Original Article

To Determine the Effects of Green Tea on Blood Pressure of Healthy and Type 2 Diabetes Mellitus (DM) Individuals

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ABSTRACT

INTRODUCTION: Green tea (GT) contains more than 4000 biologically active compounds of which *polyphenols* are important. *Flavonoids* are the most important of polyphenols family. Flavonoids contain *catechins*, which are the primary polyphenols in GT. Catechins exert anti-oxidant activity. Hence the GT neutralizes the free radicals produced during normal body metabolism. Green tea exerts many effects on the normal physiological functions of human body.

OBJECTIVE: To determine the effects of green tea on blood pressure of healthy individuals and patients of type 2 Diabetes mellitus (DM).

METHODOLOGY: This cross sectional observational study was conducted at the Department of Physiology and Medical Research Center LUMHS and NIMRA Jamshoro from April 2015 to October 2015 after approval of the research ethics committee of the Institute. Through convenience sampling, after observing inclusion and exclusion criteria, a sample of 75 healthy volunteers and 75 diagnosed DM cases was selected. Informed consent was taken from all participants. Pulse and blood pressure recorded as per standard protocol. Blood sugar was determined. Data entered in Microsoft excel sheet and analyzed on SPSS 21.0 (IBM, Incorporation, USA) Student "t" test and Chi square test were used for the analysis of continuous and categorical variables. Statistical significance was defined as p-value of ≤0.05

RESULTS: From 150 total study subjects, 75 were healthy control subjects and 75 were type 2 diabetics (DM) subjects. The systolic and diastolic BP showed statistically significant improvement in diabetics at 90th intervention day, blood glucose was also improved in diabetic subjects.

CONCLUSION: The present study concludes that the intake of green tea improves blood pressure and blood sugar in diabetic patients. Hence, the present study concludes that the green tea exerts beneficial effects on the cardiovascular physiology, modification to lowering blood pressure and blood sugar.

KEY WORDS: Diabetes Mellitus, Green Tea, blood pressure, cardiovascular diseases, spectrophotometer.

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INTRODUCTION

Cardiovascular diseases (CVD) are one of the important cause of mortality around the World[1], CVD is second frequent cause of mortality, despite recent advances in the management, with approximately 30% of deaths by the year 2015, due to cardiovascular diseases[2], which is more than double the mortality by cancer during same period[3]. It is multi factorial disease, mainly sedentary life style, alcohol consumption, hypokalemia, obesity, salt over use, and vitamin D deficiency had been suggested as cause of CVD[4].

Systemic high blood pressure is chronic vascular disorder which is considered as a major risk factor for coronary heart disease, renal failure and brain stroke. Systemic hypertension requires general preventive measures, life style modification is essential along with drugs[5]. Systemic hypertension also damages blood vessels of various organs such as eyes, kidneys, brain, etc [6]. Similarly type 2 Diabetes mellitus (T2DM) has over exceeded the infectious disease as cause of mortality and morbidity in developing countries [7]. An estimate of 2010 showed that 70% of T2DM subjects belong to middle income countries of World[8], prevalence of T2DM in Sindh province of Pakistan is 16.2% in males and 11.70 % in females[9]. The pathogenic mechanisms of T2DM have not been clearly defined, T2DM is metabolic disorder characterized by abnormal glucose and lipid metabolism because of absolute or relative insulin secretion deficiency by β-cells of pancreas[10].

Traditional herbal remedies are raw mixtures which act synergistically to produce favorable effects if observed any [11]. Therapy is directed to modify blood lipids, cholesterol and blood sugar levels by dietary factors, life style modification and/or drug agents.

Dietary factors are focused on reducing energy intake in form of saturated fat intake[12]. Tea is a widely used public beverage second to the water[13]. Tea comprises of 3 varieties, derived from *Camellia Sinensis*, which is a commercial crop[14]. Tea may be green tea, black tea and Oolong tea; they differ in chemical composition and way of processing. GT has more than 4000 polyphenols, flavanoids are most important of them which contain catechin and is the primary polyphenol in GT[15]. The potential mechanism of GT to reduce blood pressure includes decreasing the action of angiotensin converting enzyme inhibitor which need to relaxation on blood vessels. The polyphenols decreases the level of kallikrein and prostaglandin E2 and various endothelial derived hyper polarizing factors (EDHF) which increases the nitric oxide production resulting in reduced blood pressure.

The present proposed research aims to observe the benefits of extended consumption of green tea on the cardiovascular physiology parameter like blood pressure.

Objective

To determine the effects of green tea on blood pressure and blood sugar of healthy and Type 2 Diabetes mellitusindividuals.

METHODOLOGY

Settings: The study was conducted at the Department of Physiology, in collaboration with the Medical Research Centre, Liaquat University of Medical and Health Sciences Jamshoro and NIMRA Jamshoro.

Sampling: Sample size calculation was done according to general calculation formula. Sample size is stands out to be n=150, these included employees of LUMHS and patients of type 2 Diabetes on dietary control from general population of Hyderabad city. Volunteers were allocated to two groups i.e.; control and the test group.

Group A: Comprised of 75 healthy individuals with normal pulse and BP.

Group B: Comprised of 75 Diabetic patients who were on diet control only and not taking any medications.

Study Design

Study was a cross-sectional comparative study.

Inclusion Criteria

1. Group A, healthy adult males with the age range 40 to 50.
2. Group B, male patients of type 2 Diabetes on diet control, with the age range 40 to 50.
3. Normal Liver function test.
4. Low caffeine consumption (<200 mg/day or a cup of tea daily).
5. Non-smoker.

Exclusion Criteria

1. Females
2. Group A, healthy adult males with age range below 40 and above 50
3. Group B, patients of type 2 Diabetes on medications, with age range below 40 and above 50
4. Abnormal liver function tests
5. High caffeine consumption (>200 mg/day)
6. Smokers
7. Alcohol consumption
8. Use of any regular medication or multi vitamins supplements.
9. Suffering from any medical or psychiatric condition
10. Regular consumers of soft drinks, fruits products and bakery item.

METHODOLOGY

The study comprised of 3 phases: phase 1: recruitment and screening of volunteers; phase 2: A week run-in period during which volunteers consumed one serving of test drink GT per day at the study site for test adherence to GT drinking and protocol compliance; phase 3, 90 days of intervention period during which the volunteers consumed GT at home. Volunteers were required to attend the physiology department once every day in the second phase, at the same time of morning, to consume their test drink containing defined amounts of GT, and the volunteers would be required to take a light meal breakfast preferably toast with milk, before they took their test drink.

They were instructed not to consume any other beverages containing caffeine during the intervention period.

Test Drink

The beverage was prepared by adding 250 ml of hot water to the GT (1.5 g tea bag, Lipton). An average cup of GT from commercial products when prepared according to the instructions given on their packaging contains on average 83 mg of catechins and 30 mg caffeine.

Data Collection

The data was collected from 0 day, and 90 days of the intervention period, taking general physical examination, Pulse, blood pressure, and draw blood from all participant and filling performed by standard protocols, the details are as under;

Pulse

Pulse was noted in Proforma of study subject

Blood Pressure

Blood pressure was measured by sphygmomanometer by applying the procedure.Subjects were asked to have rest for 5 minutes, avoid smoking and ingesting coffee/teas for 30 minutes. Surrounding environment

was comfortable and relaxed, selectedarm was kept in rest and freed of clothing, Arm was slightly flexed at the elbow, felt the brachial artery with fingers of one hand. Cuff was encircled about 2.5 cm above the anterior cubital fossa. Cuff was deflated for auscultatory measurement of BP. Cuff was inflated to a pressure approximately 20 – 30 mmHg above the systolic BP measured by palpatory method Cuff was slowly deflated for listening of "*Korotkov's sounds*"- beginning of sounds was taken as systolic BP while disappearance of Korotkov`s sounds was taken as diastolic BP. BP was noted in Proforma of study subject.

Blood Sampling

Blood samples were taken at days 0 and 90 of intervention.3ml of Blood was collected from each participant by venopuncture into vacationers under aseptic measures, collected into gel test tube for blood sugar analysis. The blood was centrifuged at 3500 rpm for 5 min by centrifuged machine; the serum was fractionated and transferred to eppendorf cups then stored at −20°C till required for analysis. Before the analysis sample was first allowed to attain room temperature then used.

Blood Glucose Estimation

Blood glucose was measured by glucose oxidase method. The procedure was performed on Micro Lab 300 (spectrophotometer) Roche, USA at the Medical Research Center LUMHS Jamshoro.

WRITTEN INFORMED CONSENT

Written informed consent was taken from volunteers. They were informed in detail about the purpose of study, advantages, expected harm, social and economical issues. They were informed that they can withdraw from study protocol at any point and were never bound to withstand with study protocol.

DATA ANALYSIS

Data was entered in Microsoft excel sheet and copied to data sheet on the SPSS 21.0 (IBM, Incorporation, USA) for windows release. Student t test and Chi square test were used for the analysis. Statistical significance was defined as p-value of ≤ 0.05.

RESULTS

Total 150 subjects were taken for this study, 75 were healthy control subjects and 75 were type 2 diabetics (T2DM) subjects. Control and diabetic subjects were age and gender matched. Mean ±SD age of control and diabetic were noted as 45.54 ±3.9 and 46.6 ±3.0 years respectively (t+1.9, p-value=0.056).

Systolic BP in controls at baseline was noted as 119.8 ±1.2 vs. 118.7 ±1.04 mmHg after 90 days. While in diabetics it was noted as 149.8 ±17.06 vs. 145.2 ±18.06 mmHg after 90 days. Systolic BP before and after green tea (GT) intervention in controls and diabetics is shown in table 1 and graph 1 (p<0.05).

Diastolic BP in controls at baseline was noted as 80.12 ±2.51 vs. 77.21 ±3.05 mmHg after 90 days (<0.05), While in diabetics it was noted as 88.76 ±10.76 vs. 81.21 ±8.16 mmHg after 90 days. Diastolic BP before and afterintervention in controls and diabetics is shown in table 2 and graph 2.

Random blood sugar (RBS) in controls at baseline was noted as 96.81 ±9.59 vs. 95.06 ±12.42 mg/dl after 90 days. While in diabetics it was noted as 284.73 ±82.07 vs. 261.62 ±91.98 mg/dl after 90 days (p≤0.001). RBS before and after GT intervention in both controls and diabetics showed statistically significant differences as shown in table 3 and graph 3.

TABLE I: SYSTOLIC BP (MMHG) IN CONTROLS AND DIABETIC SUBJECTS (n=150)

	Mean	±SD	p-value
Controls- Baseline	119.8	1.2	<0.05
Controls- After 90 days	118.7	1.04	<0.05
DM- Baseline	149.8	17.06	<0.05
DM- After 90 days	145.2	18.60	<0.05

GRAPH I: FINDINGS OF SYSTOLIC BLOOD PRESSURE IN CONTROLS AND DIABETICS BEFORE AND AFTER GREEN TEA INTAKE

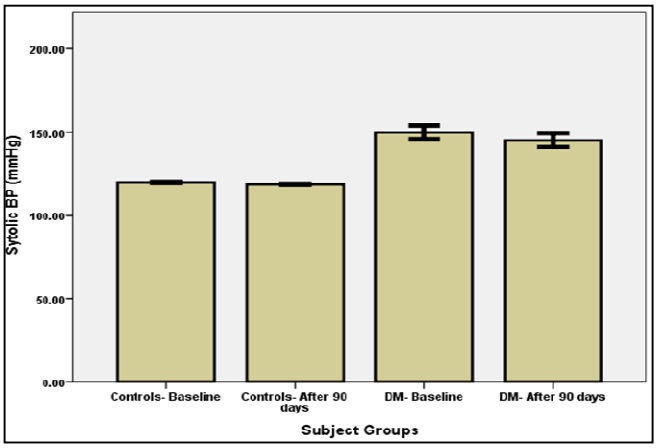


TABLE II: DIASTOLIC BP (MMHG) IN CONTROLS AND DIABETIC SUBJECTS (n=150)

	Mean	SD	p-value
Controls- Baseline	80.12	2.51	<0.05
Controls- After 90 days	77.21	3.05	<0.05
DM- Baseline	88.76	10.76	≤0.05
DM- After 90 days	81.21	8.16	≤0.001

GRAPH II: FINDINGS OF DIASTOLIC BLOOD PRESSURE IN CONTROLS AND DIABETICS BEFORE AND AFTER GREEN TEA INTAKE

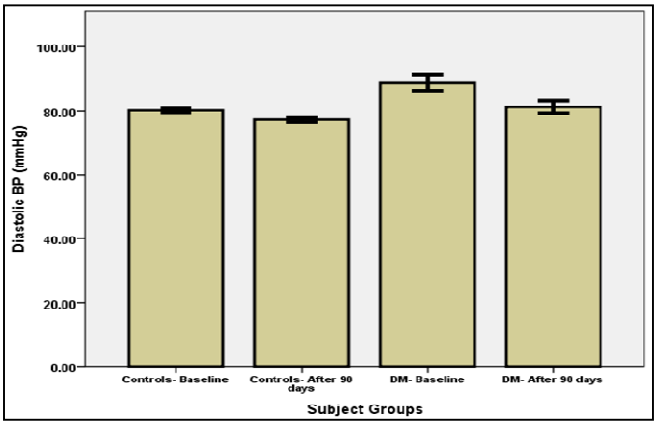
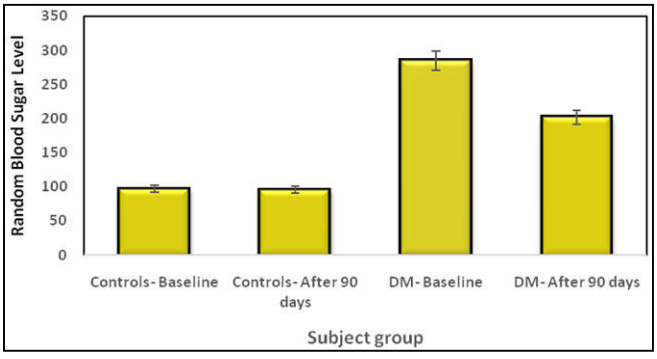


TABLE III: BLOOD SUGAR LEVELS (MG/DL) IN CONTROLS AND DIABETIC SUBJECTS BEFORE & AFTER CONSUMPTION OF GREEN TEA (n=150)

	Mean	SD	p-value
Controls - Baseline	96.81	9.59	<0.05
Controls - After 90 days	95.06	12.42	<0.05
DM - Baseline	284.73	82.07	<0.05
DM - After 90 days	261.62	91.98	<0.001

GRAPH III: FINDINGS OF RANDOM BLOOD SUGAR LEVELS IN CONTROLS AND DIABETICS BEFORE AND AFTER GREEN TEA INTAKE



DISCUSSION

Green tea is a popular hot beverage and a rich source of flavonoid. The beneficial effects of GT had been attributed mostly to catechins, which are Flavonoids like polyphenols[4,5]. In present prospective study, beneficial effects of GT on the systemic blood pressure, and blood sugar were at baseline and after 90 days of GT consumption were observed.

Systolic BP in controls at baseline was noted as 119.8 ±1.2 vs. 118.7 ±1.04 mmHg after 90 days. In diabetics, it was noted as 149.8 ±17.06 vs. 145.2 ±18.06 mmHg after 90 days (p<0.05).

Diastolic BP in controls at baseline was noted as 80.12 ±2.51 vs. 77.21 ±3.05 mmHg after 90 days(p<0.05). While in diabetics it was noted as 88.76 ±10.76 vs. 81.21 ±8.16 mmHg after 90 days (p<0.001).

Random blood sugar (RBS) in controls at baseline was noted as 96.81 ±9.59 vs. 95.06 ±12.42 mg/dl after 90 days (p<0.05) While in diabetics it was noted as 284.73 ±82.07 vs. 261.62 ±91.98 mg/dl after 90 days (p<0.001). Peng X et al[16] in their meta-analysis of 13 randomized controlled trials had suggested an overall beneficial effect on lowering of blood pressure. The findings are supporting to present study as we have observed similar effects on systolic and diastolic BP. Findings are also consistent to a previous study which has reported thaton average 2 cups/d of GT improves the cardiovascular physiology and coronary artery disease[17]. Consistent with the present study, *in vivo* studies had revealed that GT extract significantly improved the blood pressure and enhanced endothelial cell function in hypertensive rats[18].

Another previous study from USA with a cohort of 1017 (median age of 33 years) suggested that drinking large quantities of coffee increases BP[19]. Although this is in contrast to the findings of present studyhowever, the probable explanation may the fact that they have used high doses of caffeine when compared to present study. In present study, a positive improving effect of GT on blood glucose was observed in both controls and diabetics which are consistent to a recent study by Chacko et al who was concluded that the GT improves carbohydrate metabolism[20]. In a study by Sabu MC et al [21], GT intake (500 mg/kg) improved the glucose tolerance significantly after 1 hour in normal rats. While in alloxan induced diabetic rats, the blood glucose lowering effect was observed at dose of 100 mg/kg. Continuous administration of GT for 15 days at doses of 50 or 100 mg/ kg improved blood glucose levels by 29% and 44% respectively in the alloxan induced diabetic rats[21]. The findings of above study are consistent to our present study. A previous study [22] has reported that the active catechins, the EGCG inhibited the intestinal glucose absorption by Na+ glucose transporter (SGLT1), and this is one suggested possible mechanism of controlling blood sugar[22]. The findings are consistent to our present study.

Jiangsu Nutrition Study (JIN) from China[23] reported that tea consumption was inversely correlated with 5 year diastolic BP but not the systolic BP in smokers, and inversely associated with both Systolic and diastolic BP in non-smokers. Hence, the study concluded that the GT improves blood pressure however smoking abrogates the effect. The findings of above study are consistent to our present study.

CONCLUSION

The present study concludes that the green tea intake for long duration improves systemic blood pressure and improves glucose tolerance. Systolic and diastolic blood pressures were improved in both controls and diabetics.Hence it may be concluded that the Green tea exerts beneficial effects on the cardiovascular physiology and blood glucose levels.

RECOMMENDATIONS

The present study recommends further studies be

conducted to confirm the findings of present study. Intake of Green tea may be recommended to normal healthy subjects and those suffering from Diabetes mellitus.

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