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Effects of *Pereskia aculeata* Miller on the Biochemical Profiles and Body Composition of Wistar Rats

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Abstract

***Pereskia aculeata* Miller commonly known as "ora-pro-nobis" has been used extensively in folclore medicine. Plant belongs to the family Cactacea and it is found in the Brazil (reaching Bahia and Rio Grande do Sul states). The purpose was to evaluate the effects of plant on biochemical and corporal profiles of Wistar rats. The 80 animals were divided randomly into 4 groups by sex (n = 10 females and 10 males per group) as follows: G1 group (water/rat food *ad libitum*); G2 group (drink A: commercial condensed milk, sugar and water/rat food *ad libitum*); G3 group (drink B: *P. aculeata* juice/rat food *ad libitum*); G4 group (drink C: commercial condensed milk, sugar and *P. aculeate* juice/rat food *ad libitum*). After 35 days their biochemical and corporal profiles were analyzed (cholesterol, glycemia, triglycerides, HDL-c, AST, ALT, Lee Index, weight and visceral fat). Intake of the plant caused no changes in the lipid profile of Wistar rats. However, intake in male rats of the same prevented the increase in triglycerides front of a hypercaloric diet. There were significant changes in glycemic index due to the high carbohydrate content of the plant. The plant was effective in reducing the levels of AST and ALT in male rats and ALT only in females. The use of the plant did not cause significant changes in the index of Lee but the *Pereskia aculeata* Miller may reduce visceral fat gain in female with a regular diet.**

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Keywords

***Pereskia aculeata*, Wistar Rats, Glycemia, Lipids, Visceral Fat**

1. Introduction

Plant-based medicines have become increasingly popular for the treatment of several disorders for several reasons, including their cost, which is lower than that of traditional allopathic medicines. Thus, many studies have focused on evaluating the actual effect of medicinal plants in promoting health or preventing risk factors for several diseases, such as dyslipidemias, hypertension, diabetes, metabolic syndrome and cardiovascular diseases [1] [2]. These disorders are associated with high levels of body fat caused by a diet rich in saturated fats and sugar, changes in lifestyle and physical inactivity [3]-[8]. Unconventional vegetables such as *Pereskia aculeata* constitute an alternative food source for some people and also a cultural diversification in agricultural activity, primarily on family farms in low-income communities [9] [10]. *Pereskia aculeata* Miller, which belongs to family Cactaceae, subfamily Pereskioideae, is found in the southern United States and in Brazil, ranging from the state of Bahia and to that of Rio Grande do Sul, growing mainly in sandy and stony coastal plains. The plant is popularly known in Brazil as *ora-pro-nobis* and in the U.S. as leaf cactus and Barbados gooseberry. This plant, which is native to Brazil, is a scrambling shrub with numerous spiny branches and fleshy, mucilaginous leaves, which is consumed as a vegetable by people in low-income communities. This plant is non-toxic and has a high fiber and arabinogalactans content, which makes it an agriculturally and economically important food source [11]-[15]. The leaves are considered a source of minerals such as calcium, magnesium, manganese and zinc. They also contain vitamins A, C and folic acid. The most abundant amino acid found in this plant is tryptophan, representing over 20% of its amino acids. It is also rich in dietary fiber (approximately 39.0%) [12] [16]-[18]. *Pereskia aculeata* Miller shows a promising potential in the field of physiotherapy. However, although some antioxidant action and substances such as flavonols have also been identified in some genera of *Pereskia* [19] the literature is lacking in studies that demonstrate the effects of this plant on the biochemical profile of animals, and as its action in reducing the risk of chronic diseases. Therefore, *Pereskia aculeata* Miller adapts easily to different environments, is widely consumed by low-income populations as a source of energy, and its properties can be considered functional. There are no studies in the literature showing the effects of this plant on the biochemical and anthropometrical profile. The purpose of this study was to verify the effect of *Pereskia aculeata* Miller on the biochemical profiles and body composition of Wistar rats.

2. Materials and Methods

2.1. Groups of Animals

This research involved the use of 80 Wistar rats (40 female and 40 male) weighing approximately 200 g at the beginning of the experiment. The animals were kept in a vivarium at UNIMAR (University of Marília) under a dark/light cycle of 12 hours, at a room temperature of 22˚C ± 2˚C, and relative air humidity of 60% ± 5%. After a period of seven days of acclimation to the laboratory, the animals were divided randomly into 4 groups (n = 10 males and 10 females per group) which were treated for 35 days, as follows:

Group 1: Was fed water and rat food *ad libitum* (n = 10 females and 10 males);

Group 2: Was fed beverage A (commercial condensed milk, sugar and water) and rat food *ad libitum* (n = 10 females and 10 males);

Group 3: Was fed *P. aculeata* juice (beverage B) and rat food *ad libitum* (n = 10 females and 10 males);

Group 4: Was fed beverage C (commercial condensed milk, sugar and *P. aculeate* juice) and rat food *ad libitum* (n = 10 females and 10 males).

Weight gain was monitored once a week on days 1, 8, 15, 23, 31 and 35 of the experiment. The animals were fed daily, and their consumption (of rat food and water) was recorded based on the leftovers found each day. This research was approved by the Animal Research Ethics Committee of the University of Marília (UNIMAR).

2.2. Collection of Plants

The species (*Pereskia aculeata*; Family: Cactaceae) used in this study was collected in the municipality of Paraguaçu Paulista, state of São Paulo, Brazil, and was identified at the Ribeirão Preto School of Philosophy, Sciences and Literature of the University of São Paulo. Collector and number: M. Groppo 2076. Registered at the herbarium under no. SPFR 13138.

2.2.1. Preparation of *Pereskia aculeata* Leaf Juice

The juice was prepared from *P. aculeata* leaves, which were ground in a blender with water, in a proportion of 1: 20 (leaves: water). The juice was filtered through a gauze filter, stored in 500 mL plastic bottles, and frozen (−18˚C). This juice was called beverage B.

2.2.2. Preparation of the Beverages

Beverage A was prepared with commercial condensed milk (Nestlé®), sugar and water (1:1:2). Beverage C was prepared with commercial condensed milk (Nestlé®), sugar and *P. aculeate* juice (1:1:2).

2.3. Collection of Blood Samples and Determination of the Biochemical Profile

After 35 days of treatment, the animals were anesthetized with Hypnol® (sodium pentobarbital) until complete sedation, after which blood samples were drawn to determine their biochemical profile: total cholesterol, HDL-c, triacylglycerides, glycemia, aspartate transaminase (AST) and alanine aminotransferase (ALT). The glucose and lipid levels were measured in mg/dL and AST and ALT in U/L. The exams were performed at the Clinical Analysis Laboratory (Laboratório São Francisco) of the UNIMAR University Hospital and the results were interpreted according to the ADA [20].

2.4. Collection of Visceral Fat

After death was confirmed, an incision was made in the abdominal region and the visceral fat was removed with scissors and tweezers and weighed.

2.5. Determination of Body Composition Parameters

After the 35 days of the research, all the rats were anesthetized prior to measuring their body length (nose-to-anus or nose-anus length). The body weight and length were used to determine the following anthropometric para-meters: Body Mass Index (BMI) = body weight (g)/length^2 (cm^2); Lee index = cube root of body weight (g)/nose-anus length (cm), and Specific Rate of Body Mass Gain (g/kg) = dM/Mdt, where dM represents the body weight gain during dt = t2 − t1 and M is the rat body weight at t1 [21] [22].

2.6. Statistical Analysis

The variables are presented as means ± standard error. The data were analyzed by the Kruskal-Wallis test. p values of <0.05 were considered significant.

3. Results

The results described in **Table 1** and **Table 2** pertain to the biochemical variables found in the female and male groups, respectively, subjected to the different treatments.

Table 1 and **Table 2** show the biochemical profile respectively in female and male group. The levels of triglycerides (TG) varied significantly between the groups of male and female rats. A comparison of groups G1and G2, and of G1 and G4 revealed a significant increase in TG in both females and males. On the other hand, lower TG levels were observed in the groups of both sexes fed only with the plant (G3) when compared to the groups fed only with condensed milk (G2). The levels of the variable TG were also lower in the groups fed with the plant (G3) than in those treated with the plant plus condensed milk (G4). The levels of HDL-c in female showed significant increase in G4 when compared to the other groups. In males the levels of HDL-c showed a significant increase in G4. No significant differences were observed in cholesterol levels in male and female group. In female, G4 had significant increased glucose levels in comparison to G1 and in males it is possible to see that G3 increased glucose levels when compared to G1. G2 and G4 groups presented significant reduction in ALT levels when compared to G1 in female and male group. To the AST levels, we did not observe differences

Table 1. Comparison of the biochemical profile of the female rats of the control group (G1) and treated groups (G2, G3 and G4).

Variables	Groups			
	G1	G2	G3	G4
Triacylglycerides	58.50 ± 28.97a	157.20 ± 95.65b	68.10 ± 24.02ac	174.30 ± 43.46b
HDL-c	26.60 ± 4.60a	29.00 ± 2.16a	26.30 ± 3.27a	33.80 ± 4.87b
Total Cholesterol	61.10 ± 14.25a	61.70 ± 4.42a	57.60 ± 10.94a	67.30 ± 11.53a
Glycemia	148.70 ± 13.35a	170.00 ± 43.70ab	160.60 ± 25.63ab	171.78 ± 15.6b
ALT	63.90 ± 14.21a	48.00 ± 11.05b	54.50 ± 7.49ab	46.70 ± 10.48b
AST	135.30 ± 27.89a	128.10 ± 28.78a	115.50 ± 14.10a	121.70 ± 33.7a

Values are expressed as mean ± SD, $n = 10$ for each group. The data were analyzed by the Kruskal-Wallis test ($p < 0.05$). Different letters in the horizontal direction indicate statistically significant differences between treatments.

Table 2. Comparison of the biochemical profile of the male rats of the control group (G1) and treated groups (G2, G3 and G4).

Variables	Groups			
	G1	G2	G3	G4
Triacylglycerides	48.40 ± 26.25a	226.80 ± 62.78b	62.80 ± 26.77a	149.70 ± 59.61c
HDL-c	23.60 ± 2.68a	24.80 ± 3.74a	25.60 ± 3.13ab	29.20 ± 3.12b
Cholesterol	55.20 ± 6.29a	56.40 ± 7.17a	58.40 ± 7.55a	59.80 ± 6.32a
Glycemia	151.20 ± 11.59a	171.60 ± 15.87ab	173.00 ± 22.39b	160.90 ± 17.52ab
ALT	68.30 ± 10.24a	42.50 ± 7.23b	57.80 ± 4.26ac	53.90 ± 12.09c
AST	143.90 ± 26.33a	99.70 ± 16.79b	101.70 ± 11.59bc	123.40 ± 17.26ac

Values are expressed as mean ± SD, $n = 10$ for each group. The data were analyzed by the Kruskal-Wallis test ($p < 0.05$). Different letters in the horizontal direction indicate statistically significant differences between treatments.

among the groups of female but in male, AST levels showed a significant reduction in G2 and G3 when compared to G1.

Table 3 and **Table 4** list the data pertaining to the animals' body composition. As can be seen, the Lee index showed no significant difference between the treated female and male groups. The weight gain percentage showed no significant difference in female rats, but among the males, a difference was detected between the control group (G1) and groups G2, G3 and G4.

Table 3 shows that there was a significant reduction in visceral fat in G3 when compared to G2 and G4. **Table 4** shows that G3 and G4 had an augment in visceral fat when compared to the other groups.

4. Discussion

It was observed that the consumption of *Pereskia aculeata* Miller affected the concentrations of plasma lipids (triglycerides, HLD-c) of the animals (**Table 1** and **Table 2**).

Triglycerides are known to be metabolic fuel deposits stored in the adipocytes, which form the adipose tissue. Thus, most of the fat stored in adipose tissue is in the form of triglycerides. In this regard, it should be noted that the elevation of serum triglyceride levels represents an in dependent risk factor for cardiovascular diseases [23].

The results of this study showed that there were no significant differences in cholesterol levels between the treated groups of both sexes. During the period of this study, no change was observed in cholesterol levels in response to the consumption of sweetened condensed milk (G2). A study by Cardozo *et al*. (2008) [24] found that treatment with alcoholic extract of *Cordia salicifolia* reduced the cholesterol and trigly cerides levels significantly in mice treated with ahyperlipidemic diet, but no changes in this parameter were observed in this study.

Table 3. Comparison of the body composition of the female rats of the control group (G1) and treated groups (G2, G3 and G4).

Variables	Groups			
	G1	G2	G3	G4
%Weight gain	155.50 ± 27.40a	158.20 ± 41.20a	156.20 ± 36.31a	162.70 ± 47.20a
Lee Index	0.293 ± 0.006a	0.298 ± 0.010a	0.293 ± 0.011a	0.294 ± 0.020a
Visceral fat	4.76 ± 1.87ab	7.33 ± 4.90ad	1.98 ± 0.85b	9.12 ± 3.86cd

Values are expressed as mean ± SD, $n = 10$ for each group. The data were analyzed by the Kruskal-Wallis test ($p < 0.05$). Different letters in the horizontal direction indicate statistically significant differences between treatments.

Table 4. Comparison of the body composition of the male rats of the control group (G1) and treated groups (G2, G3 and G4).

Variables	Groups			
	G1	G2	G3	G4
%Weight gain	138.70 ± 33.90a	93.70 ± 25.47b	110.90 ± 31.45ab	133.60 ± 26.94a
Lee Index	0.291 ± 0.008a	0.297 ± 0.009a	0.296 ± 0.011a	0.296 ± 0.014a
Visceral fat	3.86 ± 1.71ab	6.26 ± 2.32a	2.82 ± 1.56bd	5.68 ± 3.07c

Values are expressed as mean ± SD, $n = 10$ for each group. The data were analyzed by the Kruskal-Wallis test ($p < 0.05$). Different letters in the horizontal direction indicate statistically significant differences between treatments.

As for HDL-c levels, the female group G4 showed higher values of this variable than the other groups of female rats, and also higher than the male groups G1 and G2.

Zheng and Aikawa (2012) [25] emphasize that HDL-c plays a key role in protecting against cardiac disorders. Pozzi (2011) [26] points out that, in addition to acting in reverse cholesterol transport, this high-density lipoprotein also protects the endothelial function and the thrombotic, fibrotic, inflammatory and oxidative processes.

Studies have demonstrated that the use of plants can contribute to increase plasma HDL cholesterol in experimental models, as was observed in a study by Farinazzi-Machado *et al.* (2011) [27], in which animals treated with an infusion of basil (*Ocimum basilicum* L.) showed a significant increase in this variable when compared to the control group. In this study, *Pereskia aculeata* Miller was effective in promoting an increase in this lipoprotein, even when associated with a high calorie diet.

The results of this study revealed significant changes in the enzyme ALT, since both sexes showed a significant decrease between groups G1 and G2, and between groups G1 and G4. Moreover, among the males, group G2 showed lower levels of this enzyme than the other male groups. As for the enzyme AST, its levels did not change significantly among the females. On the other hand, the male rats showed a significant difference between groups G1 and G2, between G1 and G3, and between G2 and G4 (**Table 2**).

These ALT and AST enzymes are indicators of lesions in liver cells; hence, an increase in their concentration is associated with the number of affected liver cells [28]. The present study found that AST and ALT diminished in response to the use of the plant in groups G3 and G4when comparedwithG1. Almeida and Corrêa (2012) [10] examined the effect of *Pereskia grandifolia* flouron the metabolism of Wistar rats previously fed a high calorie diet and observed no significant difference in the enzyme activity of AST. However, the group of animals fed with a concentration of10% of flour presented higher serumactivity of ALT than the control group.

With regard to the glucose levels in this study, it was found that *Pereskia aculeata* Miller did not to reduce the blood glucose levels in either females or males. Among the females, a significant difference in these levels was detected between groups G1 and G4, while among the males, group G3 showed higher glucose levels than G1. These results do not corroborate the findings reported by Almeida (2012) [10], who found that the group of animals that consumed a 10% concentration of *Pereskia aculeata* Miller flour showed a lower serum glucose level than the control group.

Other studies that examined the effect of plants on glycemiain Wistar rats reported similar results, such as that of Oliveira *et al*. (2013) [29], who evaluated the subchronictoxicity of *Morusnigra* L. tea leaves in rats and found that this plant produced the expected hypoglycemic effect, since there was no significant difference in blood glucose levels. On the other hand, there are numerous plants that have a beneficial effect onglycemia. Braga *et al*. (2010) [30] investigated the anti-hyperglycemic activity of *Passiflora edulis* Sims peel flour in diabeticmice and found a significant decrease in blood glucose levels, demonstrating the anti-hyperglycemic action of passion fruit peel flour. Barbalho *et al*. (2011) [31], who also used *Passiflora edulis* Sims, observed beneficial effects on serum glucose levels.

The data of the present study are consistent with the findings of Silva (2012) [32], who evaluated the effect of a diet containing *Pereskia aculeata* Miller and found that the plant did not significantly increase the animal's weight. Other plants have been screened for weight gain in experimental models, e.g., in a study conducted by Toledo *et al*. (2013) [33], in which different concentrations of lyophilized Ubamango pulp (*Mangifera indica* L.) were used. The Lee index determined in this study is an anthropometric parameter used to assess over weight and obesity in rats [21], and no significant changes in this indicator were found in this study. Therefore, the types of treatment did not affect the animals' weight gain, and hence, the overweight and obesity rate, since, according to Nery *et al*. (2011) [22], a Leeindex higher than 0.3 can be used as an evaluator of overweight. The accumulation of visceral fat may be the best predictor of cardiovascular disease, because, according Vasquez *et al*. (2010) [23], visceral fat has adeleterious effect on the metabolic and hemodynamic parameters and is linked to insulin resistance, glucose intolerance, arterial hypertension, and dyslipidemias. This, it can be regarded as an independent risk factor for the development of cardiovascular disease. In addition, its presence may be associated with some types of cancer. The results of this work suggest that *Pereskia aculeata* Miller reduces the risk of inflammatory events by reducing the levels of visceral fat, since the groups of both sexes that consumed only the plant (G3) showed lower levels of visceral fat.

The consumption of *Pereskia aculeata* Miller juice, a plant widely consumed by low-income populations, caused no changes in the lipid profile of Wistar rats. However, in male rats fed with a high calorie diet, its consumption was effective in preventing an increase in triglycerides. As for the glycemic index, significant changes were found due to the plant's high carbohydrate content. Considering the values of liver enzymes, the plant was effective in reducing the levels of both AST and ALT in male rats, and only ALT levels in female rats. The consumption of the plant did not cause significant changes in the Lee index, and the types of treatment did not affect weight gain. However, *Pereskia aculeata* Miller was effective in reducing the levels of visceral fat in the animals.

5. Conclusion

Pereskia aculeata constitutes an alternative food source for families in low-income communities and also it can be a diversification in agricultural activity. However, its use does not show benefits on the biochemical profile in male and female rats but it may reduce visceral fat gain in female with a regular diet.

Disclosure Statement

No competing financial interests exist.

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