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The effects of coffee consumption on serum lipids and lipoprotein in healthy individuals

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Summary

The changes in total serum cholesterol, serum triglyceride, HDL-cholesterol and LDL-cholesterol after twenty eight (28) days of consumption of moderate quantity of a commercial coffee preparation (NESCAFE brand) were studied in 30 human subjects consisting of 20 male and 10 female healthy adults. Significant increases in the mean total serum cholesterol concentration (110.8–126.5mg/100mls) and LDL-cholesterol concentration (78.4–94.5mg/100ml) were observed in the subjects. No significant differences were obtained in the mean HDL cholesterol concentration and in the mean serum triglyceride levels. The differences observed in the mean total serum cholesterol, LDL cholesterol, HDL-cholesterol and triglyceride concentrations in the individual male and female groups studied were not statistically significant.

The results from this study suggest that short-term consumption of coffee may increase the total serum cholesterol and LDL cholesterol levels. It is therefore possible that long-term consumption of coffee may lead to clinically significant alterations in serum lipid profile and could be important in the aetiology of atherosclerotic vascular diseases such as coronary heart disease.

Keywords: *Coffee, cafestol, kahweol, lipids, lipoproteins*

Résumé

Les changements dans les taux de cholestérol, triglycérides, cholestérol associés aux lipides de forte densité (HDL-Cholestérol) et de cholestérol associé aux lipides de faible densité (HDL-Cholestérol), du sérum après 28 jours de consommation d'une consommation modérée de Nescafé, ont été étudiés chez 30 sujets humains (20 mâles et 10 femelles) en bonne santé. Des augmentations significatives dans la norme de concentration de cholestérol du sérum (110,8 à 126,5 mg/100 ml) et de cholestérol à lipide de faible densité (78,4 à 94,5 mg/100 ml) ont été observées chez les sujets. Des différences insignifiantes n'ont pas été obtenues dans la moyenne du cholestérol à forte densité lipidique et la moyenne totale des triglycérides du sérum. Les différences observées dans les concentrations moyennes totales de cholestérol, LDL-Cholestérol, HDL-Cholestérol, du et des triglycérides du sérum des femmes et des hommes ont été insignifiantes.

Les résultats de cette étude suggèrent que la consommation à court terme du café pourrait augmenter les taux totaux de cholestérol et de LDL-Cholestérol. Il est par conséquent possible que la consommation à long terme du café pourrait entraîner une altération clinique significative du profil lipidique du sérum, et pourrait jouer un rôle important dans

l'étiologie des maladies artérielles vasculaires telles que la maladie coronarienne du cœur.

Introduction

Coffee as a beverage, does not have any nutritional value [1]. Over 5 million tons are produced annually in the world [2]. When coffee is taken in moderate amounts, it is a mild cerebral stimulant and diuretic but it can produce anxiety symptoms, cardiac arrhythmias, gastrointestinal discomfort or insomnia [3].

The association between coffee consumption and its effect on serum cholesterol concentration has been studied extensively. Bjelke [4] was the first to observe a positive correlation between coffee intake and serum cholesterol levels in Norwegians. This finding has since been confirmed by other studies [5,6,7,8]. Although there seems to be abundant evidence to suggest that coffee intake is associated with an increase in plasma cholesterol concentration, conflicting results have also been reported [9,10,11]. Heyden [12] in a population study observed a positive association between coffee intake and plasma cholesterol concentration only in smokers but not in non-smokers.

Bjelke, [4] proposed that certain unknown substances contained in coffee caused a reduction in the excretion of bile acids and sterols leading to a subsequent increase in serum cholesterol concentration in coffee drinkers. However, a recent study has demonstrated that intake of a coffee oil containing high contents of diterpenes (cafestol and Kahweol) increased serum lipids as well as activities of amino transferases [6].

Hypercholesterolemia due to increased LDL-cholesterol is a strong risk factor for development of premature coronary heart disease (CHD) in different populations. An increase in HDL-cholesterol is anti-atherogenic because HDL fraction is probably involved in the removal of cholesterol from tissues [13]. In Nigeria, studies by Taylor, [14] revealed that the level of serum lipids was dependent on the socio-economic status of the individual. The level of serum lipids in the low-income group was reported to be low when compared to those in the high income group.

Consumption of coffee by Nigerians seems to have increased although the quantity consumed might be less than that obtained in many European countries. However detailed studies on the effect of coffee intake in this community are lacking. This study was therefore designed to determine the short-term effects of coffee intake on serum total cholesterol, triglyceride, LDL-cholesterol and HDL-cholesterol levels in male and female Nigerians.

Subjects and methods

Thirty (20M; 10F) volunteers aged between 20 and 35 years participated in the study. They were either members of staff

or students in the University College Hospital, Ibadan. Informed consent was obtained from each participant. All subjects were apparently healthy with body mass index less than 30kg/m² and were not using any drugs known to affect serum lipid concentrations. None of the female subjects was pregnant or lactating or using any oral contraceptives. All subjects were non-smokers, non-alcohol consumers and none was drinking more than four cups (6.4g) of coffee per day. Volunteers were screened for proteinuria and glycosuria and those with a history of gastro-intestinal, liver or kidney diseases were not included in the study.

"NESCAFE", a brand of commercial instant coffee was consumed by each of the subjects and they were made to take 2 cups (3.2g) of coffee per day (1 level teaspoon of coffee per cup) for 28 days. Participants were allowed to use small amounts of sugar and milk.

Venous blood samples were collected from subjects after an overnight fast (14 - 16 hours). Serum samples obtained by centrifugation were stored at -4°C until analysis was done.

Total serum cholesterol was estimated using the modified method of Zlatkis [15] and the determination of serum triglyceride was by the Hantzsch condensation reaction [16]. The first process involved in the quantitation of serum HDL cholesterol was the separation of HDL-cholesterol from other plasma lipoproteins using the precipitation method. In the presence of manganese (II) chloride and heparin, chylomicrons, VLDL and LDL were selectively precipitated. After separation, the same procedure employed in total cholesterol estimation as given by the method of Zlatkis was applied to estimate the serum HDL cholesterol. LDL-cholesterol was calculated using Friedwald's formula [17].

Statistical Analysis: Results are expressed as mean \pm standard deviation. Comparison between baseline and 28 days post-coffee intake values in volunteers was performed using the Students t test. Significance level was set at 95% confidence interval and P values less than 0.05 were accepted as significant.

Results

As shown in Table 1, the mean serum total cholesterol and LDL-cholesterol concentrations in all subjects after 28 days of regulated coffee consumption showed significant increases when compared with the corresponding baseline values ($P < 0.05$). On the other hand, the slight changes in the mean triglyceride and HDL-cholesterol concentrations in all subjects after 28 days of regulated coffee consumption were not significantly different from the corresponding baseline concentrations. When the subject were subdivided into male and female groups, the mean total cholesterol, triglyceride, LDL-cholesterol and HDL-cholesterol concentrations in either male or female groups after 28 days regulated coffee consumption were not statistically altered when compared with the corresponding baseline values.

Table 1: Serum lipids and lipoprotein concentrations in male subjects

| | BASELINE | | | 28 DAYS | | |
|------------------------------|--------------------------|--------------|----------------|--------------------------|--------------|----------------|
| | Total n=30 | Male n=20 | Female n=10 | Total n=30 | Male n=20 | Female n=10 |
| Total cholesterol (mg/100ml) | 110.8(30.4) ^a | 109.0(34.6) | 116.2(21.2) | 126.5(31.2) ^b | 127.5(35.7) | 127.3(21.2) |
| Triglyceride (mg/100ml) | 61.0(30) | 59.9(29.0) | 63.3(7.7) | 64.0(24.8) | 62.1(28.1) | 67.9(14.1) |
| HDL - Cholesterol (mg/100ml) | 20.1(6.4) | 18.0(4.9) | 24.5(6) | 19.2(4.6) | 18.5(4.6) | 20.8(4.4) |
| LDL - Cholesterol (mg/100ml) | 78.4(26.4) ^c | 78.9(23.7) | 77.3(22.4) | 94.5(27.5) ^d | 95.1(31.2) | 90.1(22.2) |

a v s b ($P < 0.05$)

c v s d ($P < 0.05$)

n = Number of subjects

Values are means \pm 1SD

Discussion

A study by Zock *et al.* [18] showed that subjects consuming one small cup of coffee fluid enriched with lipid per day for six weeks (equivalent to about 7 cups of coffee per day) caused a significant rise in serum total cholesterol. Aro *et al.* [19] similarly found that subjects consuming eight cups of boiled coffee a day for four weeks led to a 0.89mmol/L increase in serum total cholesterol relative to subjects consuming the same amount of drip coffee (filtered coffee) and Kark *et al.* [20], using the method of 24 hours dietary recall however showed that the plasma total cholesterol and LDL cholesterol levels in male subjects who took 1-2 cups of coffee per day were significantly elevated. There was also a significant increase in the plasma total cholesterol and LDL-cholesterol of female subjects in the same study.

Arnesen *et al.* [21] did not observe a significant change in the serum total cholesterol and LDL-cholesterol in a group of coffee consumers who took 6 cups of boiled coffee for the first 4 weeks. This was attributed to a rather small increment in coffee consumption compared to pre-study intake. The subjects that constituted this present study were mainly non-consumers of coffee and this could have accounted for the significant differences in the level of serum total cholesterol and LDL cholesterol observed. It is however suspected that the significant difference observed in the serum total cholesterol and LDL cholesterol concentration of all subjects in this study might be due to the effect of diterpenes (cafestol and kahweol) which have been reported to be the active agents that affect LDL receptors. However, data on the method used in brewing the brand of coffee consumed by the subjects in the study is lacking. It is suggested that factors such as the method of growing, roasting, brewing, duration and temperature of the extraction process may influence the biologic properties of the ultimate brew [7]. Previous studies [7,8] have shown that consumption of boiled coffee was the main explanation for the strong association between the frequency of coffee intake and increased cholesterol levels. There are relatively fewer studies on the change in serum cholesterol on consumption of instant coffee.

Confounding variables were minimized in this investigation. Non-smoking, healthy males and females who were not on oral contraceptives were recruited to minimize the effect of smoking and medications. The diet consumed by the volunteers was also assumed not to vary significantly since they were advised on the importance of maintaining

their usual diet. Kark *et al.* [20] demonstrated that values of plasma total cholesterol obtained from coffee drinkers who added milk, cream or sugar and those that did not were not significantly different. In another analysis [7], the change in serum total cholesterol caused by coffee consumption was studied in association with the consumption of whole milk, skimmed milk, meat, fish and bread and consumption of none of these items interfered with the association between coffee consumption and serum cholesterol. It is thus unlikely that sugar or milk used by volunteers could have affected the results obtained in the study most especially as they were advised to reduce the intake of these items.

Consideration was also given to the age and weight of the subjects. The mean age and body mass index in male volunteers were 29.6 years and 21.5kg/m² respectively while in the females, the mean age was 23.2 years and the mean body mass index was 20.9kg/m². The volunteers had a body mass index less than 30kg/m² as recommended by Urgert *et al.* [5] and all of them were young people as reflected by their mean age despite the fact that the mean age of the females was significantly less than that of the males. It is known that atherosclerosis correlates positively with increase in age. Side effects of coffee consumption were reported by many volunteers and these included mild stomach upset, diuresis and insomnia.

The overall consistency of the data obtained in this study with other studies outside this community indicate that the association between coffee consumption and mean serum total cholesterol apparently prevail in populations that differ in lifestyle, diet, blood cholesterol concentration and genetic characteristics and the level of circulating lipids may be important in the extent of the overall increase in their concentrations in coffee consuming individuals.

The Tromso study suggests that response to coffee consumption increases over at least 4 weeks [21]. However, the patterns of change seen in the lipid and lipoprotein levels in all the subjects suggest that coffee consumption may have an effect on the metabolism of cholesterol.

The significant differences in the mean serum total cholesterol and LD-cholesterol found in all subjects in the present study did not agree with findings by Dawber *et al.* [9], Shekell *et al.* [10] and Kovar *et al.* [11]. In view of this, it is recommended that further studies are required in order to understand the mechanism and pattern of change in serum lipids and lipoproteins of subjects after consumption of coffee. This is needed so as to explicitly provide an explanation for the significant differences seen in some subjects but not in others. Studies involving larger populations and long-term coffee consumption are also needed to provide a comprehensive understanding of the serum lipids and lipoprotein profiles in relation to coronary heart disease in consumers of coffee from this community.

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