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International Journal of Current Research
Vol. 8, Issue, 02, pp.26519-26525, February, 2016

INTERNATIONAL JOURNAL OF CURRENT RESEARCH

ISSN: 0975-833X

RESEARCH ARTICLE

CONSUMPTION OF COFFEE BY ADULT INDIVIDUALS: BIOCHEMICAL, PHYSIOLOGICAL, PHYSICAL AND ANTHROPOMETRIC PARAMETER

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ARTICLE INFO

Article History:
Received 24th November, 2015
Received in revised form
15th December, 2015
Accepted 21st January, 2016
Published online 27th February, 2016

Key words:

Decaffeinated coffee,
Clinical analyses,
Stress test.

ABSTRACT

Currently, coffee is being recognized as beneficial to human health for acting as a stimulator in several areas of the organism, and being considered a functional nutraceutical plant. In the present research had as an objective to study the effects of caffeinated and decaffeinated coffee consumption on the health of adult volunteers. Forty-eight individuals were separated into three age groups, 20 to 29, 30 to 39 and 40 to 50 years, which were subdivided both into inactive and sedentary groups as well as by type of coffee consumption (caffeinated or decaffeinated). The participants were instructed how to prepare the drink and how much to consume daily for six months. Clinical exams and ergometric tests were conducted before and after six-month of study. After that all of the data were collected, they were statistically analyzed with the SISVAR, program using the Scott-Knott test and the Student t test at the level of 5% of probability. The statistical analysis verified that levels of total, LDL and HDL cholesterol were reduced after the consumption of coffee. There was an increase in ergometric test duration time, oxygen volume consumed, metabolic equivalent and systolic blood pressure with the consumption of decaffeinated coffee, and there was a reduction in systolic blood pressure and heart rate by consumption of caffeinated coffee. The consumption of coffee, caffeinated and decaffeinated, promoted improvement in or didn´t interfere with the appraised parameters, suggesting that caffeine isn´t the component responsible for the observed alterations and that coffee has characteristics that allow for its characterization as a functional food.

Citation: **Roseane Maria Evangelista Oliveira, Sára Maria Chalfoun, Carlos J. Pimenta *et al.*, 2016.** "Consumption of coffee by adult individuals: biochemical, physiological, physical and anthropometric parameter", *International Journal of Current Research,* 8, (02), 26519-26525.

INTRODUCTION

In developing regions where economies are industrialized, chronic-degenerative diseases, such as diabetes mellitus, arterial hypertension and atherosclerosis become prevalent, mainly because of the adoption of an Occidentalized lifestyle that is characterized by higher levels of sendentarism and accompanied by diets with more fat and less fiber (Nobre, 2005). Among the main illnesses with high mortality rates are cardiovascular diseases, and total cholesterol and LDL cholesterol have a direct relationship with coronary artery diseases. Isolated hypertriglyceridemia doesn´t constitute a risk factor independent of coronary heart disease, but it becomes a part of it when associated with a high LDL cholesterol level and a low HDL cholesterol level.

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However, HDL cholesterol acts in the reverse transport of cholesterol, preventing the formation of atherosclerotic plaques. The study have shown that the association between high levels of serum cholesterol and the incidence of arterial diseases, especially atherosclerosis, can lead to, among other problems, myocardial infarction (heart attack) and cerebrovascular accidents (strokes) (Akosah *et al.,* 2014). The factors that affect the levels of serum cholesterol are numerous and include age, diet, genetic predisposition and body weight (Sempos, 2002).Physical exercise, even if performed to a moderate degree, has a protective effect against coronary artery disease and a series of other benefits, including elevation of HDL cholesterol, reduction of systemic hypertension and increased body weight loss (GUS, 2002).The presence of localized abdominal fat can be more important cardiovascular risk determinant than obesity itself. There are various research studies that point to coffee as being beneficial for human health, acting as a stimulator of several body systems. Besides the caffeine, coffee contains a series of other substances, such as phenolic polymers, chlorogenic acids, lipids and terpenes that possess different biological effects, such as antioxidant, antimutagenic, antibiotic, anti-hypercholesterolemic and antihypertensive actions. According to Costa (2004), drinking up to five cups of strained or filtered coffee daily, doesn´t alter the cholesterol indices (LDL and HDL) or triglycerides and, when ingested together with a balanced diet, can help to reduce weight. Also, Yukawa *et al.* (2004) reported that the regular ingestion of coffee modestly reduced the susceptibility to LDL oxidation and, therefore reduced LDL cholesterol and malondialdehyde levels. In this context, Lima (2013), in a wide review on the effect of the coffee drink on human health, showed that the presence of antioxidant substances in the drink, such as caffeine and polyphenols, prevents free radical formation and, consequently, the development of coronary disease.

However, according to Martín and Saturnine (2007) a significant relationship exists between the method of coffee drink preparation and the effects on serum (SC) cholesterol levels. This effect of coffee preparation method was observed in volunteers that didn´t drink boiled and filtered coffee in comparison with those that drank filtered coffee. Thus, coffee could also increase the levels of circulating triglycerides. Two diterpenes that are responsible for these effects are cafestol and caveol, which are present in the coffee bean; 80% of both compounds are retained by the filter paper used for the preparation of the coffee, and therefore, the increase in serum cholesterol (CS) induced by these compounds is substantially reduced when coffee is filtered. Several mechanisms have been proposed to explain the effect of cafestol and caveol on serum cholesterol (CS) and triglycerides (TG): a decrease in the number of LDL receptors in post-transcriptional regulator mechanisms, a decrease in bile acid synthesis, an increase in the protein activity of the serum responsible for the transfer of HDL CS to LDL and an increase in hepatic VLDL synthesis. A meta-analyses from Crippa *et al.* (2014) reported that the moderate (3-4 cups/day) coffee consuption may have lower risks of death from all causes and cardiovascular disease than person who rarely drink coffee Robertson *et al.*(1984), studying the prolonged administration of caffeine, 250 mg/day in hypertensive patients, did not observe an association with significant blood pressure elevation, with plasma catecholamine levels or with the activity of plasma renin in those patients. In additcion, Ding *et al.*(2014) demonstrate a robust inverse association between coffee consumption and risk of diabetes. Compared with no coffee consumption, consumption of 6 cups/day of coffee was associated with a 33% lower risk of type 2 diabetes. Caffeinated coffee and decaffeinated coffee consumption were both associated with a lower risk of type 2 diabetes.Based on the above, the objective of the present work was to study the effects of caffeinated and decaffeinated coffee consumption on the health of active and sedentary adult volunteers; health was evaluated through the participants' lipid profiles, anthropometric evaluations and ergometric test results. Above all, this study was designed to provide an opportunity to generate rigorous scientific results that show the coffee consumption has beneficial health effects, which would, thus, demystify its current connotation of poor health.

MATERIALS AND METHODS

After approval of the project by the Human Research Ethics Commission of the Academical Center of Lavras, the present research was developed with 48 healthy, sedentary and active adult individuals of both sexes, ranging in age from 20 to 50 years, from the city of Lavras - MG. Lectures were conducted to present the research project to the volunteers as a project designed to determine whether the consumption of coffee carries health benefits. Later, an anamnesis form was filled out, and study participants were selected. Pregnant women and cardiopaths were excluded. Those subjects who were already registered were mobilized to undergo clinical exams (total cholesterol, cholesterol fractions and triglycerides) in the Laboratory Santa Cecília in Lavras – MG, under the supervision of the pharmacist-biochemist. For the clinical exams, individuals were advised to fast for a period of 12 h. Soon after blood collection, the triglyceride, total cholesterol, HDL cholesterol, LDL cholesterol and VLDL cholesterol levels were evaluated. For the ergometric test, data from the volunteers were collected; this data included patient and exam identification, including name, sex, age, anthropometric data, date and time of exam and the patient's clinical characteristics, including principal data from the medical history and pertinent physical exams and medication in use. The Ellestad Protocol was used with constant inclination until the 4th stage; the increment per stage was 3 METs, and the exam was interrupted when the patient presented intense physical fatigue and reached a submaximum heart rate, accentuated Systolic Blood Pressure (SBP) increase and absence of vasodilator effects in relation to the Diastolic Blood Pressure (DBP) (Chaitman, 2006).

The final placement of volunteers in groups classified as Active and Sedentary was made according to their response on the medical history, with 'active' being considered those who were physically active three or more times a week and with 'sedentary' being those who eitherweren´t physically active or were only physically active up to twice a week. The volunteer's performance on the ergometric test and the evaluation of the doctor were taken into account.The blocks were separated by age group and physical activity (active or sedentary) and by consumption of filtered coffee, caffeinated or decaffeinated (3 to 4 cups of 100 mL coffee/day, for a period of six months).The coffee used was of the species *Coffea Arabic*, which was collected from a single lot at the Farm of Ponte do Funil, located on the margin of the Lake of Funil in the municipal district of Perdões - MG. It was processed in the roaster of the Agrotechnical School of Machado, obtaining a medium roast ideal for consumption. The sample used was of the export type, peeled cherry-colored grains under a natural preparation process obtaining a coffee classified as a "soft" drink; the decaffeinated coffee was of the commercial brand Mellitta, and the whole product was also from the same lot. The experiment was carried out according to a completely randomized design with four repetitions. The treatment portions were arranged in a 3x2x2 factorial outline (3 age groups, 2 physical activity situations and 2 types of coffee) and subdivided in time (beginning of the treatment and six months after), using a total of 48 volunteers. The age groups, which constituted the blocks, were young (20 to 29), intermediate (30 to

39) and superior (40 to 50 years). Twenty-four volunteers began to ingest coffee with caffeine and the other twenty-four began to ingest decaffeinated coffee; all of the participants were guided to consume from three to four cups per day (100 mL/day) for a period of six months and were told not to consume other foods containing caffeine to assure higher precision of the experiment. The duration of the research was six months, and at the end of the study, clinical analyses, anthropometric measurements and ergometric tests were again conducted to verify possible variations in the studied parameters. After all of the data were collected, they were statistically analyzed with the SISVAR program using the Scott-Knott test and the Student t test at the level of 5% of probability.

RESULTS AND DISCUSSION

Laboratory Exams

a) Triglycerides

Six months of coffee drinking didn´t have a significant effect on plasma triglyceride levels (P>0.05).

b) Total Cholesterol

In Table 1, the average total cholesterol values are presented according to age group (20 to 29, 30 to 39 and 40 to 50 years), type of coffee (caffeinated and decaffeinated) and stage (before and after the supply of the different types of coffee for six months) for the individuals evaluated in this study. As presented in Table 1, average total cholesterol levels at the beginning of the experiment were significantly lower (P < 0.01) for the youngest individuals (20-29 years) who consumed caffeinated coffee than for the individuals in the intermediate (30-39) and superior (40 to 50) age range.

Table 1. Average total cholesterol values according to age range, coffee type consumed in the six months of the experiment, stage of measurement of the individuals

	Type of coffee2			
	Caffeinated		Decaffeinated	
Age group [1]	Before	after	Before	after
20 to 29 years	51.0 bB	145.6 bB	183.3 bA	163.1 bB
30 to 39 years	214.1 aA	191.6 aB	202.5 aB	194.3 aB
40 to 50 years	190.1 aB	188.8 aB	194.0 aA	171.4 bB
Standard Error	12.5			

Averages followed by the same letter in the column for each factor do not differ among themselves by the Scott-Knott (1), and by the Student (2) t test a nominal level of significance of 5%.

That trend was also present after six months of coffee consumption. Only the individuals of the intermediate age group presented a reduction of total cholesterol level after six months of caffeinated coffee consumption. However, for those who consumed the decaffeinated drink, it was observed that the highest total cholesterol values in the beginning of the research were verified in the intermediate age group individuals. After six months of decaffeinated coffee ingestion, individuals in the youngest and oldest age groups presented a significant reduction (P < 0.05) in total cholesterol levels. Averages followed by the same small letter in the column and capital on the line for each type of coffee do not differ among themselves by the Scott-Knott test (1), and the Student t test (2), with a nominal level of significance of 5%. Thus, for the total cholesterol exams carried out before and after the six months of coffee treatments (caffeinated or decaffeinated), there was an average reduction of 13.5 mg/dL in the total cholesterol levels of the evaluated individuals. This overall reduction in cholesterol level across treatment groups indicates that the consumption of filtered coffee, caffeinated or decaffeinated, contributes to a decrease in total cholesterol, and it allows us to conclude that caffeine wasn´t the substance responsible for the observed reduction in total cholesterol. In the reference values, it was observed that the general average (182.5 mg/dL) obtained for the individuals was within the range considered borderline (170 to 199 mg/dL) (SANTOS, 2001).

c) HDL Cholesterol

For HDL cholesterol, there wasn't significant difference for any of the analyzed factors, separately or in combination, except for the factor stage, where there was a significant difference.The results in Table 2 show that, after six months of coffee (caffeinated or decaffeinated) consumption, the average HDL cholesterol levels were reduced from 50.85 mg/dL to 46.40 mg/dL. However, the average value was 48.65 mg/dL, which is considered normal according to the reference values used (Santos, 2001). The observed reduction in HDL cholesterol after six months of caffeinated or decaffeinated coffee consumption was proportional to the results obtained for the level of total cholesterol. Therefore, both caffeinated and decaffeinated coffee consumption reduced HDL cholesterol, supporting the hypothesis that consumption of coffee reduces cholesterol but that caffeine isn´t the factor responsible for that reduction.

Table 2. Average values of HDL cholesterol according to stage (before and after) at which the measurements were taken in the individuals

Stage	HDL cholesterol (mg/dL)	Standard error
Before	50.85 a	0.81
After	46.40 b	

Averages followed by the same letter in the column do not differ among themselves by the Student t test a nominal level of significance of 5%.

d) LDL Cholesterol

In Table 3, the average LDL cholesterol values are presented according to age group, level of physical activity and type of coffee consumed for the six months of the experiment. Individuals in the oldest age group presented significantly higher LDL cholesterol values than the individuals of the youngest age group (P < 0.01). The youngest individuals (20-29 years) presented a lower value of LDL cholesterol (92.20 mg/dL) in relation to the individuals in the intermediate (30-39 years) and oldest (40 to 50 years) age groups, who presented averages of 122.19 mg/dL and 116.41 mg/dL, respectively. It could even be observed that, independent of physical activity and the type of coffee consumed, after six months, the level of this cholesterol fraction was significantly reduced from 114.73

mg/dL to 105.80 mg/dL (P < 0.01), verifying a beneficial effect of coffee on lowering LDL cholesterol levels. These results reinforce the hypothesis that components in coffee other than caffeine can reduce cholesterol levels. The average LDL cholesterol value found for all participants was 110.26 mg/dL, which is considered desirable (100 to 129 mg/dL) (Santos, 2001).

Table 3. Average values of LDL cholesterol according to age range, physical activity leves, type of coffee consumed in the six months of the experiment, stage at which the measurements were taken in the individuals

Age Group (years)[1]	LDL Cholesterol (mg/dL)	Standard error
20 to 29	92.20 b	
30 to 39	122.19 a	6.72
40 to 50	116.41 a	
Stage[2]		
Before	114.73a	2.28
After	105.80 b	

Averages followed by the same letter in the column for each factor do not differ among themselves by the Scott-Knott test (1), and the Student t test (2), with a nominal level of significance of 5%.

From the results obtained in the present work, it was observed that triglyceride and VLDL cholesterol levels remained stable over six months of coffee consumption. There was a significant reduction in total, HDL and LDL cholesterol levels that was independent of the type of coffee consumed for six months (Tables 1, 2 and 3). Therefore, these data suggest that caffeine wasn´t the element responsible for that reduction, indicating that other components of coffee can promote such an effect. These results corroborate those obtained by Natella *et al.* (2007), who, working with 10 healthy individuals and with the ingestion of 200 mL of coffee, showed that isolated caffeine didn´t present any antioxidant effect on total cholesterol. There is evidence that phenolics can reduce the level of LDL. Natella *et al.* have also shown that consumption of filtered coffee didn´t alter LDL levels. They hypothesized that the consumption of coffee increases the antioxidant capacity of the plasma and that coffee phenolic acid metabolites are responsible for that action. Also, Sotillo and Hadley (2002), working with mice, showed that chlorogenic acids were capable of significantly reducing blood cholesterol and triglyceride levels.

According to Bonita*et al.,* (2007), polyphenols are components present both in filtered coffee and in unfiltered coffee, and they have potential cardiovascular benefits through antioxidant mechanisms related both to the oxidation of LDL (once oxidized, LDL loses the capacity to transport the cholesterol that is deposited inside the arteries leading to obstruction) as well as to the reduction of blood pressure. However, their benefits are less pronounced when unfiltered coffee is consumed. According to Greenberg *et al.* (2006), several researchers found an association between the consumption of coffee and the elevation of serum lipids. The studies showed that the coffee that was consumed in that period was merely boiled and not filtered, which elevated the serum lipid concentrations. However, the type of coffee more often consumed in Brazil and in the United States is filtered coffee, which doesn´t affect serum lipid concentrations.

Also Bonita *et al.* (2007) verified that high consumption (> 6 cups/day) of boiled, unfiltered coffee is harmful to the heart due to an increase of total cholesterol and LDL cholesterol as a result of diterpene oils, whereas filtered coffee resulted in a reduction in total and LDL cholesterol levels. According to those same authors, individuals that drank the unfiltered coffee had 65% higher cholesterol values compared to those who consumed the filtered coffee. Yoshihiro *et al.* (1999), evaluating the effect of coffee on serum cholesterol and lipoprotein levels in 4,587 Japanese (48 to 56 years old), reported that HDL cholesterol levels weren´t altered, LDL was increased, and there was a reduction in triglyceride levels in individuals who drank instant coffee. The same was observed by Onuegbu and Agbedana (2001), who evaluated the effect of coffee (Nescafe) on lipids and lipoproteins in healthy individuals; they reported that there was an increase in the concentration of total cholesterol and LDL cholesterol; however, for HDL and triglycerides, there were no significant differences.Comparing the results of the present research with those found in the literature, it´s apparent that the preparation method used (filtered coffee) and the consumption dose (4 cups/day), considered normal for the tested population, didn´t lead to elevation of total cholesterol and of the cholesterol fractions considered to be risk factors for cardiovascular diseases but promoted the reduction of some of them, independent of the drink consumed. However, in other research, in individuals drinking unfiltered coffee or drinking coffee in doses superior to 6 cups/day, some negative effects have been observed in cardiovascular risk factors that nullify the advantages of coffee use as a supplier of a large variety of beneficial bioactive principles.

Anthropometric Measurements

There were no significant differences observed in abdominal circumference (AC) measurements or in the body mass index (BMI) for any of the groups regardless of age, physical activity level, type of coffee and stage or for any combination of these factors (P>0.005).The general average found for AC, was of 84.22 cm. This is considered normal in agreement with the reference values, which, for women are up to 88 cm, and, for men are up to 100 cm. Above those values, the risk of suffering illnesses is higher (National, 2001). The average BMI value found was 25.58 kg/ m^2, which means that the individuals were found to be overweight, which is defined as 25.0 -29.9 kg/m^2 (Coutinho *et al.,* 1991). Those results don´t corroborate with Costa (2004), who reported that the consumption of coffee in combination with exercise lead to weight reduction, reduction of body mass index (BMI) and reduction of abdominal circumference.

Ergometric Test

Based on the duration of the ergometric test, there were significant differences in the functional capacity of active and sedentary individuals; active individuals were able to endure the test for longer (11.14 ') compared to sedentary individuals (8.87 ') (P < 0.01).

a) Duration of Test

Table 4 shows that individuals in the oldest age group (40 and 50 years) had a lower baseline performance on the ergometric test than the younger age groups. After six months of consumption, the individuals in the intermediate age group (30-39 years) presented lower performance in the duration of the test (9.65 '). It is also noticed that the individuals of the oldest age group were the only ones who had a significant increase in their performance (P < 0.01) after regular coffee.

Table 4. Average Duration of Test values in seconds, according to stage x age range

Age Group (years)[2]	Stage[1]	
	Before	After
20 to 29	10.16 aB	10.74 aB
30 to 39	9.82 aB	9.65 bB
40 to 50	9.29 bB	10.34 aB
Standard Error	31.71	

Averages followed by the same small letter in the column and capital on the line, do not differ among themselves by the Student t test (1) and by the Scott-Knott (2) test with a nominal level of significance of 5%.

b) Heart rate

In Table 5, the average heart rate values are presented according to age group, physical activity and type of coffee consumed by the individuals before and after six months of the experiment. There were significant differences (P < 0.05) for the interaction: stage x age group x type of coffee. The individuals in the intermediate age group (30-39 years) who consumed caffeinated coffee presented a significant reduction in heart rate after six months of consumption. For the other age groups, there was no significant difference in heart rate with coffee consumption (P>0.05). For individuals who consumed decaffeinated coffee, there was no difference in heart rate independent of age group. The average value for the final heart rate was 176.26 bpm, which is considered normal for the ergometric test (Chaitman, 2006).

Table 5. Average Final Heart Rate values, in bpm, according to stage, age range and type of coffee consumed for six months by the individuals

Age Group (years)[1]	Coffee Type [2]			
	Caffeinated		Decaffeinated	
	After	Before	After	Before
20 to 29	174.38 bA	177.38 aA	186.50 aA	182.63 aA
30 to 39	190.13 aA	171.75 aB	182.13 aA	180.13 aA
40 to 50	167.13 bA	166.38 aA	170.13 aA	166.50aA
Standard Error	5.53			

Averages followed by the same small letter in the column and capital on the line for each type of coffee, do not differ among themselves by the Student t test (1) and by the Scott-Knott (2) test with a nominal level of significance of 5%.

c) Values of Final VO_2

Table 6 shows that there was a significant effect (P < 0.05) on final VO_2 for the interaction stage x range. The individuals of the oldest age group (40 to 50 years) presented an increase in the levels of VO_2 (49.13 to 54.50 mL/kg min) after six months of coffee consumption; for the other age groups, there was no significant difference in final VO_2. Also, the individuals of the intermediate age group had a lower average VO_2 after six months of coffee consumption than that of either of the other age groups.

Table 6. Average values of Final O_2V, in mL/Kg min, according to stage and age range

Age Group (years)[1]	Stage[2]	
	Before	After
20 to 29	54.63 aA	57.19 aA
30 to 39	53.50 aA	50.81 bB
40 to 50	49.13 aA	54.50 aB
Standard Error	2.93	

Averages followed by the same small letter in the column and capital on the line, do not differ among themselves by the Student t test (1) and by the Scott-Knott (2) test with a nominal level of significance of 5%.

c) Final MET values

In Table 7, the average MET values are presented according to the age group and type of coffee consumed by the individuals before and after six months of the experiment. It was observed that there was a significant interaction (P < 0.05) for the factors stage x age group. After six months of diet, the individuals in the intermediate range (30-39 years) presented a lower average MET level compared to those of the youngest and oldest groups. Also, for the oldest age group (40-50 years), there was a significant difference (P < 0.05) in the average MET level before and after the consumption of coffee.

Table 7. Average Final MET values (mL/Kg min), according to age range and stage

Age Group (years)[1]	Stage [2]	
	Before	After
20 to 29	15.38 aA	16.13 bA
30 to 39	15.06 aA	14.25 aA
40 to 50	14.13 bB	15.44 bA
Standard Error	0,82	

Averages followed by the same small letter in the column and capital on the line, do not differ among themselves by the Student t test (1) and by the Scott-Knott (2) test with a nominal level of significance of 5%.

d) Systolic Blood pressure

In Table 8, the average values of the final Systolic Blood pressure (SBP)/mmHg are presented according to the age group, physical activity and type of coffee consumed by the individuals before and after six months of the experiment. It can be observed that there were significant differences for the interaction stage x age group x coffee. The individuals in the superior age group (40-50 years) who consumed caffeinated coffee presented significant SBP reduction after the six months of coffee consumption; however, the individuals in that same age group who consumed the decaffeinated coffee had a significant increase in SBP, proving once again that the caffeine wasn´t responsible for that elevation, which has been previously suggested by other studies. Individuals in the youngest age group who consumed caffeinated coffee presented a lower SBP. The average value found in the final

SBP was 179/mmHg, which is considered normal for the ergometric test (Chaitman, 2006). There were no significant differences in Diastolic Blood Pressure (DBP) due to six months of coffee consumption for any of the groups.

Table 8. Average Systolic Blood Pressure (SBP) values, in mmHg, according to stage, age range and type of coffee consumed for six months by the individuals

Age Range (years)[2]	Coffee Type[1]			
	Caffeinated Coffee		Decaffeinated Coffee	
	Before	After	Before	After
20 to 29	168.75 bA	169.38 aA	175.63 aA	164.38bA
30 to 39	188.75 aA	192.50 bA	168.38 aA	175.88bA
40 to 50	195.63 aA	175.75 aB	179.38aB	193.63 aA
Standard Error	10.35			

Averages followed by the same small letter in the column and capital on the line for each type of coffee, do not differ among themselves by the Student t test (1) and by the Scott-Knott (2) test with a nominal level of significance of 5%.

e) Double product

Table 9 shows that there were significant differences ($P < 0.01$) for the interaction stage x age group x type of coffee. The individuals in the youngest age group who consumed caffeinated coffee presented the lowest average double product (DP) value compared to that of the other two groups. Also, the individuals who consumed caffeinated coffee didn´t present significant alterations in the DP value after six months of consumption. For those who consumed the decaffeinated coffee, there was a reduction in the DP only for the individuals in the young age range. The average DP value found was 31.067.89 bpm/mmHg, a value in agreement with the reference values; values above 30.000 are rarely associated with ventricular dysfunction (Chaitman, 2006).

Table 9. Average Double Product (DP) values, according to stage, age range and type of coffee consumed for six months by the individuals

Age Group (Years)[2]	Coffee Type[1]			
	Caffeinated		Decaffeinated	
	Before	After	Before	After
20 to 29	28395.63 bA	29463.75 bA	32638.13 aA	29228.13 bB
30 to 39	33693.75 aA	33462.50 aA	28700.00 bA	29885.50 bA
40 to 50	32166.88 aA	30876.88 bA	30342.50 bA	32949.00 aA
Standard Error	1768.16			

Averages followed by the same small letter in the column and capital on the line for each type of coffee, do not differ among themselves by the Student t test (1) and by the Scott-Knott (2) test with a nominal level of significance of 5%.

The individual participants in the present research didn´t present any symptomatology during the maximum test exam, which was interrupted due to physical fatigue (Tables 4, 5, 6, 7, 8 and 9). Comparing the results from the beginning of the research to those generated after six months of consumption of caffeinated or decaffeinated coffee, one can see that the individuals in the superior age group (40 to 50 years) who consumed the coffee drink had an improved performance on the ergometric test after drinking coffee, significantly increasing the time spent on the track (9.29' vs. 10.36') and the metabolic equivalent levels (14.13 METs vs. 15.44 METs). The other age groups didn´t present significant increases for those factors. In relation to the heart rate, the individuals in the intermediate age group (30 to 39 years) who consumed the caffeinated coffee had a significant reduction after the six months of consumption of the drink (190.13 bpm vs. 171.75 bpm). The other age groups remained unaffected. Therefore, it is worth pointing out that the observed increases in the test duration and the metabolic equivalent (MET) levels, as well as a lack of effect on the heart rate for the oldest age group (40 to 50 years), indicates an improvement in the physical conditioning of those individuals and, consequently, a better quality of life.

Bragaand Alves (2000) reported that the action of caffeine occurs mainly due to its ability to increase the release of catecholamines, which increase the concentration of free fatty acids (FFA) in the plasma, leading to increased FFA oxidation, reduced consumption of muscular glycogen, and increased K^+ concentrations in the intracellular medium. However, caffeine does not exercise ergogenic effects when used by habitual consumers (200 mg/day). Regarding heart rate, Roza (2006) reported that, when consumed in low dosages (2 mg/kg), caffeine provokes a heart rate increase as well as an increase in metabolism and diuresis. Those results differ from those obtained in the present research because the caffeine didn´t promote a heart rate increase. For the systolic blood pressure (SBP) results obtained in the present work, it was observed that there was a reduction only for the individuals in the age group from 40 to 50 years, when consuming the caffeinated coffee and no alteration with the consumption of the decaffeinated coffee. Also, Bonita *et al.* (2007) reported that coffee reduced systolic blood pressure (SBP) and diastolic *blood pressure* (DBP) in individuals in the age group from 25 to 64 years; however, they reported that caffeine was not responsible for such a reduction because, in their studies, the individuals who consumed decaffeinated coffee also had a significant reduction in their blood pressure. However, according to Steffen *et al.* (2012), evaluating the effect of coffee on blood pressure and hypertension, did not find any statistically significant effect of coffee consumption on blood pressure or the risk of hypertension. However, in agreement with Nurminen *et al.* (1999) and Tanaka *et al.* (1998), there are many epidemiological studies that indicate that roasted coffee doesn´t affect blood pressure in hypertensive individuals.

Conclusions

There was a reduction in the levels total cholesterol, HDL and LDL cholesterol, which was independent of the type of coffee consumed, the age group and the level of physical activity. There was an increase in the test duration time, distance traveled, VO_2, metabolic equivalent (MET) and systolic blood pressure (SBP) with the consumption of decaffeinated coffee, and there was a reduction of systolic blood pressure and heart rate (HR) with the consumption of caffeinated coffee. The consumption of coffee, caffeinated and decaffeinated, either promoted improvement in or didn´t interfere with the appraised parameters (laboratory exams, anthropometric measurements and the ergometric test), which suggests that caffeine isn´t the component responsible for the observed alterations, which may be attributed to other substances present in the coffee. Coffee presents characteristics that allow for its categorization as a functional food.

Acknowledgments

To Consórcio Brasileira de Pesquisas e Desenvolvimento do Café (CBPandD/ Café), for financial support, and cardiologist doctor Odilon T. Leite Filho.

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