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Yellow passion fruit rind (*Passiflora edulis*): an industrial waste or an adjuvant in the maintenance of glycemia and prevention of dyslipidemia?

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Abstract

The use of plants for the treatment of many disorders is a common practice in Brazil, especially for raw consumption and processed juice. The scientific community has shown increasing interest in these plants due to their phytotherapeutic properties. The aim of this study was to evaluate the biochemical profile (glucose, total cholesterol, HDL-c, LDL-c and triacylglycerol) of male Wistar rats treated with extract of Passiflora edulis rind. The rats were divided into two groups (n=15/group) dubbed the GC/control group and the GT/treated group. The intake of Passiflora edulis rind powder consisted of twice daily gavage feeding for 30 consecutive days. The values of the biochemical parameters of glucose, total cholesterol and HDL-c differed statistically. It was found that P. edulis can be helpful in controlling total cholesterol and increasing HDL-c levels.

keywords: *Passiflora edulis* rind, HDL-c, cholesterol, glycemia.

Background

Plants have been used throughout history for the treatment of a variety of disorders. Although not always scientifically confirmed, this practice still widely used today to treat numerous different diseases. These include diabetes and dyslipidemias, which represent risk factors for the development of other disorders such as cardiovascular diseases (CVD) [1,2].

Diabetes and CVD are among the most prevalent diseases in the modern world and also the ones with the highest morbimortality. The former disease is characterized by hyperglycemia due to total, partial or relative insulin deficiency, which alters the metabolism of carbohydrates, proteins, lipids and mineral salts. Hyperglycemia and dyslipidemia are risk factors for the development of hypertension and CVD [3-6].

The genus *Passiflora* (passion fruit) is one of the most well known of the various phytotherapeutic plants used by the population. This plant belongs to the family *Passifloracea*, with originated in the tropical and subtropical regions of the American continent and is abundant in Brazil. The species of this genus are well known for their effects on the central nervous system (to treat anxiety), insomnia, and for their analgesic, antispasmodic and anti-inflammatory activities [7-12].

Brazil is the largest producer of this fruit, with more than 35 thousand hectares under cultivation and an annual production in excess of 317 thousand tons. The fruit juice industry uses approximately 30% of the total mass of the fruits. The remainder is classified as industrial waste. However, this waste contains high amounts of substances indispensable to human nutrition in the form of fibers, vitamins, mineral salts, phenolic compounds and flavonoids, which could be utilized for the preparation of new products. Passion fruit rind is composed of the epicarp or flavedo (colored part) and the mesocarp or albedo (the white portion), which is rich in fibers and is a source of iron, calcium, phosphorus and niacin [13-16].

The literature contains only two studies that used powdered rind of the species *P. edulis* in human diabetics [8,17].

The use of phytotherapy has been growing, but it should be kept in mind that to achieve a safe therapeutic outcome, the production of these plants necessarily requires previous studies about their botanical, agronomic, phytochemical, pharmacological and toxicological aspects. Moreover, the results presented in such studies must be reproducible. In this context, the use of passion fruit rind not only represents a therapeutic prospect for CVD risk factors but also contributes to reduce the amount of waste produced by the fruit juice industry, which is also a highly positive factor for the environment. In view of these facts, the present work aimed to evaluate the effect of passion fruit rind on the biochemical profile of Wistar rats.

Methods

Animals and ethical aspects

The experiments involved the use of Wistar rats weighing approximately 250g supplied by the Center for Animal Model Experimentation (CEMA) of the University of Marilia (UNIMAR). The animals were housed in a vivarium under a 12/12-hour light/dark cycle at an ambient temperature of 22 ± 2ºC, a cycle and

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relative humidity of 60 ± 5%, and were fed and watered *ad libitum*. They were treated according to the "Guide to the care and use of experimental animals", which outlines the principles of the Canadian Council on Animal Care for laboratory animals.

The rats were divided into two groups (n=15 per group): a control group (CG), which received water, and a treatment (TG), which received *Passiflora edulis* extract. The amount of ration and volume of water ingested were checked daily.

This project was approved by the University of Marilia Research Ethics Committee (N. 226) from the ethical standpoint and was in line with current legislation, particularly Federal Laws Nos. 6638 of May 8, 1979 and 9605 of February 12, 1998.

Preparation of the extract and treatment of the animals. The passion fruit was purchased from the Farming Cooperative of Lins, SP, Brazil (COALINS).

The passion fruit rinds (epicarp and mesocarp) were washed, weighed and dehydrated on trays in a forced air circulation drying oven at 55ºC until they reached a constant dry weight [18]. They were then ground into powder in a multiprocessor. Each grinding run was made with 200 grams of rind and ground for a total of 6 minutes, turning off the processor at 2 minute intervals to stir the product with a plastic spatula.

A solution was then prepared consisting of 20 g of powdered rind and 500 mL of water, which was beaten in a blender for 12 minutes and then filtered through filter paper. The resulting solution was divided into aliquots, which were stored in a freezer at -10ºC until the moment they were administered.

The extract ingestion program consisted of gavage feeding twice daily (morning and afternoon, always at the same time and with an interval of 10 hours) for 30 consecutive days. The concentration administered was 1 mL of the prepared passion fruit solution per kilogram of weight. The animals were weighed weekly and the volume of extract adjusted accordingly.

Collection of blood samples for the biochemical profile. After 30 days of treatment, blood samples were collected by exsanguination after anesthetizing the animals with sodium pentobarbital (the blood was collected by puncture of the vena cava). The blood was then processed to obtain serum, which was analyzed using commercial kits to check for glycemia, total cholesterol, LDL-c, HDL-c and triglycerides (kit LABTEST® for total cholesterol, HDL-c and e triglycerides and WIENER LAB® for LDL-c). The data were analyzed based on mean values, standard deviation, and statistical testing.

Table 1. Body weight (g) from control group and group treated with P. edulis rind before (time 1) and after treatment (time 2).

	Groups		p-value
	Control	*P. edulis*	
Body weight (time 1)	246,9 ± 42,7	263,3 ± 39,3	0.0898
Body weight (time 2)	425,3 ± 29,7	305,9 ±38,8	0.0059
p-value	0.0067	0.0089	

Values presented as mean ± standard deviation (SD).

Statistical analysis

The variables are presented as means and standard deviations. The data were analyzed by Tukey-test with a 5% level of significance.

Results & discussion

An analysis of Table 1 indicates that there were significant differences in body weight after the use of the passion flower rind. Animals from control and treated group did not present significant differences in body weigh before the intervention, but they showed significant higher values when compared to the treated group after treatment.

Modifications in lifestyle and diet are major contributors for the high prevalence of obesity. Overweight and obesity are commonly associated with different risk factors to the development of diabetes, cardiovascular diseases and cancer. These findings have been confirmed in several clinical studies involving human and animal models, which found hyperglycemia and augmented levels of total cholesterol, triglycerides and LDL-c and reduced HDL-c levels associated with overweigh. Increases lipid levels are also risk factors for cardiovascular diseases. They are involved in the accumulation of lipids in the liver and are implicated in the development of type 2 diabetes and its correlated risks, such as metabolic syndrome. The consumption of healthy foods can prevent the development of these risk factors and can, as well, prevent diabetes and heart diseases [18-23]. Ramos *et al* [8] used passion fruit peel flour in human volunteers and observed reduction in body weight. They attributed this result to the presence of pectin. The flour of the passion fruit peel is rich in this kind of soluble fiber.

Table 2 indicates that LDL-c levels did not vary significantly, but HDL-c levels increased significantly. Glycemia, triglycerides and total cholesterol levels decreased in animals treated with passion fruit rind when compared with the control group.

Ramos *et al* [8] used passion fruit rind in the form of flour on type 2 diabetes mellitus patients and observed a reduction in the LDL-c and total cholesterol levels but detected no change in glycemia and HDL-c levels (they did not evaluate triglyceride levels). Janebro *et al*. [17] also used passion fruit flour on type 2 diabetes mellitus patients, but, unlike Ramos

Table 2. Biochemical profile (mg/mL) from control group and group treated with P. edulis rind.

	Groups		p-value
	Control	*P. edulis*	
Glucose	136,5 ± 21,6	86,4 ± 20,4	0.0048
Cholesterol	203,3 ± 43,9	116,9 ±16,3	0.0069
Triglycerides	83,8 ± 29,3	60,3 ± 33,9	0.00701
HDL-c	19,6 ± 5,4	46,8 ± 17,7	0.0055
LDL-c	131,9 ± 25,2	122,4 ± 20,4	0.0693

Values presented as mean ± standard deviation (SD).

et al. [8], they did not find a reduction in cholesterol and LDL-c but observed a reduction in glycemia (they also reported a reduction in triglyceride levels and increase in HDL-c levels). Other studies have shown that other parts of the passion fruit can also have beneficial effects on lipid and glycemic profiles [24]. The effects obtained with the use of rind may be attributed to the presence of fibers. Passion fruit rind is rich in soluble fibers such as pectins and mucilage. According to Yapo, Koff [25], 73% of the dry matter in the species *P. edulis* is in the form of fiber, 60% of which is insoluble fiber. Pectin is able to retain water, forming viscous gels that delay gastric voiding and bowel transit times, which are factors that reduce hunger, and thus reduce overweight/obesity. Moreover, these gels can reduce plasma levels of total cholesterol, triglycerides and LDL-c and increase HDL-c levels. This is possibly because the presence of fibers increases the excretion of cholesterol and biliary salts in the feces. Therefore, the consumption of fibers may reduce the risks for diseases such as diabetes, dyslipidemias, obesity and CVD [26-31]. Chau, Huang [32] used *P. edulis* seed fibers and observed beneficial effects on the lipid profile of hamsters.

Janebro *et al.* [17] associated the reduction in glycemia and the improvement in HDL-c and triglycerides levels to the supplementation of diet with soluble dietary fiber found in the rinds that can be considered an important therapy measure in the treatment of diabetic and obese patients. Silva *et al.* [14] also found that pectin from P. edulis decreased blood glucose and triglyceride levels in diabetic rats and concluded that this fiver has potential as a useful alternative treatment for type 2 diabetes and that its anti-inflammatory properties are probably involved in its antidiabetic action.

The presence of antioxidants, vitamins and flavonoids in passion fruit (C-glycosyl flavonoids are the main components of *Passiflora* species) is related to important effects in the maintenance of glycemia and plasma lipids. Among the compounds with antioxidant and antiinflammatory effects found in passion fruit species are chlorogenic acid, hyperoside, isovitexin, caffeic acid, quercetin, luteolin, *orentin*, rutin, vitexin and others [15,33-38]. The presence of these compounds may also explain the beneficial effects of *P. edulis* on glycemia and on plasma lipids observed in this study.

The classical known risk factors include high levels of LDL-c and low levels of HDL-c, which are implicated with an important increase in the incidence of atherosclerotic cardiovascular disease. A therapeutic target that has aroused much interest is the increase in HDL-c levels, since low levels of this fraction of cholesterol constitute the lipid abnormality most frequently found in CVD patients. Some studies have demonstrated that increased levels of serum HDL-c in the order of 1mg/dL lead to a reduction of 2%-3% in the incidence of CVD. It has also been demonstrated that high levels of HDL-c can prevent the progression of atherosclerotic plaque, promoting its regression [39]. The use of powdered *Passiflora* rind proved to play an important role in raising the levels of HDL-c in the blood of the animals used in this study, indicating that its use may be beneficial to increase this lipoprotein. Furthermore, passion fruit rinds are discarded by fruit juice processing plants and constitute an important source of industrial waste that is available in large quantities. Therefore, the use of this waste to produce new functional products may be attractive for the food industry.

Conclusion

The results of this work indicate that the use of passion fruit rinds contributed significantly to control the biochemical variables and body weight of the experimental model under study. So, its use can work as an adjuvant in the treatment of disorders of the glycemic and lipid profile, reducing risk factors for death by cardiovascular diseases, and also serving to reduce industrial wastes and hence environmental pollution.

Competing interests

Authors declare no conflict of interests.

Author's contribution

All authors contributed with all parts of the research and writing the manuscript.

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