Effect of Coffee Consumption on Blood Glucose and Lipid Profile Levels in Male Students at Nnamdi Azikiwe University, Nnewi Campus, Anambra State.

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ABSTRACT

Introduction: Coffee is one of the most consumed beverages worldwide and it contains several biologically active components which may have an impact on human health. Aim: This is an experimental study designed to evaluate the effect of coffee intake on plasma glucose and serum lipid profile levels in male students of College of Health Science, Anambra State, Nigeria. Methods: A total of 30 male participants aged between eighteen (18) and thirty (30) years were randomly recruited for the study. Five milliliters (5mls) of baseline samples (after an overnight fast) were collected from participants at day 0 as baseline samples and levels of glucose and lipid profile were evaluated. Subsequently, in addition to their normal diet, each of the participants received a cup of caffeinated coffee prior to their breakfast daily for a period of 21 days. After overnight fasting, post research (test 1st & 2nd) samples (fasting blood sample) were collected on days 11 and 22 respectively and the levels of glucose and lipid profile were re-evaluated. Plasma glucose and lipid concentrations were determined using enzymatic methods respectively. Also, the body mass index (BMI) and blood pressure readings of participants were determined before and after coffee consumption. Results: The results showed that there were significant increases in the mean plasma glucose and serum HDL-C concentrations 11 days (intermediate consumption) and 22 days (post consumption) following coffee intake when compared with baseline levels respectively (p<0.05). However, the mean BMI, SBP, DBP and serum levels of TC, TG and LDL-C remained unaltered after coffee consumption (p>0.05) respectively. Conclusion: The present study has shown that short term consumption of coffee may cause significant alterations in plasma concentration of glucose and serum HDL-C levels with no significant effects on BMI and serum concentrations of TC, TG and LDL-C. However, further studies using larger population size may be necessary in validating these findings.

KEY WORDS: Coffee, Plasma glucose, lipid profile, diabetes, cardiovascular diseases.

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INTRODUCTION
Non-communicable diseases (NCDs) are diseases that are not transmissible directly from one person to another. NCDs also known as chronic diseases tend to be of long duration and are the result of a combination of genetic, physiological, environmental and behavioral factors (1). There are four main classes of NCDs including cardiovascular diseases (CVDs), cancers, chronic respiratory diseases and diabetes. Together, these four groups of diseases account for over 80% of all premature non-communicable disease (NCD) deaths (1). Globally, NCDs result in the death of 41 million people each year, accounting for 71% of all deaths worldwide and each year, 15 million people die from NCD between the ages of 30 and 69 years; with over 85% of these premature deaths occurring in low and middle income countries with cardiovascular diseases accounting for most NCD deaths (17.9 million deaths) and 1.6 million deaths resulting from diabetes each year (1).

Diabetes is a global health problem, with the World Health Organisation (WHO) estimating the prevalence to be 9% of the adult population in 2014 (2). It affects almost 350 million people worldwide, the majority of which (90%) have T2DM. If poorly controlled, it can result in serious complications, including cardiovascular disease, nephropathy and retinopathy, and it is estimated to have caused 1.5 million deaths in 2012 (2). On the other hand, cardiovascular diseases (CVDs) are a group of disorders of the heart and blood vessels. CVDs are the number 1 cause of death globally: more people die annually from CVDs than from any other cause. In 2016, an estimated 17.9 million people died from CVDs, representing 31% of all global deaths. Of these deaths, 85% are due to heart attack and stroke (3). Also, In Nigeria, CVDs accounted for 11% of all deaths in 2018 (1).

Metabolic disorders, such as obesity, dysregulated glucose homeostasis, dyslipidemia, and abnormal elevation of systolic and diastolic blood pressure are important risk factors for cardiovascular disease (CVD) and are among the major contributors for overall mortality (4). Overweight and obese population have rapidly increased worldwide leading to a concomitant rise of type 2 diabetes incidence, especially in the highest income regions. Hypertension and dyslipidemia affect 20%–40% of the population, showing a significant association with elevated BMI, waist circumference, and fasting blood glucose (6). Altogether, these conditions represent a major public health issue that could potentially be reduced by the adoption of a healthier lifestyle. Importantly, both CVDs and diabetes are caused by modifiable factors such as behavioural risk factors such as tobacco use; unhealthy diet and obesity, physical inactivity and harmful use of alcohol (1).

Coffee is a complex mixture of more than a thousand different chemicals, many of which are reported to be biologically active (7). There are two main species of coffee which are traditionally used for making Arabica and Robusta coffees, with the former representing the most diffused species worldwide (8). It has been reported that arabica coffee contains more lipids, while robusta contains more caffeine and polyphenols (9). Coffee contains large amounts of bioactive compounds including caffeine, phenolic compounds, trigonelline, diterpenes and soluble fiber (10). Among phenolic compounds, chlorogenic acids (CGAs) are the most abundant in coffee, representing more than 98% of its total phenolic content, while the remaining 2% is composed of alkylmethoxyphenols, alkylphenols, methoxyphenols, and other phenolics such as pyrogallol, catechol, and phenol (11). Coffee has been extensively studied for antioxidant activity (12-14) and
has been described as probably the most relevant source of dietary antioxidant compounds (15), which are thought to counteract the action of reactive oxygen species (ROS), the main contributors to the development of oxidative stress.

Furthermore, a number of recent studies reported a substantial positive effect of coffee consumption on human health, especially in relation with cardio-metabolic risk factors (16-18). Coffee consumption seems to be reasonably associated with decreased risk of diabetes and cardiovascular disease (CVD) (19-21). Although, a number of authorities have evaluated the effect of coffee consumption on plasma glucose and serum lipid profile levels in other countries, researches in this regard seems to be scanty in Nigeria. Therefore, the present study seeks to evaluate the effect of coffee consumption on plasma glucose and serum lipid profile levels in male students of College of Health Sciences and Technology, Anambra State, Nigeria.

MATERIALS AND METHODS

Study design
This is an experimental study designed to evaluate the effect of coffee intake on plasma glucose and serum lipid profile levels in male students of College of Health Sciences, Anambra State, Nigeria. A total of 30 male participants within the age range of eighteen (18) to thirty (30) were randomly recruited for the present study. The protocols for the study were properly explained to the prospective participants and thereafter, written consents were obtained from participants prior to the commencement of the study. Each participant was advised to abstain from coffee and similar food consumption for a period of three weeks. Afterwards, 6mls each of baseline samples (after an overnight fast) was collected from the participants at day 0 as baseline samples, and levels of glucose and lipid profile (TC, TG, LDL-C, HDL-C) were evaluated. Subsequently, in addition to their normal diet, each of the participants received a cup of caffeinated coffee early in the morning before meal daily for a period of 21 days. After an overnight fast, 6mls of post research (1st test and 2nd test) samples was collected on day 11 and 22 respectively and the levels of glucose and lipid profile were re-evaluated. Blood glucose (fasting blood sugar) and lipid concentrations (Total cholesterol, Triglyceride, Low density lipoprotein cholesterol and High-density lipoprotein cholesterol) were determined using enzymatic methods. Also, a structured questionnaire was used to obtain relevant information such as age, height, sex, demographic factors, dietary patterns, physical activities, medical history, lifestyle and history of coffee intake, while participants’ weight and blood pressure readings were obtained using weighing scale and sphygmomanometer respectively before and after coffee consumption.

Preparation of coffee
The coffee used for this study was commercially prepared and marketed by Tesco. Each of the participants was given the same quantity of coffee comprising of a mixture of 150milliliter of water and 1gram of coffee powder.150ml of hot water was measured using a measuring cup and a gram of coffee measured using a weighing scale was added to it. Afterwards, 50mg of non-dairy creamer was added.

Inclusion criteria
Apparent healthy male participants aged between 18 and 30 years who consented to the study were included for this study.
Exclusion criteria
Individuals consuming coffee and similar foods, Diabetic and hypertensive individuals, and those diagnosed with ulcer and cardiovascular disease, alcoholics and smokers or those outside the age bracket of 18-30 years were excluded from the present study.

Ethical Consideration
The ethical approval for this study was sought and obtained from the Ethics Committee of Faculty of Health Sciences and Technology, Anambra State, Nigeria (reference number: ERC/FHST/NAU/2018/169 and dated: September 24, 2018).

Estimation of total cholesterol (TC)
Total Cholesterol level was estimated using enzymatic method as described by Roeschlau et al. (22).

Estimation of triglycerides
Triglyceride level was estimated with the enzymatic method as described by Tietz, (23).

Estimation of high-density lipoprotein cholesterol (HDL-C)
HDL level was estimated using the method described by Burstein et al. (24).

Estimation of low-density lipoprotein cholesterol (LDL-C)
LDL level was estimated using the enzymatic method described by Assman et al. (25).

Estimation of plasma glucose (FBS)
Plasma glucose level was determined using glucose oxidase method as described by Barham and Trinder, (26).

Statistical analysis
The data obtained was statistically analyzed using Statistical package for Social Sciences (SPSS) Version 23.0. Paired students’ t-test were used to compare means. The results were expressed as mean±SD and confidence limit was chosen at 95% (p<0.05). p<0.05 was considered statistically significant.

RESULTS
The result of analysis of variance showed that the mean concentrations of plasma glucose and serum high density lipoprotein cholesterol (HDL-C) were significantly different amongst the groups (F=11.246 and 29.387) (P<0.05) respectively, whereas, body mass index (BMI), systolic blood pressure (SBP), diastolic blood pressure (DBP), total cholesterol (TC), triglyceride (TG) and low density lipoprotein cholesterol (LDL-C) levels did not differ significantly amongst the groups (P>0.05). See table 1.

There were no significant differences in the mean values of BMI, DBP, SBP when compared between baseline (day 0), intermediate consumption (day 11) and post (day 22) coffee consumption respectively (p>0.05). Also, the mean serum levels of TC, TG and LDL-C did not differ significantly when compared between the groups (p>0.05). See table 1. However, a significant increase was observed in the mean level of plasma glucose when compared between baseline (0 day) and intermediate consumption (day 11) of coffee (3.93±0.39 Vs 4.37±0.32; p=0.011). Also, there was a significant increase in the mean plasma concentration of glucose when compared between baseline and post (day 22) coffee intake (3.93±0.39 Vs 4.71±0.69; p=0.000). Furthermore, the mean plasma glucose concentration differed significantly when compared between the intermediate (day 11) and post (day 22) coffee consumption (4.37±0.32 Vs 4.71±0.69; p=0.042). See table 1.
Interestingly, the mean serum HDL-C level was significantly increased in intermediate consumption of coffee than in baseline (3.21±0.98 Vs 1.11±0.98; p=0.000). Also, the mean serum HDL-C level was significantly increased in post consumption of coffee than in baseline (2.97±1.17 Vs 1.11±0.98; p=0.000), but the mean serum level of HDL-C did not differ significantly when compared between intermediate and post coffee consumption (p>0.05). See table 1.

BMI, Blood pressure, plasma glucose and serum lipid profile levels of male students before and after coffee consumption (Mean±SD; n=20).

<table>
<thead>
<tr>
<th>Variables</th>
<th>BMI (Kg/m²)</th>
<th>SBP (mmHg)</th>
<th>DBP (mmHg)</th>
<th>Glucose (mmol/L)</th>
<th>TC (mmol/L)</th>
<th>TG (mmol/L)</th>
<th>HDL-C (mmol/L)</th>
<th>LDL-C (mmol/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline (1)</td>
<td>22.27 ±3.21</td>
<td>122.00 ±13.08</td>
<td>77.94 ±8.67</td>
<td>3.93 ±0.39</td>
<td>5.05 ±1.34</td>
<td>1.17 ±0.41</td>
<td>1.11 ±0.32</td>
<td>3.54 ±1.31</td>
</tr>
<tr>
<td>Intermediate consumption (2)</td>
<td>22.39 ±3.03</td>
<td>121.44 ±12.77</td>
<td>74.44 ±9.27</td>
<td>4.37 ±0.32</td>
<td>4.59 ±1.13</td>
<td>0.97 ±0.44</td>
<td>3.21 ±0.98</td>
<td>3.21 ±0.98</td>
</tr>
<tr>
<td>Post consumption (3)</td>
<td>21.94 ±3.02</td>
<td>122.17 ±9.98</td>
<td>78.39 ±7.76</td>
<td>4.71 ±0.69</td>
<td>4.47 ±1.12</td>
<td>1.07 ±0.26</td>
<td>2.97 ±1.17</td>
<td>2.97 ±1.17</td>
</tr>
</tbody>
</table>

1 Vs 2 (p-value) 0.915 0.890 0.227 0.011* 0.260 0.119 0.000* 0.388
1 Vs 3 (p-value) 0.748 0.967 0.877 0.000* 0.152 0.452 0.000* 0.142
2 Vs 3 (p-value) 0.668 0.858 0.174 0.042* 0.753 0.411 0.426 0.537

*Results are expressed as Mean±SD and are statistically significant at p<0.05 (Confidence Interval (CI) is set at 95%).

DISCUSSION
Coffee has been the focus of major attention due to its global consumption and impact on human health (27). It is among the most widely consumed pharmacologically active beverages, and its consumption has become a regular part of daily life worldwide (28). Coffee contains several biological active compounds which may affect human health (29).

In this study, the effect of coffee consumption on plasma glucose and lipid profile levels in male students was evaluated. The present finding indicates that there was no significant effect of coffee consumption on the body mass index (BMI) of the participants. A potential explanation to this result could be related to the quantity of coffee consumed by the participants. A study by Gavrieli et al. stated that by increasing the amount of coffee there is also a potential alteration of the equilibrium between the actions of the different coffee compounds (30). In line with this, Salinardi et al. hypothesized that when a small amount of coffee is consumed, the dominant effect comes from the compounds that promote energy intake, but when a higher coffee amount is consumed, then the balance is changed in favor of compounds such as caffeine, chlorogenic acids and mannooligosaccharides that prevent energy consumption thereby inducing a reduction in body weight (31). However, some authorities had earlier recorded differing result from our present finding (32-36).

Also, the present study observed no significant effects of coffee consumption on the mean values of DBP and SBP when compared between before and after coffee consumption.
consumption. The possible reason for this result is not clearly understood. This is in line with the finding of Mesas et al. who recorded no significant difference in the mean blood pressure after two weeks of coffee consumption (37). In contrast to the present study, Nurminen et al. suggested that acute coffee intake increases blood pressure (38).

Interestingly, there was a significant increase in the mean glucose value when compared before and after coffee consumption. This increase may have been potentiated by the caffeine component of the coffee which causes alterations in glucose homeostasis by decreasing glucose uptake into skeletal muscle, thereby causing elevations in blood glucose concentration. Previous studies have documented acute hyperglycemia and reduced insulin sensitivity or impaired glucose tolerance after short term consumption of coffee (39-41). The present finding is in consonance with some previous studies which reported that the ingestion of caffeinated coffee with either a high or low glycemic index (GI meal) significantly impairs acute blood glucose management and insulin sensitivity thereby resulting in increased mean glucose level (42-44). Additionally, Van-Dam et al. observed an increase in mean glucose value after coffee consumption in a population-based Hoorn Study, which included Dutch men and women (45). Furthermore, in a systematic review and meta-analysis, Shi et al. concluded that coffee intake might shift glycemic homeostasis toward hyperglycemia (46). However, some other studies have also documented results which are in contrast with the present results (47-49).

This present study observed no significant differences in the mean serum TC, TG and LDL-C levels in the studied subjects when compared before and after coffee consumption. This may be due to the type of coffee beans utilized in this study or it could be as a result of the quantity of coffee consumed in the present study. The coffee beans used in this research was derived from Coffea robusta which has been reported to have fewer amounts of caesol and kahweol than other types of coffee (50). Cafestol, and to a lesser extent kahweol, have been shown to increase total cholesterol, low-density lipoprotein cholesterol (LDL-C) and triglyceride concentrations, without substantial effects on high-density lipoprotein cholesterol (HDL-C) concentrations (51, 52). Also, previous studies have indicated that increased consumption of coffee results in a dose-dependent increase in serum levels of TC, LDL-C and triglycerides (TG) (53-55). Relatively small quantities of coffee was consumed by the subject compared to the quantity consumed in other previous research works hence the result. Consistent with these findings, Zargar et al. reported no significant changes in the serum levels of TC and LDL-C with a significant reduction in TG level following coffee consumption in a study population of 49 adult participants (56). Furthermore, the reports of Karabudak et al. is in keeping with the present study (55). By contrast, a meta-analysis study by Cai et al. showed that coffee was directly related to increased total cholesterol, LDL-cholesterol and triglycerides when consumed boiled or non-filtered (57). Similarly, Rezq and Fathy, (58) revealed that administration of boiled and Turkish coffee induced a significant increase in atherogenic index represented as increase in total lipids, TG, TC, LDL-C and VLDL-C. Also, Abd El-Fatta, (59) showed a significant elevation of serum total cholesterol, TC, TG, LDL-C, with a significant decrease of HDL-C in rats fed on diet supplemented with low or high dose of coffee. Furthermore, Onuegbu et al. observed a significant increase in the mean...
total serum cholesterol concentration and LDL-cholesterol concentration in healthy human subjects after regular administration of coffee (60). Another key finding in this present study is a significant increase in the mean serum level of HDL-C when compared before and after coffee consumption. However, no significant difference was observed in the mean serum level of HDL-C when compared between intermediate and post coffee consumption. The reason for the alterations in the level of HDL-C is not clearly understood but could however be attributed to the additives used in this study. Cheung et al. which suggested that the addition of flavoring substances, such as sugar and cream, to coffee resulted in significant alterations in the serum level of HDL-C (61). However, the findings in this study is in contrast with work by Onuegbu et al. who reported non-significant difference in the mean HDL cholesterol concentration when healthy humans were administered coffee over a period of time (60). Driessen et al. observed no association of coffee consumption with HDL cholesterol (62). Karabudak et al. indicated that there was no significant association between coffee consumption and serum HDL-C level (55).

Conclusion
In conclusion, the present study have shown that short term consumption of coffee may cause significant alterations in plasma glucose and serum HDL-C concentrations without significant alterations in the mean BMI and serum concentrations of TC, TG and LDL-C. However, further studies using larger population size may be necessary in validating these findings.

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