

Eggplant (*Solanum melongena*) infusion has a modest and transitory effect on hypercholesterolemic subjects

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Abstract

Eggplant (*Solanum melongena*) is consumed extensively in Brazil. It has been believed that infusion of a powdered preparation of the fruit may reduce serum cholesterol. However, there are few documented reports on its effects on cholesterol metabolism and its possible hypocholesterolemic effect has not been proved by well-controlled studies. The aim of the present study was to observe the effects of *S. melongena* on the serum cholesterol and triglycerides of 38 hypercholesterolemic human volunteers ingesting *S. melongena* infusion for five weeks. Thirty-eight hypercholesterolemic subjects receiving either *S. melongena* infusion (N = 19) or placebo (N = 19) participated in two clinical experiments in which the effect of *S. melongena* infusion was studied with (N = 16) or without (N = 38) dietary orientation. Total cholesterol and its fractions, triglycerides, and apolipoproteins A and B were measured in blood at the beginning of the experiment and three and five weeks thereafter. No differences were observed compared to control. Intraindividual analysis showed that *S. melongena* infusion significantly reduced the blood levels of total and LDL cholesterol and of apolipoprotein B. After dietary orientation, no intra- or intergroup differences were seen for any of the parameters analyzed. The results suggest that *S. melongena* infusion had a modest and transitory effect, which was not different from that obtained with standard orientation for dyslipidemia patients (diet and physical activities).

Key words

- Cholesterolemia
- Eggplant
- Diet
- *Solanum melongena*
- Atherosclerosis index

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Research carried out at Laboratório de
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Ambulatório Bias Fortes, Hospital das
Clínicas, Faculdade de Medicina,
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Research supported by CNPq and
FAPEMIG.

Received May 22, 1999

Accepted April 10, 2000

Introduction

Elevations of cholesterolemia and of serum low-density lipoprotein cholesterol (LDL-c) are primary risk factors for cardiovascular disease. Many studies have clearly shown that the reduction of LDL-c levels and the increase of high-density lipoprotein cho-

lesterol (HDL-c) reduce the risk of cardiovascular events and overall mortality (1,2). This fact has led to more aggressive treatment of hypercholesterolemia and to a renewed focus on modification of life style and diet. Eggplant (*Solanum melongena*) is widely consumed in Brazil and in other countries and its infusion has been used in popular

medicine as a hypocholesterolemic agent. However, there are few controlled studies of its effect on cholesterol metabolism, and its possible hypocholesterolemic effect in humans has not been proved by rigorous studies. Mitschek (3) showed that a preparation of *S. melongena* prevented both hypercholesterolemia and the formation of atheromas in the aorta of rabbits fed high cholesterol diets. However, Kritchevsky et al. (4) did not confirm these findings in rats fed diets containing 1% *S. melongena* fruit or leaf powders. Recently, Jorge et al. (5) studied the effects of *S. melongena* on plasma lipid levels, lipid peroxidation and endothelial dysfunction in experimental hypercholesterolemia. The authors fed rabbits a cholesterol-rich diet and administered 10 ml/day of eggplant juice (10:7, whole fruit:water) for 4 weeks. The authors concluded that eggplant juice administered to hypercholesterolemic rabbits significantly reduced weight, plasma cholesterol levels, aortic cholesterol content, and malondialdehyde concentrations in native-oxidized LDL and in the arterial wall and increased endothelium-dependent relaxation.

The aim of the present study was to determine the effects of *S. melongena* on serum cholesterol and triglycerides of 38 hypercholesterolemic human volunteers ingesting a *S. melongena* infusion for five weeks. We demonstrated that *S. melongena* infusion had a discrete, transitory effect in reducing hypercholesterolemia which was similar to that obtained with standard orientation for dyslipidemia (diet and exercise).

Material and Methods

S. melongena analysis

The concentrations of macronutrients (carbohydrates, proteins, lipids and total fiber) and minerals (calcium and phosphorus) were determined in the powder of *S. melongena* but not in the infusion (especially total

fiber) since the concentrations were too low. The pharmacognostic analyses were performed on *S. melongena* powder and infusion. The presence of chemical classes having therapeutic significance was determined by qualitative standard methods and thin-layer chromatography (for saponin analysis) (6,7). The following groups were investigated: polyphenols, tannins, alkaloids and heterosides of anthracene, flavonoids, saponins (two different methods), and cardio-tonics. The aqueous extract was then evaporated at room temperature under a stream of air. The dried residue thus obtained was dissolved in 2 ml of 70% ethanol and this solution was submitted to thin-layer chromatography. For preliminary analyses the plates were prepared with a Vetec 69G F254 silica gel suspension and water. Later, 250- μ m-wide Whatman glass plates with silica 60^A were used. The specific reagents for saponins used were vanillin/sulfuric acid, anis-aldehyde/sulfuric acid and Kagi-Mischer reagent, the latter being the best.

Clinical experiment

Phase 1: The first phase of this study was a randomized double-blind experiment in which three measurements were made on each subject (at baseline and at three and five weeks after the beginning of *S. melongena* or placebo administration). The sample size was determined taking this repetition into account, i.e., a positive correlation between the three measurements for a targeted 80% statistical power and a 0.05 significance level. The protocol was approved by the Ethics Committee of the Medical School, Federal University of Minas Gerais, and the subjects gave written informed consent to participate in the study.

Thirty-eight volunteers aged 25-62 years (11 men and 27 women) participated in the experiment. Two of them (one from the placebo group and one from the *S. melongena* group) did not complete the experiment due

to personal or medical reasons not related to it (elective surgery). The criteria for inclusion in the trial were age over 18, borderline or high cholesterol levels (>220 mg%), LDL-c/HDL-c ratio over 2.5, normal or borderline high triglyceride levels (<400 mg%), and no metabolic or uncontrollable disease affecting cholesterol metabolism. Exclusion criteria were introduction or modification of drugs, intolerance to *S. melongena* or placebo infusions, use of *S. melongena* infusion before the beginning of the experiment, and interruption of infusion intake for three days or more.

S. melongena was given as a 2% (w/v) infusion prepared as follows: the whole fruit was washed, dehydrated and powdered and 12 g of this powder was sealed in filter paper. Twelve grams of powder corresponded to 100 g of eggplant *in natura*. Each subject received 35 packets containing 10 g of powdered *S. melongena* or wheat bran (placebo). They were instructed to prepare the infusion by placing 1 package in 500 ml of hot water for 15 min and to drink it twice a day. The protocol of *S. melongena* preparation was based on interviews with individuals seen at the University Hospital of UFMG who had used *S. melongena* on their own initiative to reduce cholesterolemia. Wheat bran was chosen as placebo since it is well known that this fiber has no effect on cholesterolemia. The use of dehydrated, powdered *S. melongena* was introduced to conserve the fruit during the 5 weeks of the experiment.

At the beginning and after the 3rd and 5th week of the experiment, individuals were interviewed and requested to report on food and life habits, physical activity, previous personal and family diseases, especially dyslipidemia, diabetes mellitus or other metabolic diseases affecting cholesterol metabolism. Body weight, blood pressure and food ingestion were evaluated during each interview. Food ingestion was calculated using food questionnaires previously tested by dietitians and analyzed with a Body Manager

software (Kinesis, Belo Horizonte, MG, Brazil). Body mass index (BMI) was calculated by the formula: $BMI = \text{weight (kg)}/\text{height}^2$ (m). On the 35th day, *S. melongena* packets that had not been consumed were returned by the patient and computed for the calculation of eggplant infusion intake. After 12 to 14 h of fasting, blood samples were collected without an anticoagulant. The subjects were also instructed to maintain their normal food and life habits, including physical activity, during the experimental period. No dietary recommendations were made during this phase of the experiment. One week after the end of phase 1 all individuals received dietary recommendations to prevent dyslipidemia and were advised particularly to avoid foods with a hypercholesterolemic action, like dairy products, eggs, meat, etc.

Sera were separated by centrifugation immediately after puncture (10,000 g, 10 min). Total cholesterol and triglycerides were determined using the cholesterol oxidase and glycerophosphate oxidase methods, respectively (Labtest kit, Belo Horizonte, MG, Brazil). HDL-c was determined with a Boehringer Mannheim kit (Indianapolis, IN, USA) after selective and quantitative precipitation of LDL-c and very low-density lipoprotein cholesterol (VLDL-c) fractions with phosphotungstic acid. After centrifugation, HDL-c was determined in the supernatant by the cholesterol oxidase method. LDL-c was measured by the polyvinyl sulfate precipitation method (Boehringer Mannheim). LDL-c is calculated indirectly as the difference between total cholesterol and cholesterol in the supernatant after precipitation. VLDL-c was calculated as the difference between total cholesterol and the cholesterol present in the LDL and HDL fractions. Apolipoprotein A-1 (apo A-1) and apo B levels were measured by the immunoturbidimetric method (Sigma diagnostic apo A-1 and apo B reagent kit, respectively; Sigma Chemical Co., St. Louis, MO, USA). Serum alkaline phosphatase and gamma-glutamyl transpep-

tidase concentrations were determined using commercial kits (Analisa, Belo Horizonte, MG, Brazil).

Phase 2: Three months after the end of phase 1, all volunteers were invited to participate in the second phase of the trial when dietary advice was given. One week after the end of phase 1, all participants had already received instructions about dietary recommendations and physical activity for the treatment of hypercholesterolemia. The objective of this part of the study was to determine the influence of *S. melongena* infusion on subjects under dietary recommendations for dyslipidemia. The same protocol as described in phase 1 was followed.

Only 16 of 36 individuals were able to participate in this second phase. The individuals who did not participate in phase 2 did so because some started to take hypocholesterolemic drugs, some maintained the use or started (in the placebo group) to use the eggplant infusion, and some could not participate for personal reasons. In order to avoid bias, the volunteers assigned to the placebo group in the first phase received *S. melongena* during this phase and vice-versa (groups *S. melongena2* and placebo2, respectively). Thus, this phase did not represent a transverse study since, in contrast to phase 1 of the experiment, the guidelines related to the treatment of hypercholesterolemia had already been given. The preparation of the experimental and placebo infusions and blood analyses were the same as described for phase 1.

Statistical analysis

The Student *t*-test was used to analyze the data obtained in phase 1 and phase 2 experiments. The time effect was assessed by the paired Student *t*-test within each treatment group. Comparisons between treatment group means were made by the Student *t*-test for independent groups (8). In addition, a longitudinal data analysis approach was

adopted for the analysis of the entire data set, comprising both treatment and time effect evaluation (9). Prior to this analysis, a correlation matrix of the covariates was estimated according to Diggle (9). The level of significance was set at 0.05 for all tests except when otherwise stated. The calculations were performed using the SAS-Release 6.11 software (SAS Institute, Cary, 1996), available at the Federal University of Minas Gerais mainframe computer center.

Results

The *S. melongena* powder contained 15.09% protein, 1.42% total lipids, 13.89% fiber, 0.22% calcium, and 0.31% phosphorus. The qualitative test for composition was positive for polyphenols and negative for anthracenic, flavonic, saponic and cardiotonic heterosides, polyphenols and tannins, as well as tertiary and quaternary alkaloids. However, steroidal saponins were detected when eggplant infusion was analyzed by thin-layer chromatography using Kagi-Mischer developing solution.

The placebo and *S. melongena* patient groups were homogeneous in terms of age, proper use of *S. melongena* or placebo and initial blood levels of total cholesterol, HDL-c, LDL-c, VLDL-c, and triglycerides (Table 1). There were no significant differences in body weight, arterial blood pressure or food ingestion for the same subject throughout the experimental period or between the two groups (data not shown). The acceptability of the infusions was quite satisfactory. There were no complaints during the experimental period.

In the first phase of the experiment, no significant differences in serum cholesterol concentrations were observed between groups (Figure 1). The averages were 251 ± 38 and 245 ± 9 mg/dl for the placebo and experimental groups, respectively. However, there was a small but significant difference in total plasma cholesterol levels in indi-

Table 1 - Initial characteristics of 38 individuals consuming S. melongena or wheat bran for five weeks.

Data are reported as means ± SD and range (in parentheses). The 6 individuals using medication did so for the 5-week period of the study. There were no significant differences between groups for any of the parameters (Student t- test). BMI = Body mass index.

Parameters	S. melongena	Placebo
Total number (men/women)	19 (15/3)	19 (11/7)
Age	43.7 ± 8.4 (25-54)	45.4 ± 9.0 (30-62)
BMI	27.0 (20.8-34.9)	27.7 (21.1-44.4)
Post-menopausal women (with/without hormonal replacement)	7 (3/4)	5(0/5)
Use of medication (N)	Diuretics (1) Contraceptives (1)	β Blocker (1) Contraceptives (3)
Serum cholesterol	263 (226-317)	262 (221-338)
LDL-c	192 (134-301)	182 (143-234)
HDL-c	50 (21-92)	47 (19-78)
LDL/HDL ratio	4.73 ± 1.71 (2.67-8.76)	4.72 ± 1.91 (2.60-10.58)
VLDL-c	31 (14-57)	28 (12-60)
Serum triglycerides	152 (70-286)	117 (50-188)
No. of packets consumed	33.9 (31-35)	33.6 (31-35)

viduals in the *S. melongena* group between the beginning and the end of the 5-week experimental period (P = 0.04). No difference was detected in the placebo group (P = 0.17) (Figure 1). It is interesting to note that these differences were due to reductions in subjects whose plasma levels were higher than 240 mg% (Table 2) and for the period of 0-5 weeks but not 0-3 weeks.

A significant reduction in LDL-c levels was observed between the 3rd and 5th weeks (data not shown). This reduction in LDL-c averaged 13.51% (+14 to -42%) in the *S. melongena* group, as opposed to 1.5% (+43 to -50%) in the placebo group. There were no variations in blood levels of HDL-c, VLDL-c or triglycerides in subjects from the two groups throughout the experimental period (Table 3). The levels of apo A and apo B were in agreement with the results for LDL-c and HDL-c, i.e., there was a significant reduction in the levels of apo B in relation to the 5th week only in the subjects in the *S. melongena* group, and similar levels of apo A in both groups (Table 3). The maintenance of HDL-c levels and the reduction of LDL-c levels promoted a significant reduction in the LDL-c/HDL-c ratio in the individuals

from the *S. melongena* group (Figure 2).

The levels of alkaline phosphatase and gamma-glutamyl transpeptidase were the same for both groups, suggesting that the experimental treatment did not affect these tests of hepatic function (Table 3). There

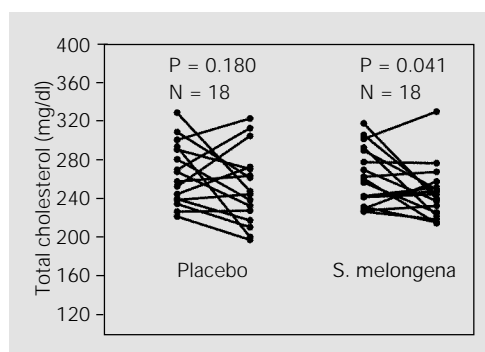


Figure 1 - Plasma cholesterol of hypercholesterolemic volunteers with no dietary orientation (phase 1), ingesting a 2% infusion of S. melongena or placebo. The points indicate the plasma cholesterol level of each subject before the study and after 5 weeks. Data are reported as means ± SD. P values are given for the paired Student t- test.

Table 2 - Statistical analysis (paired t-test) of total cholesterol levels for 38 hypercholesterolemic volunteers with no dietary orientation (phase 1) ingesting a 2% infusion of S. melongena or placebo (wheat bran) for five weeks.

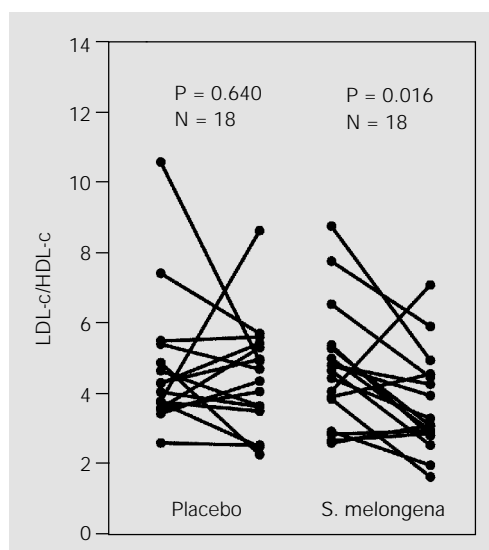
Cholesterol level	S. melongena		Placebo			
	N	0-3 weeks	0-5 weeks	N	0-3 weeks	0-5 weeks
220-320 mg%		P = 0.160	P = 0.041*		P = 0.645	P = 0.174
Borderline (≤240 mg%)	8	P = 0.778	P = 0.630	8	P = 0.465	P = 0.130
High (>240 mg%)	11	P = 0.177	P = 0.025*	11	P = 0.530	P = 0.650

Table 3 - HDL-c, VLDL-c, triglycerides (TG), apolipoprotein (apo A), apo B, alkaline phosphatase (AP) and gamma-glutamyl transpeptidase (γ GT) of 38 subjects consuming *S. melongena* or wheat bran for five weeks in phase 1 of the experiment.

Data are reported as means \pm SD. * $P < 0.05$ compared to initial and 3-week values for the *S. melongena* group (Student *t*-test).

	Placebo (N = 18)			<i>S. melongena</i> (N = 18)		
	Initial	3 weeks	5 weeks	Initial	3 weeks	5 weeks
HDL-c	43.3 \pm 12.9	45.5 \pm 10.2	42.3 \pm 10.9	43.5 \pm 12.3	48.3 \pm 16.2	49.4 \pm 17.0
VLDL-c	27.7 \pm 11.4	28.7 \pm 15.0	29.2 \pm 12.8	31.7 \pm 13.3	32.1 \pm 11.5	30.6 \pm 13.7
TG	122.9 \pm 42.7	143.6 \pm 74.8	148.6 \pm 66.1	153.5 \pm 65.0	160.6 \pm 57.6	151.7 \pm 66.1
Apo A	108.3 \pm 18.7	114.7 \pm 17.4	114.7 \pm 17.9	112.6 \pm 20.9	115.6 \pm 31.6	119.9 \pm 35.6
Apo B	109.2 \pm 25.1	106.1 \pm 25.4	98.8 \pm 17.9	101.5 \pm 17.41	103.6 \pm 24.6	89.5 \pm 17.4*
AP	82.4 \pm 16.7	87.9 \pm 22.6	85.7 \pm 22.1	81.8 \pm 21.7	80.8 \pm 22.9	85.4 \pm 24.5
γ GT	28.9 \pm 2.9	34.8 \pm 5.5	24.7 \pm 4.5	41.1 \pm 8.1	20.7 \pm 6.5	18.75 \pm 4.13

Figure 2 - LDL-c/HDL-c ratio of hypercholesterolemic volunteers with no dietary orientation (phase 1), ingesting a 2% infusion of *S. melongena* or placebo. The points indicate the plasma cholesterol level of each subject before the study and after 5 weeks. Data are reported as means \pm SD. P values are given for the paired Student *t*-test.



was no correlation between serum parameters and the intake of protein, fibers, cholesterol or total, saturated, monounsaturated or polyunsaturated fat (data not shown).

When the initial data obtained for 16 individuals who participated in phase 1 and phase 2 were compared, the initial levels of total cholesterol were found to be significantly lower in phase 2 when compared to initial levels in phase 1 ($P = 0.048$ and $P = 0.013$ for placebo2 and *S. melongena*2 groups, respectively) (Table 4). The initial LDL-c and LDL-c/HDL-c ratio for individuals of the placebo2 group (who received *S.*

melongena infusion in phase 1) were also significantly lower ($P = 0.05$ and $P = 0.032$, respectively) and HDL-c values were significantly higher ($P = 0.016$) in phase 2 compared to initial values in phase 1 (Table 4). This means that volunteers receiving placebo or *S. melongena* infusion had a reduction in serum cholesterol after the end of phase 1. This reduction was due to the dietary orientation, since no hypocholesterolemic drug treatment was introduced. However, there was no additional serum cholesterol reduction after 3 and 5 weeks of phase 2. Other serum parameters (LDL-c, HDL-c, triglycerides, apoproteins) were also statistically similar between groups at the 3rd and 5th weeks of phase 2 (as determined by paired or unpaired Student *t*-test). Since all individuals continued the step 1 dietary treatment during phase 2, it can be assumed that the effects of dietary orientation and *S. melongena* infusion were not additive with respect to serum cholesterol, LDL-c and LDL-c/HDL-c rate.

Discussion

Although some studies have demonstrated the hypocholesterolemic effect of eggplant in experimental animals, to our knowledge, this is the first controlled study regarding the

Table 4 - Total cholesterol, LDL-c and HDL-c levels and LDL-c/HDL-c ratio of 16 individuals before (phase 1) and after (phase 2) dietary orientation, ingesting a 2% infusion of *S. melongena* or placebo (wheat bran) for five weeks.

The volunteers assigned to the placebo group in the first phase received *S. melongena* during phase 2 and vice-versa. Data are reported as means \pm SD. Statistical differences compared to initial values during phase 1 (paired Student t-test): ^areduction ($P < 0.048$), ^breduction ($P < 0.013$), ^creduction ($P < 0.050$), ^dincrease ($P < 0.016$), ^ereduction ($P < 0.032$).

	Initial	3 weeks	5 weeks	Initial	3 weeks	5 weeks
	Placebo (phase 1)			S. melongena (phase 1)		
Total cholesterol	272 \pm 27	267 \pm 24	255 \pm 38	254 \pm 23	256 \pm 35	238 \pm 21
LDL-c	195 \pm 21	190 \pm 28	185 \pm 46	166 \pm 17	161 \pm 37	148 \pm 23
HDL-c	45 \pm 6.4	48 \pm 9	44 \pm 10	43 \pm 8.8	57 \pm 15	56 \pm 15
LDL-c/HDL-c	4.4 \pm 0.6	4.1 \pm 0.9	4.6 \pm 2	4.0 \pm 0.9	3.0 \pm 1.1	2.8 \pm 0.8
	S. melongena (phase 2)			Placebo (phase 2)		
Total cholesterol	242 \pm 37 ^a	269 \pm 42	299 \pm 33	229 \pm 29 ^b	236 \pm 32	212 \pm 42
LDL-c	180 \pm 35	205 \pm 44	207 \pm 36	147 \pm 22 ^c	154 \pm 21	135 \pm 35
HDL-c	40 \pm 6.0	41 \pm 12	44 \pm 12	50 \pm 11 ^d	59 \pm 18	52 \pm 18
LDL-c/HDL-c	4.6 \pm 1.0	5.7 \pm 2.9	5.1 \pm 1.7	3.1 \pm 0.9 ^e	2.8 \pm 0.7	2.9 \pm 1.3

effects of *S. melongena* in humans. The data obtained here during phase 1 should be analyzed very carefully since the effect of the ingestion of *S. melongena* infusion was observed only after intraindividual but not interindividual comparisons. This lack of differences between placebo and *S. melongena* may probably be due to 1) the small number of individuals in each group, 2) the wide range of cholesterolemia levels within the same group, and 3) the concentration of *S. melongena* infusion (2%), which may have been lower than that needed to induce hypocholesterolemic effects. However, all positive risk factors, i.e., total cholesterol, LDL-c, LDL-c/HDL-c ratio and apo B levels (10), were reduced by *S. melongena* ingestion, while HDL-c and apo A, both negative risk factors, were kept at the same levels. Taken together, these results suggest a transient small but significant hypocholesterolemic action of *S. melongena* infusion but no effect in reducing serum triglycerides. Although Jorge et al. (5) described a hypocholesterolemic effect of eggplant juice in rabbits fed a cholesterol-rich diet, our human experiments using filtered *S. melongena* infusion cannot

be compared to their study since they administered the whole fruit juice (only mixed with water). Moreover, the juice prepared by Jorge et al. was more concentrated (about 58% eggplant) than the *S. melongena* infusion used in our experiment (2%).

Some vegetables may cause hepatic injuries when administered in large amounts to rats and humans, probably due to antinutritional factors such as tannin or alkaloids (11-13). Under the present experimental conditions, the *S. melongena* infusions were apparently harmless, as suggested by the normal levels of alkaline phosphatase and gamma-glutamyl transpeptidase in individuals from the *S. melongena* group.

The possible mechanism of action of *S. melongena* on cholesterol metabolism has not been clarified. Soluble fibers reduce the levels of blood cholesterol by 5 to 15% in experimental animals and in humans (14,15) through a number of mechanisms. However, it is improbable that soluble fiber is the main hypocholesterolemic component of *S. melongena* infusions, since the amount of dietary fiber needed for this effect is 15 to 30 g/day (16) and the amount present in 10 g of

powder (the quantity used to prepare the infusion) was only 1.3 g. Antioxidants such as vitamin C (ascorbic acid) and phenols have received some credit as preventive agents of atherosclerosis (17,18) but their action in reducing plasma cholesterol levels has been seldom described (18).

Our chemical analysis showed the presence of polyphenols and steroidal saponins in both the powder and infusion of *S. melongena*. Saponins are a group of glycosides that stimulate the heart and may be found in many vegetables. On shaking, they form foam, a property of the *S. melongena* infusion. Saponins in amounts as low as 150 mg/kg diet increase the fecal excretion of bile salts in experimental animals and in humans, reducing total cholesterol without affecting the HDL fraction (19-21). Quantification of saponin concentration and other chemical compounds in the infusion of *S. melongena* is currently under investigation in our laboratory. The presence of steroidal saponins in *S. melongena* infusion suggests that they may be among the agents responsible for this effect on serum cholesterol. These results are in agreement with those of Paczkowski and Wojciechowski (22), who found steroidal saponins in *S. melongena* samples. Although flavonoids were not found in our analysis of the infusion, these compounds have also been reported to have some effects on cholesterol metabolism (23,24). Flavonoids have been suggested to be the hypocholesterolemic agents of several vegetables. Flavonoids from the fruits of *S. melongena* orally administered at a dose of 1 mg 100 g body weight⁻¹ day⁻¹ showed a significant hypolipidemic action on normal and cholesterol-fed rats (23). HMG CoA reductase, lipoprotein lipase and plasma LCAT activity were enhanced. The concentrations of hepatic and fecal bile acids and fecal neutral sterols were also increased, indicating a higher rate of cholesterol degradation. Flavonoids isolated from *S. melongena* also showed a potent antioxidant activity (24-

26). Concentrations of malondialdehyde, hydroperoxides and conjugated dienes were significantly reduced. Catalase activity was found to be significantly enhanced in the tissues of normal and cholesterol-fed rats receiving 1 mg flavonoid from *S. melongena* 100 g body weight⁻¹ day⁻¹. However, all of these studies used compounds extracted from *S. melongena* or its whole fruit juice. In our experiment, only the filtered infusion of the dehydrated fruit was ingested. No flavonoid was detected in the infusion. New analyses of *S. melongena* infusions by nuclear magnetic resonance are under way in our laboratory to detect other chemical compounds which could exert hypocholesterolemic effects.

Independent of its mechanism of action, phase 2 results showed that the effects of *S. melongena* were not demonstrable after dietary orientation, confirming the efficacy of the conventional dietary treatment for moderate dyslipidemias (27). Three months after the end of phase 1 and of the dietary recommendation, six of 16 individuals had blood cholesterol levels below 220 mg%. It should be pointed out that the results obtained for all 38 individuals during phase 1 (reduction of plasma cholesterol levels in the *S. melongena* group and no differences in the placebo group) persisted only in these 16 individuals. With respect to the association of *S. melongena* with traditional diet therapy, the lack of additional beneficial effects may be due to similar mechanisms of action in the two treatments, i.e., the small effect of *S. melongena* in the reduction of cholesterol absorption may have been masked by the lower cholesterol ingestion. It is interesting to point out that individuals in the placebo2 group (i.e., subjects who had ingested the *S. melongena* infusion during phase 1 and who followed dietary orientations) had lower risk factors (lower total cholesterol and LDL-c, higher HDL-c) at the beginning of phase 2 compared to the beginning of phase 1 (Table 4).

We conclude that a 2% infusion of *S.*

melongena has a slight effect on the reduction of cholesterolemia and, most importantly, reduces LDL-c with no alteration in HDL-c. Steroidal saponins could be involved in the modest hypocholesterolemic effect of *S. melongena* infusion, since they were detected in both powder and infusion of *S. melongena*. However, this effect does not

seem to add anything to the widely accepted conventional dietary treatment for hypercholesterolemia.

Acknowledgments

The authors thank Prolacteos Ltda. for providing the *Solanum melongena* powder.

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