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Original Research Article

Effect of black coffee and green tea on plasma C-peptide level in apparently healthy adults

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ABSTRACT

Background: Black coffee and green tea, both known for their antioxidant properties and potential health benefits. Black coffee, rich in chlorogenic acid, is stimulating but can cause jitteriness due to its caffeine content. In contrast, green tea offers a balanced approach, with catechins providing anti-inflammatory effects and L-theanine promoting calm focus. In this study, we will investigate and compare the effects of black coffee and green tea on glucose metabolism and insulin sensitivity, aiming to deepen our understanding of their roles in managing metabolic health and related disorders.
Methods: The study was conducted at King George's Medical University, Lucknow, from April 1, 2023, to March 31, 2024, involved 140 healthy participants aged 20 to 30 years, divided into three groups: black coffee Group (35 participants), green tea group (35 participants), and lukewarm water control group (70 participants).
Results: The study found no significant changes in plasma C-peptide levels after 21 days of consuming black coffee, green tea, or lukewarm water. Black coffee group (case), plasma C-peptide p=0.224. Green tea group (case), plasma C-peptide p=0.768. Lukewarm water group (control), plasma C-peptide p=0.491. All p values were above 0.05, indicating no significant effect of the beverages on these metabolic markers**.**
Conclusions: The study concluded that neither black coffee nor green tea had a significant impact on plasma C-peptide levels in the short term. However, further research with larger sample sizes and varied demographics is recommended to validate these findings and explore long-term effects.

Keywords: Black coffee, Caffeine, Diabetes mellitus, Green tea, Metabolic health, Plasma C-peptide

INTRODUCTION

Black coffee and green tea are two of the most predominant refreshments around the world, celebrated for both their specific flavors and potential prosperity benefits. Research highlights their powerful antioxidant properties, which may help protect against chronic diseases like cancer and cardiovascular conditions. lack coffee, abundant in chlorogenic acid, is renowned for its stimulating effects. However, its high caffeine content may also cause side effects such as jitteriness and disturbances in sleep. On the other hand, green tea, with its origins in ancient China, offers a more balanced health approach. Its antioxidants, particularly catechins, have strong anti-inflammatory properties, while the amino acid L-theanine promotes a state of relaxed alertness. This makes green tea a popular choice for enhancing focus without the nervousness often associated with coffee. Regular green tea consumption has also been linked to a reduced risk of cognitive decline and neurodegenerative diseases. The study of coffee's impact on metabolic health has evolved significantly over the decades,

reflecting growing interest in its potential benefits and risks. The exploration of black coffee and green tea's effects on glucose metabolism and insulin sensitivity has evolved significantly over the past decade, reflecting a growing interest in their potential health benefits.

Research into black coffee began with Yusni et al, Their study with healthy female participants found no significant changes in serum insulin levels, suggesting limited immediate impact on glucose metabolism.[1] Building upon this foundation, Mokwena et al explored various herbal teas, including black coffee, in the context of metabolic syndrome. Their findings indicated that black coffee might improve glucose absorption and insulin resistance, highlighting its potential role in managing metabolic disorders.[2]

As research progressed, Adeniyi et al their study revealed that daily coffee intake could positively influence metabolic parameters, potentially enhancing insulin sensitivity and regulating glucose levels over time.[3] This narrative was further enriched by Gonzalez et al, Researchers examined the effects of caffeinated versus decaffeinated coffee and found that caffeinated coffee significantly improved insulin sensitivity more than decaffeinated coffee. This indicates that caffeine is a crucial factor in these metabolic advantages.[4] In 2023, Chang et al, expanded the research by assessing coffee's impact on glucose tolerance and metabolic syndrome markers across diverse populations. Their results confirmed that regular coffee consumption could notably lower blood glucose levels and enhance insulin sensitivity, reinforcing coffee's role in diabetes management.[5] The story culminated with Smith et al, whose large-scale meta-analysis demonstrated that moderate coffee consumption is associated with a lower risk of type 2 diabetes and improved glucose metabolism.[6]

Parallel to these developments, research on green tea has also provided valuable insights into its effects on glucose metabolism. The journey began with Toolsee et al who studied Mauritian green tea and its potential to mitigate diabetes-related risk factors. Their findings suggested that green tea could reduce symptoms of metabolic syndrome and diabetes risk, though the short trial duration limited long-term observations.[7] Maruyama et al who investigated how varying concentrations of green tea influenced blood glucose levels. They observed that higher concentrations were associated with lower fasting blood glucose levels, although consumption frequency did not significantly affect HbA1c or fructosamine levels.[8]

The narrative evolved further with Wein et al who explored the antidiabetic and anti-inflammatory properties of green tea catechins. Their study indicated that high-dose green tea extract could temporarily improve fasting glycemia and reduce inflammation markers, suggesting potential anti-inflammatory benefits.[9] Liu et al, whose comprehensive meta-analysis demonstrated that green tea significantly lowers HbA1c and fasting glucose levels, solidifying its role in enhancing insulin sensitivity and glucose regulation.[10] Martin et al also contributed to this understanding by examining the effects of green tea extract on glucose kinetics during post-exercise recovery, finding reduced insulin levels associated with green tea consumption.[11]

Further research by Snoussi et al highlighted the metabolic benefits of green tea in rats encouraged a high-fat count calories, appearing decreases in blood lipids, glucose levels, and fat capacity in the liver, recommending potential in corpulence avoidance.[12] Alves Ferreira et al, they found that green tea alone effectively lowered fasting glucose and improved lipid profiles, although its effects were neutralized when combined with metformin.[13]

Fu et al reviewed various teas and underscored that green tea's antioxidant compounds could improve blood sugar regulation and reduce inflammation, highlighting its preventive role in diabetes.[14] Later author Xu et al supported this study, by confirming that green tea consumption lowers fasting blood glucose levels, though it does not significantly affect HbA1c or fasting insulin concentrations, suggesting short-term glucose control benefits.[15] Zhang et al found that regular tea consumption, including green tea, was associated with improved glucose metabolism and insulin secretion, while Zeng et al demonstrated that decaffeinated green tea extract improved glycemic control and reduced gut inflammation, reinforcing its role in managing metabolic syndrome.[16,17]

This chronological examination highlights the growing body of evidence supporting both black coffee and green tea as important components in the study of metabolic health, illustrating their evolving roles in the pursuit of better health outcomes. Despite the promising findings, the existing research is limited, and more rigorous studies are necessary to fully understand the health impacts of these beverages. Over the last four decades, the relationship between their consumption and health benefit has generated great interest. However, the evidence of study is limited.

METHODS

Study place

This study was conducted at King George's Medical University (KGMU), Lucknow, India, specifically in the Department of Physiology.

Study duration

The study period was from April 1, 2023, to March 31, 2024.

Participants were assigned to one of three groups. Black Coffee (n=35), Green Tea (n=35), or Lukewarm Water (control, n=70). The aim was to evaluate the effects of these interventions on plasma C-peptide over a 21-day period. Participants consumed their assigned beverage daily, and blood samples for plasma C-peptide levels were collected before and after the intervention and sent to the Department of Pathology at KGMU for analysis. Statistical analysis using paired t-tests assessed changes in biomarkers and compared intervention effects. Following ethical approval, volunteers were recruited voluntarily, with informed consent obtained from all participants, ensuring they were fully aware of the study's goals, methods, risks and benefits.

Subject

We spread the information about our study mainly through social media, reaching out to a diverse group of people. We also made announcements in public places like apartments, colleges and cafeterias in Lucknow City. This approach worked really well, and we got a great response. Many volunteers expressed interest in participating in our study. This method was crucial for us to gather a large number of volunteers. The recruitment process was conducted in a manner that ensured the volunteers understood the purpose of the study and were willing to participate. Each volunteer was informed about the study's objectives, the procedures that would be followed and the potential risks and benefits of participation.

For this study, a total of 140 volunteers were selected based on a set of clear inclusion and exclusion criteria.

Inclusion criteria

Only those volunteers who expressed a clear willingness to participate and signed an informed consent form were included in the study.

The inclusion criteria were designed to ensure that the participants were apparently healthy adults, with no known metabolic disorders that could potentially influence the study's outcomes.

Exclusion criteria

The exclusion criteria were established to omit individuals who might have conditions or circumstances that could confound the results of the study (Table 1).

Data collection methods

Data collection commenced after March 31, 2023, shortly after the Ethics Committee's approval. Full informed consent was obtained from all participants before the study commenced. Baseline parameters, including age, gender, anthropometric measurements (BMI, height, and weight), and biochemical marker (serum C-peptide), were collected for all subjects, results recorded in a chart. For C-peptide analysis, approximately 5 ml of venous blood was collected in a plain serum vial. These samples were sent to the Department of Pathology, where they were centrifuged, and the serum was stored in cryogenic vials before being frozen for further analysis. Subjects were then given their assigned beverage supplements, which they consumed for 21 days under monitored conditions. After the intervention period, blood samples were drawn again for C-peptide estimation. The C-peptide levels were determined in the Department of Pathology, King George's Medical University, using a C-peptide kit and the results were recorded from the microplate reader.

RESULTS

The demographic and baseline characteristics of participants. The study involved 140 participants, who were split into three groups: 35 in the Black Coffee group, 35 in the Green Tea group and 70 in the Lukewarm Water group. The demographic and baseline physiological characteristics-such as age, weight, height, and BMI-were analyzed and compared, showing significant differences across the groups (Table 2).

Overall, participants in the Lukewarm Water group were the oldest and heaviest, with the highest average BMI. In contrast, those in the black coffee group were the tallest. The green tea group had the shortest participants and the highest BMI. These differences highlight the variability in demographic characteristics across the groups. Following the interventions, data was carefully tabulated and subjected to statistical analysis to assess the outcomes.

Table 1: Inclusion and exclusion criteria.

	Inclusion criteria	Exclusion criteria
Age	20 to 30 Years	<20 and >30 Years
BMI	18.5 to 25 (Ref CDC) [20]	<18.5 and >25 (Ref CDC)
Status	Healthy individual	Individual with other illness
Habit	Non-alcoholic, non-smoker, non-tobacco, not on any medicine	Alcoholic, smoker, tobacco user, on any medicine, regular caffeine consumer, regular green-tea or tea consumer
Any Disease	None	Metabolic and endocrinal diseases

Plasma C-peptide

In the black coffee group, the paired t-test results yielded a t-value of 1.239 with a p-value of 0.224, and the 95% confidence interval for the difference ranged from -0.0238 to 0.0981. In the Green Tea group, the t-value was 0.298 with a p value of 0.768, and the 95% confidence

interval ranged from -0.0500 to 0.0671. For the lukewarm water group, the t-value was 0.692 with a p value of 0.491, and the 95% confidence interval ranged from -0.02178 to 0.04493. Similar to the fasting blood glucose results, the p-values for plasma C-peptide levels in all groups exceed the 0.05 significance level, suggesting that none of the beverages have a statistically significant impact on plasma C-peptide levels (Table 5).

Table 2: The demographic and baseline characteristics of participants.

Group	Gender	Average age (in years)	Average height (cm)	Average weight (kg)	BMI
Black coffee n=35	Overall	21.9±2.5	166.9±7.7	60.1±6.6	21.8±2.0
	Female	21.1±1.8	163.8±6.1	58.1±5.7	21.6±1.8
	Male	22.6 ±2.8	169.4±7.6	61.7±6.8	22.0±2.1
Green tea n=35	Overall	22.5±2.7	162.4±6.4	60.0±5.5	22.7±2.1
	Female	22.5±2.8	161.5±5.1	58.2±3.5	22.3±1.9
	Male	22.6±2.7	165.4±8.2	64.0±7.3	23.8±2.3
Lukewarm water n=70	Overall	23.31±2.82	164.02±6.64	62.67±6.06	23.16±1.42
	Female	22.53±2.31	163.21±5.56	61.26±5.12	22.83±1.48
	Male	24.20±3.10	164.93±7.68	64.27±6.6	23.54±1.27

Table 3: Statistical summary (means, standard deviations, and ranges).

Group	Parameter	Mean	Standard deviation	Range
Black coffee	C-Peptide pre-intervention	0.99 ng/ml	0.20 ng/ml	0.60-1.20 ng/ml
	C-peptide post-intervention	0.96 ng/ml	0.20 ng/ml	0.55-1.15 ng/ml
Green tea	C-peptide pre-intervention	0.74 ng/ml	0.19 ng/ml	0.50-1.00 ng/ml
	C-peptide post-intervention	0.73 ng/ml	0.19 ng/ml	0.45-0.95 ng/ml
Lukewarm water	C-peptide Pre-Intervention	0.77 ng/ml	0.21 ng/ml	0.50-1.05 ng/ml
	C-peptide post-intervention	0.77 ng/ml	0.22 ng/ml	0.45-1.10 ng/ml

Table 4: Baseline and post-intervention measurements.

Group	Pre-intervention plasma C-peptide (ng/ml)	Post-intervention plasma C-peptide (ng/ml)
Black coffee	0.99±0.20	0.96±0.20
Green tea	0.74±0.19	0.73±0.19
Lukewarm water (control)	0.77±0.21	0.77±0.22

Table 5: Statistical analysis of plasma C-peptide.

Group	t-value (C-peptide)	P value (C-peptide)	95% Confidence interval (C-peptide)
Black coffee	1.239	0.224	-0.0238-0.0981
Green tea	0.298	0.768	-0.0500-0.0671
Lukewarm water (control)	0.692	0.491	-0.02178-0.04493

The comparison across all groups-black coffee, green tea, and lukewarm water-shows that none of the beverages had a statistically significant effect on plasma C-peptide levels. The results from the paired t-tests for each beverage group consistently yielded p-values greater than 0.05, indicating that the consumption of black coffee, green tea or lukewarm water does not lead to significant changes in these metabolic parameters.

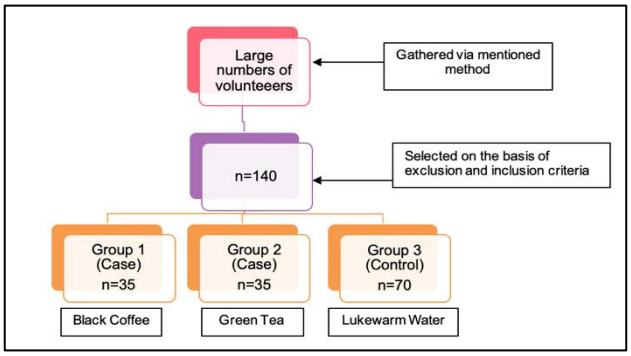

Figure 1: Subject selection flowchart.

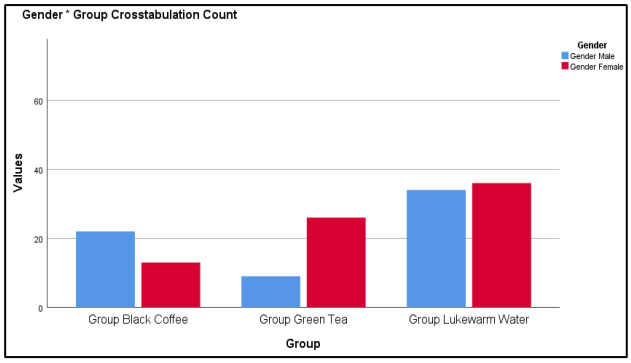

Figure 2: Group and gender crosstabulation.

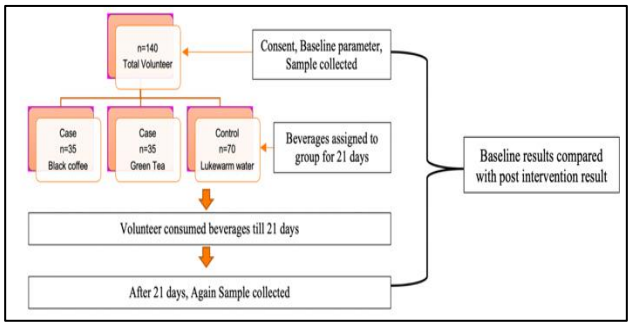

Figure 3: Data collection flow chart.

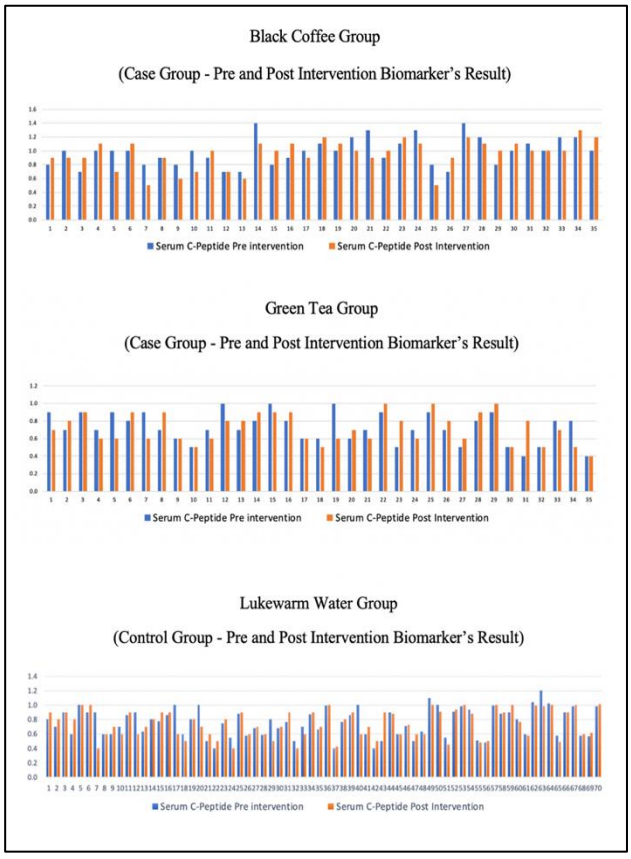

Figure 4: Pre and post intervention biomarker's result.

DISCUSSION

The objective of this study was to assess the effects of black coffee and green tea consumption on plasma C-peptide levels in a healthy population. The study sample consisted of 140 participants, aged 20 to 30 years, randomly assigned to three groups. Black coffee group, green tea group and a lukewarm water control group. After a 21-day intervention period, we observed no statistically significant differences in plasma C-peptide levels across the groups. This suggests that short-term consumption of either black coffee or green tea does not have a notable impact on plasma C-peptide concentrations in young, healthy individuals.

Previous research has highlighted the role of black coffee and green tea in metabolic processes, particularly in glucose metabolism and insulin sensitivity. Black coffee is known to contain caffeine, polyphenols, and other bioactive compounds that have been reported to improve insulin sensitivity and potentially reduce the risk of type 2 diabetes van Dijk et al, Bhupathiraju et al.[19,20] Similarly, green tea is rich in catechins, which are believed to have anti-inflammatory and glucose-regulating properties (Hodgson et al, Ryu et al).[19,21]

Despite these findings from prior studies, our research did not show significant changes in plasma C-peptide levels. This result may be attributed to the relatively short duration of the intervention. Most studies reporting positive effects of coffee or green tea on insulin secretion or glucose metabolism typically involve longer durations or higher consumption levels. For example, van Dijk et al.[19] found improved insulin sensitivity after 4 weeks of coffee consumption, whereas our study only spanned 21 days. Similarly, Ryu et al demonstrated that regular green tea consumption for several months could lower fasting glucose levels in individuals with impaired glucose tolerance, a finding not mirrored in our healthy cohort over a shorter period.[21] The gender differences observed in beverage preferences, with males more likely to choose black coffee and females more inclined towards green tea, align with cultural and social trends reported in previous studies.[22] It is possible that different bioactive compounds in black coffee and green tea, when consumed habitually, could exert gender-specific metabolic effects, though our study did not focus on this aspect.

Our findings also align with studies suggesting that the acute or short-term consumption of black coffee or green tea is unlikely to cause significant metabolic changes in healthy individuals.[23] Given that plasma C-peptide levels are stable markers of insulin production, the lack of significant changes in our study could imply that more prolonged consumption or studies in populations with pre-existing metabolic conditions may be necessary to detect meaningful differences.

Black coffee group

Participants in the black coffee group had a mean age of 22.49±2.29 years, a mean height of 165.77±7.93 cm, a mean weight of 59.94±7.05 kg, and a mean BMI of 21.79±1.73. Pre-intervention plasma C-peptide levels were 0.99±0.20 ng/ml and post-intervention plasma C-Peptide level were 0.96±0.20 ng/ml. Paired t-tests for plasma C-peptide (Table 5), the t-value was 1.239 with a p-value of 0.224, and the 95% confidence interval ranged from -0.0238 to 0.0981. These results indicate that Black Coffee consumption did not significantly alter plasma C-peptide levels.

Green tea group

Participants in the green tea group had a mean age of 22.26±2.47 years, a mean height of 162.16±6.94 cm, a mean weight of 59.17±4.62 kg, and a mean BMI of 22.45±1.66. Pre-intervention plasma C-peptide levels were 0.74±0.19 ng/ml and post-intervention plasma C-Peptide level were 0.73±0.19 ng/ml. For plasma C-peptide (Table 5), the t-value was 0.298 with a p-value of 0.768, and the 95% confidence interval ranged from -0.0500 to 0.0671. These findings suggest that Green Tea did not significantly affect plasma C-peptide levels.

Lukewarm water (control) group

Participants in the lukewarm water group had a mean age of 23.37±3.07 years, a mean height of 164.23±6.76 cm, a mean weight of 62.16±8.78 kg, and a mean BMI of 23.14±2.53. Pre-intervention plasma C-peptide levels were 0.77±0.21 ng/ml and post-intervention plasma C-Peptide level were 0.77±0.22 ng/ml. Paired t-tests for plasma C-peptide (Table 5), the t-value was 0.692 with a p-value of 0.491, and the 95% confidence interval ranged from -0.02178 to 0.04493. These results indicate no significant changes in plasma C-peptide levels following lukewarm water consumption.

A comparative analysis across all group's black coffee, green tea, and lukewarm water demonstrated that none of the beverages had a statistically significant impact on plasma C-peptide levels. The paired t-test results consistently showed p-values greater than 0.05 for both metabolic parameters in each group. Specifically, the p values for plasma C-peptide, the p values were 0.224, 0.768, and 0.491, respectively. The 95% confidence intervals for the differences in plasma C-peptide levels were consistent with the null hypothesis of no effect.

Historical research on black coffee's impact on plasma C-peptide levels has shown varied results. A 2022 study by Yusni and Yusuf, published in Pharmacia, evaluated the acute effects of Arabica black coffee on blood glucose, insulin, and serum cortisol levels.[24] This randomized controlled trial, involving 20 healthy female participants, found no significant negative correlation between glucose and insulin levels, concluding that a single cup of black coffee does not significantly affect serum insulin levels. Another study by Biaggioni and Davis (2002), published in Diabetes Care, investigated the effects of caffeine on insulin sensitivity.[25] They found that intravenous caffeine, at levels producing plasma concentrations of approximately 30 μmol/l, decreased insulin sensitivity by about 15% (from 0.46 to 0.39 μmol/kg per min/mU/l). Although a decrease in insulin sensitivity was noted, the study did not establish a clear link between caffeine consumption and insulin resistance.

There are some limitations of the study these are as follows.

Sample size: With 140 subjects, the sample may be too small to generalize findings broadly.

Age range: Participants were aged 20-30, so results may not apply to older adults or adolescents.

Lack of diversity: Limited diversity in ethnicity or socioeconomic status may affect the generalizability of the findings.

Lack of blinding: The study did not include blinding, which may introduce bias. Participants and/or researchers knowing the intervention group could influence behaviour and reporting, potentially affecting the study's outcomes.

Short-term intervention: The study observed effects over a short period; long-term effects remain unknown.

Diet and lifestyle factors: Other factors like physical activity, diet quality, sleep, and stress were not considered.

CONCLUSION

None of the interventions (black coffee, green tea or lukewarm water) showed a statistically significant effect on plasma C-peptide levels in this study. However, further research with larger sample sizes and different study designs may be needed to confirm these findings. It's also important to consider other factors such as diet, physical activity, and individual metabolic differences, which could influence the result.

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Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

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