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EFFECTS OF *SOLANUM MELONGENA* IN THE METABOLIC PROFILE OF WISTAR RATS

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ABSTRACT

The industrial revolution led to profound modifications in the lifestyle and increased the percentages of obesity, insulin resistance/Diabetes, dyslipidemia, and hypertension that augment the risk of developing Cardiovascular Diseases (CD). *Solanummelongena* (eggplant) is popularly much used with the purpose of reducing lipid levels. This study aimed to evaluate the effects of the eggplant on the metabolic profile of Wistar rats. The animals were treated with eggplant floor mixed with the commercial rat chow for 45 days. After that, we evaluated anthropometric and biochemicalparameters (glycemia, total cholesterol (TC), Low-Density Lipoprotein (LDL-c), High-Density Lipoprotein (HDL-c), triglycerides (TG) and Atherogenic Indices). The use of the eggplant increased body weight, thoracic and abdominal circumference and did not promote modifications in the glycemia, lipid profile, and Atherogenic indices. Our study showed that the use of the popular *S. menongena* did not promote modifications in the anthropometric and biochemical profile, nor even the level of lipids, that is the main reason for its popular use. Based on these results we suggest that more studies should be performedin order toestablish the effects of this plant in humans and if benefits are proved, the studies should also demonstrate the correct amounts that should be used by the patients. Until now we may say that the use of *S. menongena* floor does not have support to be used as a lowering lipid agent.

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INTRODUCTION

The industrial revolution produced a plethora of benefits to the world,but it also brought many negative repercussions for the human health such as obesity, insulin resistance/diabetes, dyslipidemia, and hypertension that are components of the Metabolic Syndrome (MS) and substantially increase the risk of developing Cardiovascular Diseases (CD). These are between the leading causes of deaths worldwide and are associated with hereditary and environmental circumstances such as the increase in the energetic intake with sugars and fats and decrease of energy expenditure due to the reduction of the practice of physical exercises (Mohammadi-Sartang *et al*, 2018; Namazi, Larijani, Azadbakht, 2018; Bhatt *et al*, 2015). The MS, that also is characterized by a pro-inflammatory and prothrombotic status, represents a prominent position as a global public health problem, reachingrates of 30% in some countries and meaning a significant impact on publichealth systems (Toftlund *et al*, 2018; Martins *et al*, 2018; Coffman *et al*, 2015). Since ancient times many plants have been used to treat the components of the MS and reduce the risk of CD. The eggplant (*Solanummelongena*) is popularly much used with the purpose of reducing lipid levels and are used as an infusion or powdered preparation of the fruit. It is rich in phenolic compounds that are useful asantimutagenic activities and to reduce oxidative stress, that could bring beneficial

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consequences to the metabolism of sugars and lipids (Sung *et al*, 2018; Xu t al, 2018; Cheriot, Billaud, Nicolas, 2006). In the past, much was said about the use of eggplant in reducing the components of MS, and its use by the population reached high proportions until nowadays. Consumers could easily find capsule with the dry extract of eggplant that, according to the famous reputation, could reduce the cholesterol levels. Despite this benefit, not many studies have tested this plant andit'slipid-lowering effects that could be useful in the prevention of CD diseases (Silva *et al*, 2004; Guimarães *et al*, 2000). As the use of medicinal plants with the purposes or treating or preventing diseases is increasing worldwide,and some studies and popular knowledge have postulated that *S. melongena*may work as a complementary approach for dealing with the components of the MS, the aim of this study was to evaluate the effects of this plant in the metabolic profile of Wistar rats.

MATERIAL AND METHODS

Ethical principles: This study had the approval of the *Animal Research Ethics Committee* of the School of Medicine of Marília (UNIMAR), Marília - SP, Brazil. Animals received food and water *ad libitum* during all the experimental protocol and were cared for according to the recommendations of the Canadian Council's *Guide for the care and use of experimental animals.*

Animal groups : Twenty male Wistar rats (170g-220g) were maintained in the vivarium at UNIMAR -Marília, SP, Brazil, and kept in collective cages under a dark/light cycle of 12 hours, relative air humidity of 60 ± 5%, and room temperature of 22 ± 2°C.Animals were acclimated for seven days to laboratory conditions and were randomly separated in the following groups (n=10): G1 that received water and rat food *ad libitum* and G2 that received water and rat food supplemented with eggplant 20% *ad libitum.* The weight gain was evaluated every three days.

Preparation of the supplemented rat feed: The eggplant flour was obtained from local markets in the city of Marilia – SP – Brazil. It was mixed with the crushed commercial chow (20% eggplant: 80% commercial chow), molded into pellets (dried in an air circulating oven at 65°C for about 8 hours) and stored in polyethylene packaging at 5°C until its utilization.

Biochemical evaluations: After 45 days of treatment, the animals underwent euthanasia (use of a lethal injection of thiopental until complete sedation. After death, blood samples were collected from the vena cava for the biochemical analysis of glycemia, total cholesterol (TC), Low-Density Lipoprotein (LDL-c), High-Density Lipoprotein (HDL-c), and triglycerides (TG). Atherogenic Index (AI), Atherogenic Coefficient (AC), non-HDL-c, Cardiac Risk Ratio 1 (CRR1), and Cardiac Risk Ratio 2 (CRR1), were calculated according to Erejuwa *et al*. 2016; Ahmadv and *et al*. 2016.

Anthropometric parameters

The body weight and length of the rats were evaluated to determine the Lee index (cube root of body weight (g) / nose-anus length (cm)), and the percentage of weight gain. We also evaluated the thoracic circumference (TrC) and the abdominal circumference (AC).

Composition of the *S. melongena* floor

The study of the floor was performed according to IAL (2008). The analysis of moisture we performed with the gravimetric method in an oven at 105 °C for 16 hours until it reached a constant weight. Soxhlet extraction was used to evaluate the lipids content. Total nitrogen was studied by the Method of Kjeldahl. A muffle furnace at 550 °C was used to the calculate the ashes content; carbohydrates and fibers were analyzed by difference. Analyses were performed in triplicate.

Statistical analysis

T test was used for the statistical analysis, and the variables were presented as mean and standard deviation (5% level of significance).

RESULTS

Table 1 shows that after 45 days, the use of *S. melongena*(G2) increased significantly body weight, the percentage of weight gain, TrC, and AC.

Table 1. Initial and final weight, the percentage of weight gain, feed and water intake during the experimental protocol for G1 and G2

Parameters	G1	G2	*p*-value*
Weight [1]	160±12.64	153±25.2	0.190
Weight [2]	223±15.1	246±20.3	0.000*
% weight gain	27,96±8,15	43,30±12,19	0.000*
LEE	29.5±6.50	29.79±11.54	0.620
TrC	7.3±0.48	8.2±0.54	0.000*
AC	8.1±0.33	9.2±0.75	0.000*
Visceral fat	1.18±0.40	1.65±0.35	0.00*

[1]Weight at the beginning of the experimental protocol; [2]Weight at the end of the experimental protocol;TrC: Thoracic circumference; AC: Abdominal circumference; *significant difference.

Table 2. Biochemical parameters of G1 and G2 after the treatment

Parameters (mg/dL)	G1	G2	*p*-value*
Glycaemia	169.93±25.84	178.8±44.8	0.270
Triglycerides	122.6±10.17	144.10±27.48	0.120
Cholesterol	171.4±4.40	169.00±13.43	0.350
HDL-c	49.75±2.5	49.00±1.64	0.730
LDL-c	25.32	28.24	0.470

HDL-c: High-Density Lipoprotein; LDL-c: Low-Density Lipoprotein; *Significant difference.

Table 2 shows that the animals treated with eggplant (G2) did not present significant modifications in glycemia and lipid parameters. In table 3 we observe that animals treated with eggplant (G2) did not present significant modifications in the atherogenic indices.

Table 3. Atherogenic indices in the experimental protocol for G1 and G2

Parameters	G1	G2	*p*-value*
Non-HDL-c	131.60±22.32	115.5±10.6	0.230
AC	2.46±0.25	2.39±0.34	0.770
AI	3.97±0.87	4.48±1.08	0.470
CCR1	3.46±0.25	3.39±0.34	0.770
CCR2	4.00±1.12	3.61±1.72	0.710

AI: Atherogenic Index; AC: Atherogenic Coefficient; CRR1: Cardiac Risk Ratio 1; CRR2: Cardiac Risk Ratio 2.

Table 4. Results of the analysis of Antioxidant Activity and some other parameters in the roasted and in the raw seeds of *baru* (*Dypterixalata*)

Parameters	*S. melongena* floor
Humidity 105ºC (% m/m)	9.2
Ashes (% m/m)	0.9
Total fat(% m/m)	1.4
Carbohydrate (%m/m)	86.6
Total protein (%m/m)	2.9
Total fiber (%m/m)	3.2
Energy (calories) (100g)	366.6

In Table 4 it is found the analysis of the eggplant floor. Carbohydrates are the most part of the composition of the floor.

DISCUSSION

The need for an alternative therapeutic approach for treating cardiovascular risk factors has been increasing rapidly worldwide. Several studies show that plants are rich sources of phenolic compounds that exert antioxidant actions that may be benefit in reducing body weight, glycemia, triglycerides, CT, LDL-c and may increase HDL-c, thus, decreasing the risk factors for the MS and CD(Urbatzka *et al*, 2018; Smith, 2018; Xu *et al*, 2018; Sung *et al*, 2018; Sangeetha *et al*, 2018; Hu *et al*, 2018). Our results showed that the treatment of animals with *S. melongena*did not bring benefits in the anthropometric and biochemical parameters and the atherogenic indices. Other authors found similar results. Guimaraes *et al* (2000) evaluated the effects of the infusion of *S. melongena* on the serum levels of TC and TG of 38 hypercholesterolemic volunteers during five weeks (with or without dietary orientation). They did not observe differences in TC, HDL-c and TG parameters in treated and control patients but observed reduction in the levels of LDL-c and apolipoprotein B suggesting that *the* eggplant infusion promoted only modest and transitory effect, in the patients. The saponins of the plant may be related to the modest effects of the infusion, once they were seenin both powder and infusion of the eggplant. Silva *et al* (2004) investigated the effects of the dry extract of the eggplant orally administrate to patients with high blood cholesterol levels. These patients received capsules with the plant with 450mgorreceived placebo capsules twice a day. After three months of treatment, the authors observed reduction in the levels of LDL-c, TC, and LDL-/HDL-c but similar effects were observed in the placebo group. They did not observe modifications in the HDL- levels.

Jorge *et al* (1998) investigated the effects of *S. melongena*juice on the plasma lipids of hypercholesterolemia rabbits and found that, after four weeks, the animals showed a reduction in the body weight, CT, LDL-c, triglycerides and aortic cholesterol content. Furthermore, authors found reduced malondialdehyde concentrations in the LDL-c particles. Other study enrolling hypercholesterolemic individuals who did not show significant modifications on the serum lipids (Praça *et al*, 2004). Botelho *et al* (2004) studied the effects of the extract of eggplant in animals fed an atherogenic diet for 12 weeks but they did not observe alterations on the TC. They also did not observe differences in lesion area of the aorticvalve but observed increased oxidative stress, that is known to increase the risk for atherosclerosis. On the other hand, Sudheesh *et al* (1997) found that the flavonoids isolated from the eggplant have potent antioxidant activity. The increased atherogenic indices are strongly linked to the development and progression of CD once may represent some of the components of the metabolic syndrome (Erejuwa *et al* 2016; Ahmadvand, *et al* 2016). We did not find studies in the literature comparing the use of *S. melongena* and the Atherogenic indices. As shown above, few studies evaluated the effects of *S. melongena* on biochemical and parameters of humans or animal models and the results usually are contradictory.

Conclusion

Our study showed that the use of the popular *S. melongena*did not promote modifications in the anthropometric and biochemical profile, nor even the level of lipids, that is the main reason for its popular use. Based on these results we suggest that more studies should be performedin order toestablish the effects of this plant in humans and if benefits are proved, the studies should also demonstrate the correct amounts that should be used by the patients. Until now we may say that the use of *S. melongena* floor does not have support to be used as a lowering lipid agent.

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