Vegetarian Diet and Cholesterol and Triglycerides Levels

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Objective: Compare levels of triglyceride (TG), total cholesterol (TC), low density lipoprotein (LDL) and high density lipoprotein (HDL) among vegetarians and omnivores.

Methods: Blood samples were collected from 76 individuals – both males and females – separated in four different diet groups: omnivores, lacto-ovo vegetarians, lacto vegetarians, and restricted vegetarians (or vegans). Dosing was done for: TC, LDL, HDL and TG.

Results: Significant difference was reported for TC, LDL and TG levels among the samples. Higher levels were reported by omnivores, with decreased levels for vegetarians as animal products were restricted, with lowest levels having been reported by vegans. Mean and standard deviation for TC were 208.09 ± 49.09 mg/dl in the group of omnivores, and 141.06 ± 30.56 mg/dl in the group of vegans ($p < 0.001$). LDL values for omnivores and vegans were respectively: 123.43 ± 42.67 mg/dl and 69.28 ± 29.53 mg/dl ($p < 0.001$). As for TG, those values were 155.68 ± 119.84 mg/dl and 81.67 ± 81.90 mg/dl ($p < 0.01$). As for HDL level no difference was reported between the samples, but HDL/TC ratio was significantly higher in vegans ($p = 0.01$).

Conclusion: Vegetarian diet was associated to lower levels of TG, TC and LDL as compared to the diet of omnivores.

Key words: Vegetarian diet, cholesterol, triglycerides.

Literature brings evidence of the association between cholesterol high serum levels and the prevalence of arterial diseases, especially atherosclerosis, which may lead, among other problems, to myocardial infarction and cerebral vascular accidents[1-6]. Recent evidence has suggested that increased cholesterol levels have also been found to be a risk factor for Alzheimer disease[7,8].

Cholesterol is transported in the blood by lipoproteins. Among them are: very low density lipoproteins (VLDL), low density lipoproteins (LDL), and high density lipoproteins (HDL). Differently from VLDL and LDL, HDL does not contain the apolipoprotein B-100, which is recognized by the tissues. Therefore, HDL reports fully distinctive behavior and function as compared to the others. It is responsible for reverse transportation, carrying basically the cholesterol from tissues to the liver[3], and therefore helps protect individuals against atherosclerosis. Therefore, if an individual reports high ratio between high density and low density lipoproteins, the probability of developing atherosclerosis is significantly reduced[4]. According to the Vahit[9] Study (Veterans Affairs High Density Lipoprotein Cholesterol Intervention Trial), a 1 mg/dl HDL reduction results in 3%-4% increase in coronary artery disease prevalence. High levels of triglycerides have also been associated to higher prevalence of coronary diseases from atherosclerosis[3].

Cliffton and Nestel[10] have suggested that the type of diet would have little influence on serum cholesterol, to be determined almost exclusively by metabolic activity, which in its turn would be the expression of individuals' genetic load, age, and gender. However, there is evidence that moderate consumption of alcohol increases HDL fraction and stimulates reverse transportation of lipids[11, 12].

Research also shows that certain diets – as the Mediterranean diet – contribute for a better cholesterolemic profile[13]. Likewise, other studies have concluded that individuals under vegetarian diets have lower lipid blood levels, especially LDL, as well as triglycerides, as compared to individuals who eat meat [14-18,19, 20-22].

In Brazil, studies on the lipid profile of vegetarians are still rare. Three studies have been made available: the trial by Mancilha-Carvalho and Crews[14], investigating blood lipids in the Yanomami; the trial by Navarro et al[15], investigating blood pressure, lipid profile and other biochemical parameters among vegetarians, semi-vegetarians and omnivores in Peru; and Navarro's[16] doctorate dissertation comparing electroencephalographic findings, blood pressure, bone mass index (BMI) – among other variables – in Seventh Day Adventists in São Paulo City.

The three types of vegetarian diets are: restricted or total: with no animal product in their food (this type is also called vegan); lacto vegetarians: from animal products, only milk and by-products are included; and lacto-ovo, which also allows the inclusion of eggs[23].

This paper objective was to compare the ratio between triglycerides (TG), total cholesterol (TC) and their fractions (LDL and HDL) among vegetarians, to compare them with omnivores.

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Methods

A cross-sectional study was carried out. Seventy-six voluntary individuals participated. Most of them were residents in the area the research took place. From those, 22 were omnivores, and 54 were vegetarians. Vegetarians were divided into 3 groups: 19 lacto-ovo vegetarians, 17 lacto vegetarians, and 18 total vegetarians. Recruiting of vegetarians was carried out at vegetarian restaurants, at Seventh-day Adventist Churches, among Hare-Krishna members, and at spiritualistic centers. Newspapers and the University Press Center also released announcements giving possible participants instructions on how to join in.

All participants were sent a letter prior to the study, with explanation on procedures, and risks and benefits involved. They all signed an informed consent, and the study was started after the approval by the Institutional Ethics Committee.

Participants filled out a questionnaire with the following personal information: name, gender, age, type of diet, physical exercise practice, alcohol consumption, smoking habits, weight and height, the use of statins. Blood was then collected after fasting was confirmed for at least 12 hours. Blood collection was carried out in compliance with standard procedures for blood samples.

Sample analysis was carried out at the Hospital Complex Central Laboratory (Laboratório Central do Conjunto Hospitalar-CHS) through a working agreement with the University. The dosing equipment used for TG, TC and HDL was Dade Behring-Dimension AR, and reactant for Kit Flex Cartriabe was by Dade Behring-Dimension™ IVD (2 °C a 5 °C).

Concentration measures for TC, TG and HDL were obtained through enzyme biochemical method; LDL concentrations were calculated based on those values and following Friedwald's formula.

As for statistical analysis, two criteria were used to decide on the use of ANOVA: data with NORMAL distribution and variances among homogeneous samples. Should those two criteria not be met, Kruskal-Wallis would be used. Fischer exact test was used for smoking habits analysis since the contingency table had one cell expected to be lower than 5, which contra-indicates the use of χ^2.

For the multivariate analysis, the procedure was the following: in the initial model the variable outcome (lipid), the variable diet, and all factors under investigation were included, as shown in Table 1. Factors as $p > 0.05$ were removed from subsequent models – one by one – following p decreasing order (level of significance). Therefore, in the final model under study, the variable diet and $p < 0.05$ factors were kept. So, results found for lipid regression and diet were not dependent on other factors.

Results

Table I shows data on the characteristics of samples following factors under investigation. The samples are shown to be similar in regard to gender, age, physical exercise and BMI. However, there are significant differences in alcohol consumption ($p < 0.001$), with higher level among omnivores (4 in 22) as compared to vegetarians (9 in 54, being 6 among lacto vegetarians, 3 among lacto-ovo and none among vegans). The same was shown for the use of tobacco, but only 5 individuals referred use, being 4 in the omnivore group and 1 in the lacto vegetarian group. No reference was made to the use of statins in any of the groups.

Table 2 describes samples of lipid serum level per diet. Significant difference was reported for TC, LDL and TG levels among the samples. Higher values were reported by omnivores, with decreased levels as animal products were restricted, with lowest levels having been reported by vegans. Mean and standard deviation for TC were 208.09 ± 49.09 mg/dl in the group of omnivores, and 141.06 ± 30.56 mg/dl in the group of vegans ($p < 0.001$). LDL values for omnivores and vegans were respectively: 123.43 ± 42.67 mg/dl and 69.28 ± 29.53 mg/dl ($p < 0.001$). For TG, those values were 155.68 ± 119.84 mg/dl and 81.67 ± 81.90 mg/dl ($p < 0.01$).

As for HDL level no difference was reported between the samples, but HDL/TC ratio was significantly higher among vegans ($p = 0.01$).

Table 3 shows results of regression analysis between lipid serum level, associated factors, and type of diet. Even after adjustment for different confusion variables (as indicated in each model), the three groups of vegetarians reported significantly lower TC, LDL, and TG levels; vegans additionally reported significantly higher HDL/TC ratio. So, variables such as alcohol consumption, physical exercise and BMI were not included, since they were not shown to be statistically significant for data in Tables 1 and 2.

Factor	Omnivores	Lacto-ovo Vegetarians	Lacto Vegetarians	Vegans	p
	n=22	n=19	n=17	n=18	
Gender (M/F)	7/15	6/13	5/12	10/8	0.31
Age (years) $\bar{x}$ ± SD	37.96 ± 15.56	37.10 ± 10.24	35.76 ± 10.02	29.94 ± 12.50	0.20
Smokers (no/yes)	18/4	19/0	16/1	18/0	0.057
Alcohol users (no/yes)	8/14	16/3	11/6	18/0	<0.001
Physical Exercise (no/yes	10/12	10/9	5/12	4/14	0.198
BMI (kg/m2) $\bar{x}$ ± SD	25.4 ± 5.18	23.5 ± 4.48	25.97 ± 5.10	21.79 ± 1.83	0.18

$\bar{x}$- mean; SD- standard deviation.

Table 1 - Samples characteristics: factors under investigation

Lipid	Omnivores	Lacto-ovo Vegetarians	Lacto Vegetarians	Vegans	p
Total Cholesterol $\bar{x} \pm SD$	208.09 ± 49.09	175.32 ± 28.47	164.82 ± 51.00	141.06 ± 30.56	< 0.001
HDL $\bar{x} \pm SD$	56.23 ± 18.29	55.47 ± 14.61	57.71 ± 14.92	55.67 ± 13.93	0.96
HDL/Total Cholesterol Ratio	0.29 ± 0.12	0.32 ± 0.09	0.37 ± 0.13	0.41± 0.11	0.01
LDL $\bar{x} \pm SD$	123.43 ± 42.67	101.47 ± 28.07	87.71 ± 41.67	69.28 ± 29.53	< 0.001
Triglycerides $\bar{x} \pm SD$	155.68 ± 119.84	93.95 ± 33.43	94.71 ± 62.51	81.67 ± 81.90	< 0.01

$\bar{x}$- mean; SD- standard deviation.

Table 2 - Sample characteristics: serum levels (mg/dl) of lipids under investigation

Description	Total Cholesterol	HDL	HDL/Total Cholesterol Ratio	LDL	Triglycerides
Lacto-ovo Vegetarians					
b	-31.41	-4.15	0.009	-22.22	-59.35
CI 95%	-54.09 to -8.73	-13.44 to 5.14	-0.06 to 0.08	-42.80 to 1.64	-105.78 to -12.92
p	0.007	0.376	0.793	0.035	0.013
Lacto Vegetarians					
b	-39.74	-1.03	0.06	-34.21	-54.08
CI 95%	-63.16 to 16.32	-10.40 to 8.34	-0.004 to 0.13	-55.43 to -12.99	-102.05 to -6.12
p	0.001	0.827	0.066	0.002	0.028
Vegans					
b	-54.14	-1.73	0.07	-44.92	-62.35
CI 95%	-77.79 to -30.49	-11.37 to 7.92	0.0004 to 0.139	-66.24 to -23.59	-111.55 to -13.16
p	0.000	0.722	0.049	0.000	0.014
r2 of Final Model	0.45	0.20	0.33	0.40	0.32
Final Model Adjusted for	age	gender and age	Age and smoking habits	age	gender and age

**Omnivore diet was defined as the comparison group. b- regression coefficient; CI 95% = 95% confidence interval.*

Table 3 - Regression analysis between serum lipid levels and associated factors following types of diet *

Discussion

Literature gives evidence that vegetarian diet seems to play a role in vascular protection. Results from the present study were similar to those of a number of other studies, which did not, however, investigate the subdivision among vegetarians.

In a study with African Americans, Melby et al[17] investigated the lipid profile of 66 vegetarians, 56 semi-vegetarians and 45 omnivores. They found that vegetarians reported the lowest TC, LDL, and TG levels. In a study with individuals in Peru, Navarro et al[15] found the lowest TC and LDL serum concentration among vegetarians. In his doctorate dissertation the same author confirmed lowest TC and LDL levels among vegetarian Adventists in São Paulo.

Harman and Parnell[18], in their turn, while investigating Seventh Day Adventists in New Zealand, did not find differences between the lipid profile of vegetarians and omnivores, although lipid levels for both groups showed to be lower than what could be observed for the population in general in that country. In the authors' point of view, life style associated to religion, lower stress levels, no alcohol or caffeine consumption, as well as smoking prohibition could explain low lipid levels in those groups.

While studying 233 vegetarians paired with 233 non-vegetarians and taking into account residence location, sex, age, marital status, body weight, height and occupation, West and Haies[21] have observed that TC was significantly lower in the first group, whereas in the second group TC level increased as meat consumption increased.

In an interesting study on the influence of vegetarian diet on lipid levels, Cooper et al[22] divided 15 individuals into 2

groups: one group followed the regular American diet (with individuals having a weekly average of 1 egg per day, one commercial baked good per day, and at least one serving of red meat per day); the other group was made up of vegetarians. Participants complied with one of those two types of diets for three weeks. Then, the groups switched diets, and complied with it for another three weeks. It was found that vegetarian diet significantly decreased TC and LDL levels irrespective of the group, and also that in the vegetarian period calorie intake was approximately 30% lower. Therefore, cholesterol reduction could have been a result of lower calorie intake, rather than abstaining from eating meat. The study is quite relevant, though, since it excludes the influence of genetic variables and lifestyle.

Mancilha-Carvalho and Crews[14] conducted a study with Yanomami Indians. That population has quite a different lifestyle from the individuals living in the industrialized world. Their diet is based on local agriculture, including roots, sweet potato, sugar cane, added by wild fruits and insects. The Yanomami do not raise animals, and the meat they include in their diet comes from hunting, and therefore, it is relatively rare. They have little access to processed sugar, salt, alcohol, milk and its by-products, and eggs. In the study, the lipid profile of Brazilian Yanomamis is compared to American men from studies such as the NHANES (National Health and Nutrition Examination Survey-1976-80) and LRC (Lipid Research Clinics Population). When compared to the Americans in the NHANES study, the Yanomamis reported lower TC serum levels as compared to Americans – both males and females. When compared to Americans in the LRC study, the Yanomamis were found to have lower TC, LDL, and HDL levels – also both males and females. One interesting aspect is that blood collection of the Yanomamis was carried out with no data in the time span between their last meal and the time of collection.

In our sample, vegans reported significantly lower levels as compared to omnivores in regard to TC, LDL, and TG, and significantly higher ratio HDL/TC (Table 2), even after age, gender and smoking habits had been adjusted (Table 3). As for lacto-ovo vegetarians and lacto-vegetarians, TC, LDL, and TG levels have been found to be significantly lower (Table 2 and 3). So, our results point towards the association between low lipid levels and vegetarian diet - in agreement with the authors mentioned earlier. However, they disagree with Cliffton and Nestel[10], who consider the metabolic component as determining factor for serum cholesterol levels.

Based on such observations, one could speculate on the use of vegetarian diet – especially vegan – as coadjutant action in preventing or treating dyslipidemias. Nonetheless, it is important to point out that the present study investigated vegetarian diet under one single focus - lipids – in a sample from the general population. Other counterpoints have been reported, though. Among them, the most common and the most widely investigated is cobalamin deficiency, which leads to megaloblastic anemia[24,25]. Iron deficiency may also be associated, thus masking the megaloblastic anemia condition[24]. There are also reports of higher prevalence of hypospadia[26] and higher levels of homocysteine among vegetarians as compared to omnivores[27]. Additionally, congenital hypothyroidism cases have been reported in children breast fed exclusively with vegan mothers' milk (in regions where not all salts are iodated)[28], as well as bilateral optical neuropathy, severe sight impairment, and other visual problems in vegan patients (there has been significant improvement of the condition after multivitamin supplement administration)[29]. Taking all that into account, further studies are required before indicating the vegetarian diet for prevention and/or therapeutic purposes.

Concluding, vegetarian diet was associated to lower levels of TG, TC and LDL as compared to the diet of omnivores.

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