sesame oil and 80% physically refined γ-oryzanol–rich rice bran oil) in hypertensive patients is desirable before such a blend of edible oil is considered for broader use in this population. Therefore, we used a prospective, open-label dietary approach to study the effects of a blend of sesame oil and rice bran oil with or without antihypertensive medication in people with mild-to-moderate hypertension.

Materials and methods

Participants

Men and women aged 40 to 60 years who had essential hypertension for ≥3 months were recruited from the general community with similar socioeconomic and lifestyle patterns. Entry criteria included a persistent high blood pressure; SBP ≥140 mm Hg, DBP ≥90 mm Hg. Subjects were excluded if they had secondary hypertension; recent history of heart disease, angina, or major surgery; or had a recent history of myocardial infarction or stroke; or had significant liver or renal disease. Lifestyle habits of the study participants, including smoking, alcohol intake, and physical activity were obtained by a questionnaire. The family history of hypertension was defined as a history of those whose mothers or fathers were once diagnosed having hypertension. The questionnaire also included date of birth, educational level, family size, and socioeconomic status. We invited 150 normotensives and 400 eligible hypertensive patients who were not on antihypertensive medication for at least 4 weeks and were referred for blood pressure monitoring to the Hypertension Clinics of Hindu Rao Hospitals, New Delhi, India and Dr. Bhimrao Ambedkar Multi Specialty Hospital, Noida, India. Of those invited, 300 hypertensives and 100 normotensives provided their consent to participate in the study. They were told that they are free to decide about their inclusion in the study or to stop at any time. Subjects were informed about the objectives, methods, and the potential benefits of the sesame oil blend. The study protocol was approved by the Ethics Committee of International Institute of Stress Management And Allied Sciences, New Delhi, India. The study was performed in accordance with the ethical guidelines of the Helsinki Declaration.

Study design

Baseline (0 day) measurements included resting SBP, DBP, and mean arterial pressure (MAP), anthropometric data and 12-hour overnight fasting serum lipid profile (TC, low-density lipoprotein cholesterol [LDL-C], TG, HDL-C, and non–HDL-C) were done during which all subjects maintained their usual diet. Subjects were asked not to change their lifestyle or dietary habits, mainly the consumption of salt, fruits, vegetables, and fat,[30] during the study period, other than the use of study oil for cooking. All the 300 hypertensive participants were randomized into 3 intervention groups based on SBP and lipid levels. Baseline levels of blood pressure and lipids were comparable for all 3 hypertensive groups, in spite of difference in body weight and waist: hip ratio among the hypertensives. As shown in Figure 1, the hypertensives and normotensives were then assigned to groups as (1) normotensives treated with sesame oil blend (n = 100), (2) hypertensives treated with sesame oil blend (n = 100), (3) hypertensives treated with nifedipine (n = 100), a known antihypertensive calcium channel blocker drug (20 mg/d), and (4) hypertensives receiving the combination of sesame oil blend and nifedipine (20 mg/d; n = 100). The normotensive and hypertensive groups except the nifedipine alone–treated hypertensive group were supplied with the unsaturated and antioxidants-rich sesame oil blend (Table 1) 4 to 5 liters for a 4- to 5-member family/month, and they were instructed to use the oil blend as the only source of cooking oil in place of other edible oils for 60 days. The participants were generally using palm oil, sunflower oil, mustard oil, sesame oil, and soya been oil at random before their enrollment into this study. The patients and the normotensives were advised to use the sesame oil blend for all their cooking practices including frying, salad dressing, and so forth. They were advised to adhere to the recommended daily consumption of oil for cooking up to 35 to 40 mL/person/d. Hypertensives, if prescribed with nifedipine, were asked to continue the medication for 60 days. Resting blood pressure was measured at days 15, 30, 45, and 60. Fasting lipid profile was measured again at the end of 60th day.

Table 1 Fatty acids and antioxidant content of sesame oil blend

Fatty acids and antioxidants (%)	Sesame oil	Rice bran oil	Sesame oil blend
SFA			
Palmitic acid	9.31	20.08	17.92
Stearic acid	5.43	2.41	3.01
Arachidic acid	0.66	0.52	0.52
MUFA			
Oleic acid	42.91	42.98	42.97
PUFA			
Linoleic acid	41.28	33.63	35.56
Linolenic acid	0.44	0.39	0.4
Antioxidants			
Sesame lignans	1.5	—	0.3
Oryzanol	—	1	0.8
Total tocopherols (mg/100 g)	50	50	50

MUFA, monounsaturated fatty acid; PUFA, polyunsaturated fatty acid; SFA, saturated fatty acid.

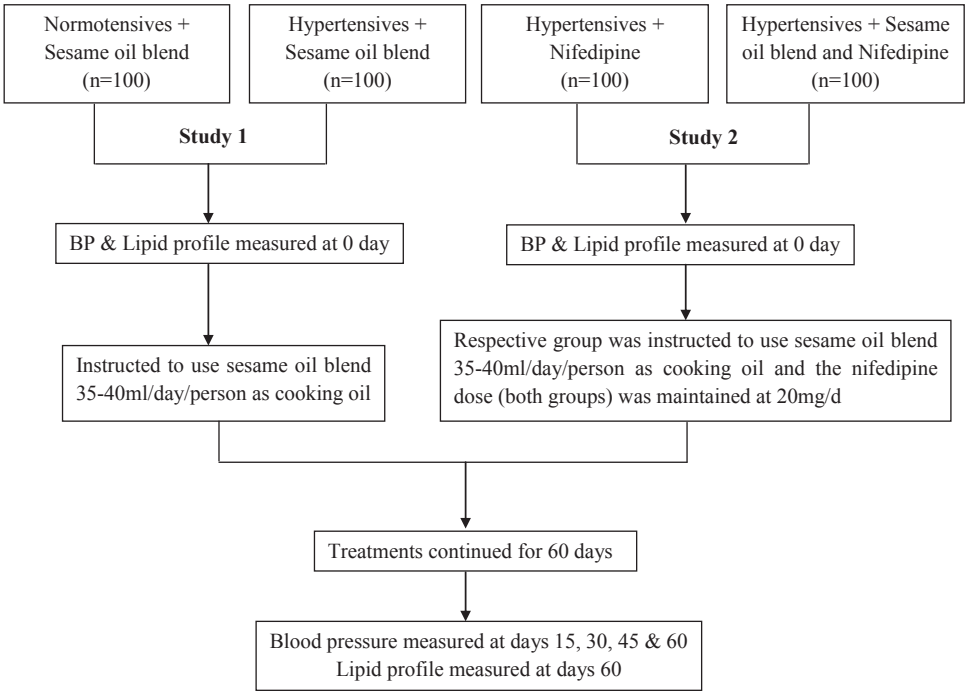

Figure 1 Study design. BP, blood pressure.

Table 2 Baseline characteristics between normotensives and hypertensives randomized into 3 intervention groups

	Normotensives	Hypertensives				
	Sesame oil blend (n = 100)	Sesame oil blend (n = 100)	*P* value	Nifedipine (n = 100)	Nifedipine + Sesame oil blend (n = 100)	*P* value
Parameters	Study 1			Study 2		
Age, y	32.6 ± 10.0	51.0 ± 12.0	<.001	50.1 ± 13.4	48.1 ± 10.2	.24
Gender						
Male	55 (55%)	47 (47%)	.26	53 (53%)	49 (49%)	.57
Body weight, Kg	62.5 ± 9.6	66.5 ± 13.4	.02	65.3 ± 13.1	71.2 ± 11.3	<.001
Waist:hip ratio	0.99 ± 0.04	0.98 ± 0.03	.76	0.98 ± 0.10	1.02 ± 0.14	.02
BMI, Kg/m^2	23.9 ± 3.6	25.9 ± 4.8	<.001	25.8 ± 4.6	26.7 ± 3.9	.12
Smoking, n (%)	3 (3)	6 (6)	.5	7 (7)	10 (10)	.61
Alcohol, n (%)	0 (0)	0 (0)		7 (7)	9 (9)	.80
Betel nut chewing, n (%)	0 (0)	2 (2)	.50	6 (6)	6 (6)	1.0
Physical activity, n (%)	100 (100)	99 (99)	1.0	62 (62)	55 (55)	.39

BMI, body mass index.
n indicates the number of subjects who had the habit of smoking, alcohol drinking, betel nut chewing, or physical activity.

Blood pressure and anthropometric measurements

Baseline blood pressure (SBP and DBP) and anthropometric measurements (weight and height) were measured during one examination by trained nurses who were unaware of the treatment groups. Blood pressure was measured 3 times at 1-minute intervals on the left arm of seated individuals after a 10-minute rest, using an automated validated blood pressure–measuring device (OMRON-HEM 906). A repetition of 3 measurements was carried out if a difference of 10 mm Hg or more was observed between the second and the third measurement. Measurements were made between 9:00 AM and 11:00 AM. MAP was calculated as (SBP − DBP)/3 + DBP. Weight and height measurements were performed on participants lightly dressed without shoes using an electronic scale and stadiometer, respectively.

Biochemical measurements

Briefly, serum concentrations of TC and TG were determined enzymatically, HDL-C concentrations were determined on a heparin–manganese supernatant using a single-precipitation procedure. LDL-C concentrations were calculated by using the Friedewald formula.[31] Non–HDL-C, apolipoprotein B–containing lipoprotein, calculated as TC – HDL-C. Samples from 0 day and at day 60 were measured in a single assay to minimize the interassay variation.

Statistical data analyses

All the data analyses were performed using the SAS (Statistical Analysis System) Software Package (ver. 9.4; SAS Institute Inc, Cary, NC) at Fukuoka University, Fukuoka, Japan. Changes in continuous variables during the study period for each group were examined by a repeated measures analysis of variance (ANOVA). Differences in continuous variables between groups were examined by an ANOVA. Patterns of changes between groups were examined by a 2-way repeated measure of ANOVA. Changes at day 60 of the study period from baseline for each group were examined by Wilcoxon signed-rank test. Differences in changes between groups at day 60 of the study period from baseline were examined by Wilcoxon rank-sum test. Relations between changes at day 60 of the study period and baseline values for each group and comparison of regression lines between 2 groups were examined by the regression analysis using general linear model.[32] Data are presented as the mean ± standard deviation, and the significance level was considered to be less than 0.05 unless indicated otherwise.

Results

Baseline characteristics of the study participants

Three hundred mild-to-moderate hypertensive patients and 100 normotensives completed the study. The study had no dropout from the participants, which is fairly a reliable indicator of sesame oil blend acceptability and/or tolerability. The study participants did not report any changes in their usual physical activity levels and socioeconomic status during the study period. The characteristics of the hypertensive patients randomized to 3 intervention groups confirmed that they were well matched for almost all entry criteria (Table 2), and there were no significant differences between the hypertensive groups on either blood pressure or lipid profile. The normotensives were relatively young by age, and their body weight and body mass index were significantly lower than the hypertensives.

Table 3 Changes in blood pressure and serum lipid levels in normotensives treated with sesame oil blend, hypertensives treated with sesame oil blend, hypertensives treated with nifedipine, and hypertensives treated with nifedipine + sesame oil blend during the study period

	Normotensives	Hypertensives				
	Sesame oil blend (n = 100)	Sesame oil blend (n = 100)	Group period interaction (*P* value)*	Nifedipine (n = 100)	Nifedipine + sesame oil blend (n = 100)	Group period interaction (*P* value)*
Parameters	Study 1			Study 2		
SBP (mm Hg)						
0 d	122 ± 6	164 ± 17†		164 ± 14	164 ± 14	
15 d		155 ± 14*		153 ± 12*	149 ± 12*,†	
30 d		149 ± 13*		149 ± 11*	134 ± 9*,†	
45 d		145 ± 8*		146 ± 6*	127 ± 7*,†	
60 d	120 ± 5	143 ± 10*,†	<.001	146 ± 8*	125 ± 6*,†	<.001
DBP (mm Hg)						
0 d	79 ± 4	104 ± 5†		104 ± 5	106 ± 7†	
15 d		98 ± 4*		97 ± 5*	95 ± 5*,†	
30 d		94 ± 4*		96 ± 5*	91 ± 6*,†	
45 d		92 ± 5*		93 ± 5*	85 ± 5*,†	
60 d	79 ± 4	90 ± 6*,†	<.001	92 ± 6*	81 ± 4*,†	<.001
MAP (mm Hg)						
0 d	94 ± 4	124 ± 8†		124 ± 6	125 ± 8	
15 d		117 ± 6*		116 ± 6*	113 ± 6*,†	
30 d		112 ± 6*		114 ± 6*	105 ± 6*,†	
45 d		110 ± 5*		111 ± 5*	99 ± 5*,†	
60 d	93 ± 3	108 ± 6*,†	<.001	110 ± 6*	96 ± 3*,†	<.001
TC (mg/dL)						
0 d	172 ± 14	230 ± 33†		231 ± 32	232 ± 34	
60 d	171 ± 14	188 ± 23*,†	<.001	235 ± 32*	186 ± 25*,†	<.001
TG (mg/dL)						
0 d	145 ± 8	182 ± 23†		186 ± 30	184 ± 27	
Median (Q1–Q3)	144 (140–150)	178 (164–197)		188 (166–200)	180 (167–191)	
60 d	145 ± 8	159 ± 15*,†	<.001	189 ± 31*	159 ± 24*,†	<.001
Median (Q1–Q3)	144 (140–160)	158 (150–160)		189 (165–209)	151 (144–179)	
HDL-C (mg/dL)						
0 d	49.4 ± 5.5	45.9 ± 5.0†		43.8 ± 5.9	43.8 ± 5.3	
60 d	49.8 ± 5.3	51.0 ± 5.6*	<.001	44.2 ± 5.9	49.2 ± 5.5*,†	<.001
LDL-C (mg/dL)						
0 d	94 ± 15	149 ± 29†		150 ± 33	151 ± 34	
60 d	92 ± 15	108 ± 22*,†	<.001	153 ± 33	106 ± 25*,†	<.001
Non–HDL-C (mg/dL)						
0 d	123 ± 16	184 ± 34†		187 ± 33	188 ± 34	
60 d	121 ± 15	137 ± 24*,†	<.001	191 ± 34*	137 ± 26*,†	<.001

DBP, diastolic blood pressure; HDL-C, high-density lipoprotein cholesterol; LDL-C, low-density lipoprotein cholesterol; MAP, mean arterial pressure; SBP, systolic blood pressure; TC, total cholesterol; TG, triglyceride.

*$P < .05$, changes during the study period, assessed by a repeated measures analysis of variance.

†$P < .05$, differences between groups, assessed by an analysis of variance.

Study 1: Effect of sesame oil blend on normotensives vs hypertensives

As shown in Table 3 and Figure 2, SBP, DBP, and MAP levels were significantly lowered ($P < .001$) in hypertensives treated with sesame oil blend at days 15, 30, 45, and 60 as compared with the baseline values, whereas normotensives treated with sesame oil blend did not show any significant reduction ($P < .001$). As shown in Table 3, hypertensives had significantly higher levels of TC, LDL-C, TG, and non–HDL-C levels, and low levels of HDL-C as compared with normotensives at baseline. TC, LDL-C, TG, and non–HDL-C levels were significantly reduced ($P < .001$) in hypertensives treated with sesame oil blend, whereas normotensives treated with sesame oil blend did not show any significant changes in lipid profile at day 60 as compared with respective baseline concentrations.

From the scatter plots (Fig. 3) and Table 4, the change in SBP with sesame oil blend depends on baseline SBP, this is

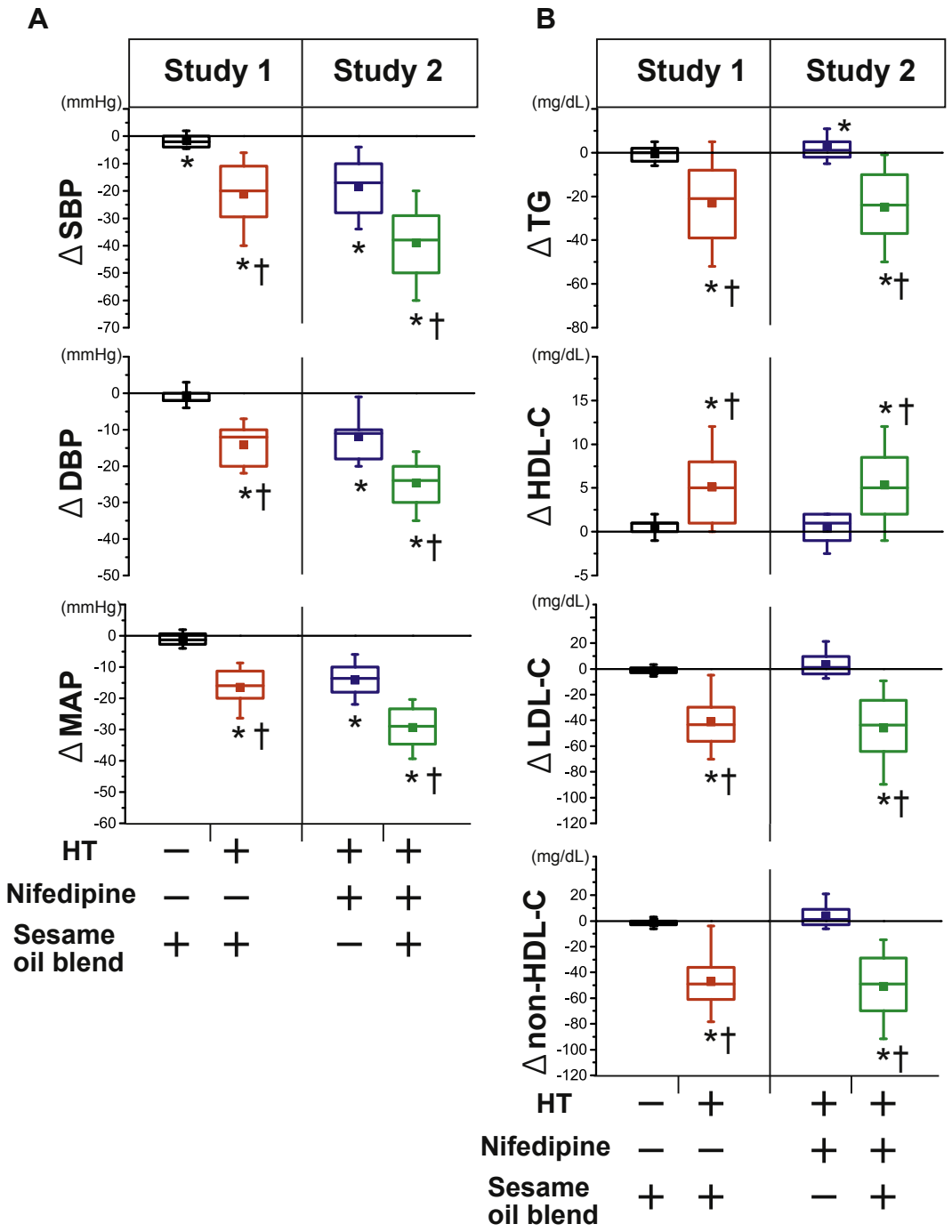

Figure 2 Box-and-whisker plots showing the mean (■), median (middle bar in the rectangle), and 10th (bottom bar), 25th (bottom of rectangle), 75th (top of rectangle), and 90th (top bar) percentiles of changes in blood pressure (A) and serum lipids (B) in normal subjects and nontreated patients with hypertension who received sesame oil blend (left panel) and patients with hypertension who were treated with nifedipine with and without receiving sesame oil blend (right panel) at baseline and 60 days of the study. *$P < .05$, within group changes (60 days vs baseline), assessed by Wilcoxon singed-rank test; †$P < .05$, changes between groups (nontreated patients with hypertension vs normal subjects who received sesame oil blend or nifedipine-treated patients with hypertension who received and did not receive sesame oil blend), assessed by Wilcoxon rank-sum test. DBP, diastolic blood pressure; HDL-C, high-density lipoprotein cholesterol; HT, hypertensives; LDL-C, low-density lipoprotein cholesterol; MAP, mean arterial pressure; SBP, systolic blood pressure; TG, triglyceride.

more prominent among hypertensives than normotensives, possibly due to the narrow range of baseline SBP among normotensives. With respect to lipids, the slope of the regression line between net change and baseline level is practically zero for normotensives as compared with hypertensives.

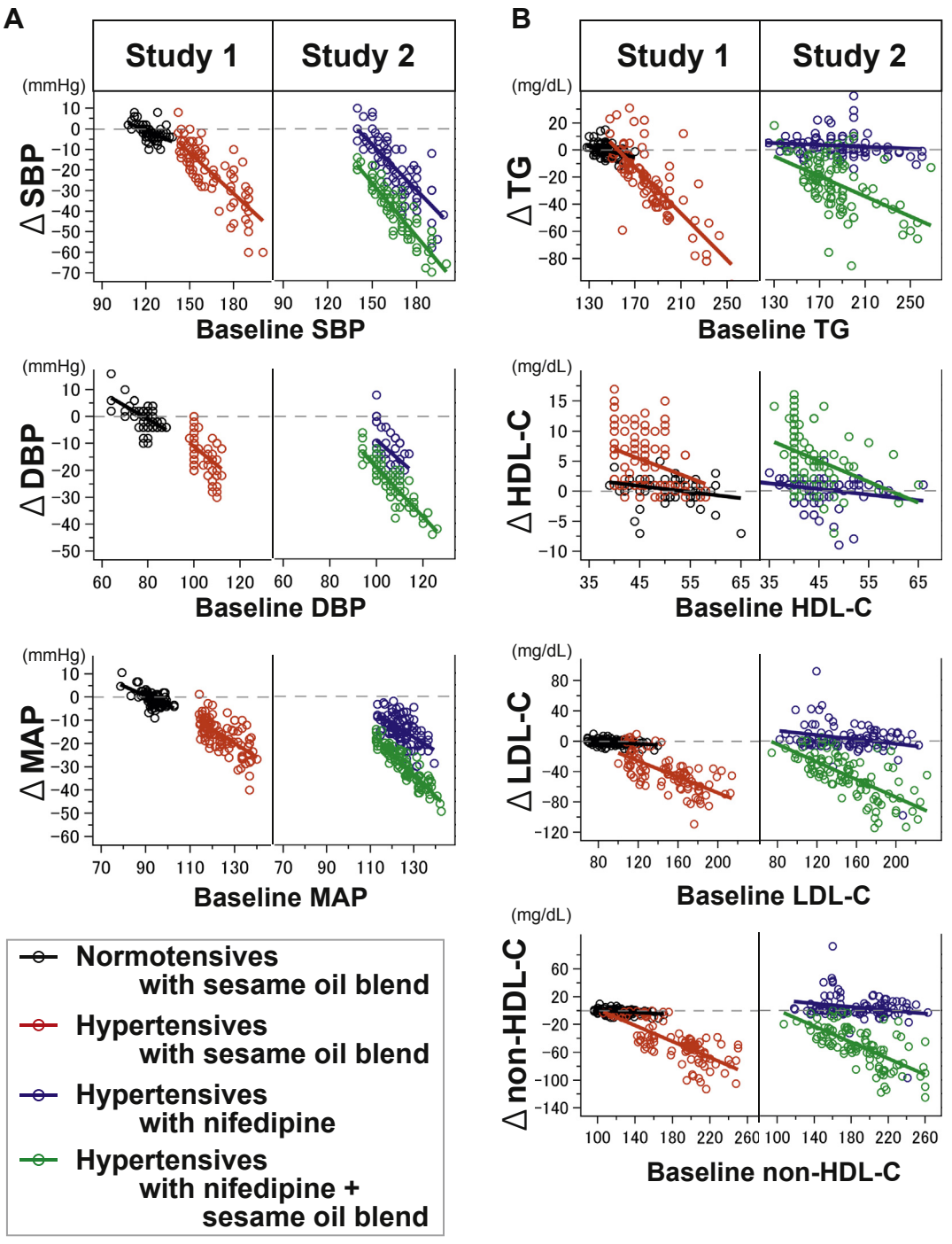

Figure 3 Dependence of the effects of sesame oil blend on blood pressure (A) and serum lipids and lipoproteins (B) on their baseline levels in normotensive subjects, hypertensive patients with and without sesame oil blend treatment. (A) Scatter plot of changes (Δ) in SBP vs baseline SBP, ΔDBP vs baseline DBP, and ΔMAP vs baseline MAP in normotensive subjects (in black color) and hypertensive patients (in red color; left panel) and hypertensive patients with (in green color) and without (in blue color) sesame oil blend treatment (right panel). (B) Scatter plot of changes (Δ) in TG vs baseline TG, ΔHDL-C vs baseline HDL-C, and ΔLDL-C vs baseline LDL-C, and Δnon–HDL-C vs baseline non–HDL-C in normotensive subjects (in black color) and hypertensive patients (in red color; left panel) and hypertensive patients with (in green color) and without (in blue color) sesame oil blend treatment (right panel). DBP, diastolic blood pressure; HDL-C, high-density lipoprotein cholesterol; LDL-C, low-density lipoprotein cholesterol; MAP, mean arterial pressure; SBP, systolic blood pressure; TG, triglyceride. (Color version of figure is available online.)

Table 4 Comparison of the relation of changes to baseline values of blood pressure and serum lipid levels between 2 groups in study 1 and study 2 by regression analysis

		Study 1				Study 2			
Dependent variable	Independent variable	Normotensives with sesame oil blend: Slope of regression line	Hypertensives with sesame oil blend: Slope of regression line	Interaction between baseline value and group	Between-group effect	Hypertensives with nifedipine: Slope of regression line	Hypertensives with nifedipine + sesame oil: Slope of regression line	Interaction between baseline value and group	Between-group effect
ΔSBP	Baseline SBP	−0.302*	−0.662*	<0.001		−0.742*	−0.864*	0.08	<0.001
ΔDBP	Baseline DBP	−0.498*	−0.691*	0.18	0.39	−0.768*	−0.923*	0.25	<0.001
ΔMBP	Baseline MBP	−0.425*	−0.602*	0.14	0.23	−0.583*	−0.912*	<0.001	
ΔTG	Baseline TG	−0.202*	−0.856*	<0.001		−0.035	−0.372*	<0.001	
ΔHDL-C	Baseline HDL-C	−0.102*	−0.321*	0.020		−0.093*	−0.347*	0.005	
ΔLDL-C	Baseline LDL-C	−0.078*	−0.526*	<0.001		−0.144*	−0.580*	<0.001	
ΔNon–HDL-C	Baseline non–HDL-C	−0.072*	−0.576*	<0.001		−0.123*	−0.580*	<0.001	

DBP, diastolic blood pressure; HDL-C, high-density lipoprotein cholesterol; LDL-C, low-density lipoprotein cholesterol; MBP, mean blood pressure; SBP, systolic blood pressure; TG, triglyceride.
* $P < .05$, different from zero, analyzed by the regression analysis. When the test for parallelism (interaction between baseline value and group) was not significant, significance of test for equal intercepts (between-group effect) was given.

Study 2: Additional beneficial effect of sesame oil blend in hypertensives receiving nifedipine

Hypertensives treated with the combination of sesame oil blend and nifedipine showed a highly significant reduction of SBP, DBP, and MAP levels at days 15, 30, 45, and 60 as compared with the baseline values and nifedipine alone–treated group as well. Moreover, the blood pressure values were very close to normal in hypertensives receiving the combination of sesame oil blend and nifedipine. TC, LDL-C, TG, and non–HDL-C levels were significantly reduced ($P < .001$), whereas HDL-C levels significantly increased in hypertensives treated with the combination of sesame oil blend and nifedipine at day 60, whereas nifedipine alone group did not show any significant changes in lipid profile (Table 3 and Fig. 2).

From the scatter plots (Fig. 3) and Table 4, for comparable baseline SBP, the data show that the addition of sesame oil blend to nifedipine resulted in greater reduction in SBP (lower regression line). With respect to lipids, nifedipine alone treatment resulted in regression line of zero slope, whereas the treatment with the combination of sesame oil blend and nifedipine had negative slope.

Discussion

In this study, we found that using a blend of unrefined cold-pressed antioxidants-rich sesame oil and physically refined γ-oryzanol–rich rice bran oil as cooking oil showed a significant reduction in SBP, DBP, and MAP, besides an independent effect on lowering the TC, LDL-C, TG, and non–HDL-C values and increased the HDL-C levels in mild-to-moderate hypertensive patients.

The curiosity in the potential cardiovascular health benefits of sesame oil has increased as the use of sesame oil as cooking oil has been shown to control hypertension, hyperglycemia, and lipoprotein cholesterol, and systemic antioxidant enzymes in hypertensive, diabetic-hypertensive, and T2DM patients.[18–22] In our earlier study, the use of sesame oil as a sole source of cooking oil for 60 days showed significant reduction in SBP and DBP as compared with sunflower and peanut oils.[19] We concluded that the reduction of blood pressure and lowering of lipid profile and the improvement of antioxidant status could be attributed to the antioxidative and unsaturated fatty acids capacity of sesame oil.

Sesame oil as cooking oil has been shown to have additive effects with antihypertensive and antidiabetic medications in lowering blood pressure, lipids, and blood sugar in hypertensive and diabetic-hypertensive patients.[18–20,22] Use of sesame oil as cooking oil also produced synergistic effects with antidiabetic medication for lowering blood glucose, glycated hemoglobin (HbA1C) besides lowering the cholesterol in T2DM.[21] Rice bran oil is rich in γ-oryzanol, tocopherols, and tocotrienols. Tocotrienols have been shown to inhibit the HMG CoA reductase activity, resulting in

hypocholesterolemia.[33] Rice bran oil–enriched diet did result in a greater reduction in TC in moderately hypercholesterolemic humans and animal models.[29,34] A recent study has reported that rice bran oil, when consumed as part of a healthy diet for 4 weeks, is effective in improving the risk factors for CVDs by lowering TC, LDL-C, and atherogenic ratio of TC/HDL in hyperlipidemic subjects.[35] Thus, rice bran oil could be suitable edible oil for cardiovascular and hyperlipidemic patients.

Because sesame oil and rice bran oil have unique biological and physiological properties that are largely augmented with scientific evidences for cardiovascular health benefits, blending of these 2 oils would therefore endow more constructive synergistic effects. Although there are numerous studies suggesting the beneficial effects of using sesame oil and rice bran oil individually on cardiovascular health, we reveal the fact for the first time that a blend of sesame oil and rice bran oil reduced blood pressure in mild-to- moderate hypertensive patients. The magnitude of blood pressure reduction by the use of sesame oil blend (median reduction: SBP, –20 mm Hg; DBP, –12 mm Hg; MAP, –16 mm Hg) mimics the antihypertensive action of nifedipine (median reduction: SBP, –17 mm Hg; DBP, –11 mm Hg; MAP, –14 mm Hg) as noted from our study, which clearly indicated that using sesame oil blend alone has the potential effect in controlling high blood pressure, and also, the sesame oil blend showed additive effects with nifedipine for a remarkable and highly exceptional blood pressure–lowering effect (median reduction: SBP, –38 mm Hg; DBP, –24 mm Hg; MAP, –29 mm Hg). Blend of sesame oil and rice bran oil is composed of antioxidant lignans (0.3%), total tocopherols (50 mg/100g), and γ-oryzanol (0.8%), followed by the abundance availability of unsaturated fatty acids, mainly oleic acid and linoleic acid (Table 1). Indeed, the antioxidant lignans and γ-oryzanol itself may also have induced marked and significant reductions in blood pressure, although it is unlikely that the unsaturated fatty acids alone are responsible for the blood pressure–lowering effects of sesame oil and rice bran oil blend.

Our results are in line with the results of earlier studies, which have reported that oleic acid–rich oils lowered blood pressure in animal models.[36,37] Accordingly, it appears that the major fatty acid found in the blend of sesame oil and rice bran oil is oleic acid, which may also account for the blood pressure–lowering effects. In humans, blood pressure and cardiac β-adrenergic receptor responsiveness decreased on a low-fat diet with a high polyunsaturated fat/saturate fat (P/S) diet ratio.[38] A high-fat meal can reduce the brachial artery reactivity, which suggests that fatty acids influence blood pressure by modulating the endothelial functions.[39] Dietary saturated fats may also promote atherosclerosis and arterial stiffening and thereby may increase blood pressure.[40] Animal studies suggest that linoleic acid may reduce the blood pressure by serving as a substrate for vasoactive prostaglandins[14] by promoting relaxation of vascular smooth muscle cells.[41] Similarly, the blend of sesame oil and rice bran oil that is rich in linoleic acid next to oleic acid, which may have a substantial effect on the collective improvement of blood pressure in this study.

Besides lowering the blood pressure, we also observed that the use of the sesame oil blend decreased TC, LDL-C, TG, and non–HDL-C, with significant improvement in HDL-C, which is in accordance with most of the previous sesame oil and rice bran oil studies in hypertensive, diabetic-hypertensive, diabetic, and hyperlipidemic patients.[18–22,24,25] Many studies in humans and animals have reported that oils containing saturated fatty acids raise serum TC, TG, in particular, LDL-C levels,[42] whereas those rich in unsaturated fatty acids lower TC, TG, and LDL-C.[43,44] Consumption of sesame oil as a source of cooking oil in T2DM patients over a period of 2 months reduced the TC, LDL-C, and TG values by 20%, 33.8%, and 14%, respectively.[21] Studies have also reported that sesame lignans such as sesamin and episesamin modulate the cholesterol metabolism by inhibiting the synthesis and absorption of cholesterol in stroke-prone spontaneously hypertensive rats.[45] Several studies have shown that rice bran oil consumption can reduce cholesterol.[29,46–49] Clinically, consumption of 50 mL of rice bran oil for about 4 weeks remarkably reduced the lipid profile in hypercholesterolemic subjects.[28] In addition, the use of rice bran oil as cooking oil for 3 months significantly reduced blood cholesterol in hyperlipidemic subjects as compared with sunflower seed oil as cooking oil for 3 months.[50] The significant reduction in cholesterol and TG values observed in this study may therefore most likely be attributed to the extensive availability of unsaturated fatty acids, γ-oryzanol, tocopherols, tocotrienols, and antioxidant lignans of the sesame oil blend.

Indeed, numerous reports showing the antihypertensive, antidiabetic, and lipid-lowering effects of sesame oil and rice bran oil individually as cooking oil. The magnitude of blood pressure and lipid-lowering effects of sesame oil and rice bran oil blend is highly pronounced in this study. It is perhaps the richness of sesame lignans, oryzanol, tocopherols, tocotrienols, and unsaturated fatty acids contents of the sesame oil blend, all of which may possibly affects high blood pressure and lipids. Nonetheless, the present study can be considered as preliminary, requiring subsequent trials to validate that the remarkable blood pressure and cholesterol-lowering effects of this oil blend are reproducible.

The study has several limitations and strengths. First, the study is an open-label dietary approach and not blinded or placebo controlled, and also, the background diets of the participants during the study period and the amount of oil consumed by each subject of the studied groups were not monitored. Second, the actual fat intake was not recorded either at baseline or during the sesame oil blend consumption, and this perhaps accounts for the weaker effect of the intervention among normolipidemics. A difference in fat intake could explain the difference in body weight and body mass index between normotensives and hypertensives and if extended to the treatment phase, may be associated with the lower consumption of the

sesame oil blend and thus the insignificant effect. Finally, the study was conducted in a rural Indian population, which minimized the potential confounding by lifestyle and socioeconomic factors but also may limit the study generalization of the study. We, however, believe that our results may indeed be generalizable to other populations because the blend of sesame oil and rice bran oil is a rich source of unsaturated fatty acids and antioxidants. Nevertheless, these findings are important because they have the potential to influence future, nondrug options for the treatment of hypertension and hypercholesterolemia, both factors that increase the risk of heart diseases and other CV risk. Strength includes the prospective design, comparing a known antihypertensive drug with the sesame oil blend alone or combination, reasonable sample size and 100% follow-up.

In conclusion, we demonstrated for the first time that using blend of 20% unrefined sesame oil and 80% physically refined rice bran oil as cooking oil remarkably reduced the blood pressure and improved the blood lipids and also showed additive effects to antihypertensive medication for lowering of blood pressure to normal level. The present study provides prospective evidence to support the role of a sesame oil blend in the prevention of hypertension and hypercholesterolemia. These findings will have important implications in the management of high blood pressure and lowering the cardiovascular risk.

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Author Contributions: S.D. helped in the study design, general supervision of the research group, and the writing and critical revision of the manuscript for important intellectual content; R.S. conducted study management, follow-up patients enrollment, and data collection; B.C. carried out the theoretical conception and formulation of the sesame oil blend and reviewing the manuscript; A.A. edited, interpreted, and revised the intellectual content of the manuscript; B.Z. performed the statistical analysis, figure illustration, and interpretation of data.

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