Evaluation Of Anti-Obesity Activity of *Passiflora Incarnata* on Experimental Animal

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ABSTRACT

Background: Obesity is a significant, chronic disease that can negatively impact numerous bodily systems, making it a challenging health issue to handle. Numerous health issues, including diabetes, heart disease, osteoarthritis, and certain malignancies, may be made more likely by being overweight or obese. Around the world, obesity is surging at an alarming rate. More than 300 million obese persons are thought to exist in the globe today. The development of anti-obesity medications could preferentially target the enzymes involved in lipid metabolism, which is thought to be a problem in obesity. The majority of the anti-obesity medications that were approved and sold, though, have since been pulled from the market because of dangerous side effects. Obesity and its related secondary consequences have been treated with traditional medicinal plants and their active phytoconstituents. Clinical research have also proven the efficacy of some active medicinal plants and the bioactive substances they contain in treating obesity. The focus of this review is on natural phytoextracts, including their method of action and preclinical experimental models.

Materials and Methods: *Passiflora incarnata* extract was used to evaluating the anti-obesity activity in wistar albino rats. Rats were divided into five groups. Control group (Group 1) received normal diet. HF control group (Group 2) received HF diet. Group 3 received orlistat (25 mg/kg body weight per oral). Group 4and 5 received 100 and 200 mg/kg body weight *Passiflora incarnata* respectively. Treatment was given for 7 week to the respective group along with HF diet. Body weight, food intake was measured every week for 7 w. On day 42, the serum biochemical parameters like blood glucose and insulin, serum leptin, total cholesterol and triglyceride were evaluated. Animals were sacrificed with overdose of diethyl ether. The liver and retroperitoneal adipose tissues were removed and weighed immediately.

Results: When compared to the HF diet control group, treatment with *Passiflora incarnata* at doses of 200 mg/kg and 400 mg/kg significantly (p< 0.001) decreased body weight and adipose tissue weight. It also significantly decreased serum total cholesterol, triglyceride, and glucose levels (***p < 0.001, **p < 0.01, *p < 0.5 when compared to normal control, ###p < 0.001, and #p < 0.05 5 when compared to high fat control). Additionally, it prevented the buildup of hepatic triglycerides, which causes fatty liver.

Conclusions: In rats fed a high-fat diet, *Passiflora incarnata* had an anti-obesity impact by causing reductions in body weight, abdomen circumference, total cholesterol, triglyceride levels, and glucose levels.

Keywords: Obesity; Anti-obesity drugs; Medicinal plants, HF diet-induced obesity.

1. INTRODUCTION

1.1 Obesity

Being obese refers to having excessive bodily fat. Overweight and obesity are two distinct conditions. Being overweight means weighing more than is healthy. Bones, muscles, fat, and/or bodily water make up most of an individual's weight. In either scenario, carrying more weight is bad for a person's health. Increased calorie consumption and reduced calorie loss lead to obesity. Genetics, binge eating, physical characteristics, consuming a high-fat diet, and inactivity are all factors that contribute to obesity. Diabetes, arthritis, stroke, and various types of cancer are all more common in those who are obese.

1.2 Definition

Obesity on the basis of WHO criteria, is defined as the individuals showing body mass index (BMI) ≥30Kg/m^2, is due to an imbalance in which energy intake increased over energy expenditure for prolonged period, ultimately resulting in excessive body fat accumulation to degree that adversely affects health. 1[1]
Ancient Greek medicine notes that the Ancient Egyptians also recognised obesity as a medical problem. According to Hippocrates, "Corpulence is not only a disease in and of itself, but also a sign of other diseases." The Indian surgeon Sushruta connected diabetes and cardiac conditions with obesity in the sixth century BCE. He advised doing physical activity to assist treat illness and reduce its negative effects. Throughout the most of human history, there was a food shortage. As a result, obesity has traditionally been seen as a symbol of success and affluence. In both ancient East Asian civilizations and the Middle Ages and Renaissance in Europe, it was typical among elite officials. Tobias Venner, an English physician who wrote in the 17th century, is recognised as one of the earliest.

1.3 Classification of overweight, obesity and central obesity
a. Fat Mass and Percent Body Fat
As previously indicated, a number of imaging modalities, including DEXA, CT, and MRI, can directly quantify fat mass; however, these techniques are impracticable and prohibitive expensive for broad clinical usage; as a result, they are primarily employed in research. Using water (underwater weighing), air displacement (BODPOD), or bioimpedance analysis (BIA), fat mass can be indirectly assessed. Each of these techniques provides an estimate of the percentage of fat or non-fat mass and enables body fat percentage estimations. Of these, BODPOD and BIA are frequently provided by gyms and clinics controlled by experts in obesity care. However, it is still not advised to use them routinely in the treatment of individuals who are overweight or obese. Common disorders associated with obesity, especially when fluid status is disturbed as in congestive heart failure or chronic kidney illness, may make it difficult to interpret the outcomes of these examinations. Additionally, the boundaries between normal and abnormal for these techniques are not well established, therefore, practically speaking, understanding them won't modify the present guidelines for supporting patients' sustained weight reduction.

b. Body Mass Index
Body mass index enables weight comparisons between populations, regardless of stature. BMI and percentage of body fat correlate well, with the exception of those who have gained lean weight through intense exercise or resistance training (such as bodybuilders), but this relationship is independently influenced by sex, age, and race, particularly South Asians, in whom evidence suggests that BMI-adjusted percent body fat is higher than in other populations. A BMI of 27.3 kg/m² or higher for women and a BMI of 27.8 kg/m² or higher for men was used in the United States to define adult obesity according to data from the second National Health and Nutrition Examination Survey (NHANES II). These parameters were developed using the gender-specific BMI 85th percentile values for people aged 20 to 29.

c. Fat Distribution (Central Obesity)
A proportionally higher concentration of fat in the abdomen or trunk relative to the hips and lower extremities has been linked to an increased risk for type 2 diabetes mellitus, hypertension, and heart disease in both men and women. This is in addition to an increase in total body weight. Although the waist-to-hip ratio is frequently used to describe abdominal obesity, it can really be best measured by a single circumferential measurement taken at the level of the superior iliac crest. Men were categorised in the initial US national recommendations as having a higher relative risk of co-morbidities such diabetes and cardiovascular disease.

1.4 Signs and Symptoms
Body mass index (BMI) greater than or equal to 30 is the indicator of obesity. Body mass index (BMI) defined as weight in kilograms by your height in meters squared. BMI higher than 30 indicates the higher amount of fat tissue. The athletes have higher BMI but it doesn’t mean that they are obese.

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>BMI</th>
<th>Indication</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>Less than 18.5</td>
<td>Underweight</td>
</tr>
<tr>
<td>02</td>
<td>18.5 to 24.9</td>
<td>Normal</td>
</tr>
<tr>
<td>03</td>
<td>25 to 29.9</td>
<td>Overweight</td>
</tr>
<tr>
<td>04</td>
<td>30 to 39.9</td>
<td>Obese</td>
</tr>
<tr>
<td>05</td>
<td>≥ 40.0</td>
<td>Morbid obesity</td>
</tr>
</tbody>
</table>

2. MATERIALS AND METHODS
2.1 Experimental animals
The experiment was performed on wistar rats, 125- 130g which was obtained from the animal house of Department of Pharmacology, Vidyabharati college of Pharmacy, Amravati. All the animals were acclimatized to animal house prior to use. They are kept in cage to animal house with 12h light:12h dark cycle. Animals were fed on pellets and tap water ad libitum. The care and handling of rats were in accordance with the internationally accepted standard guidelines for use of animals (CPCSEA). Permission Registration number-1504/PO/Re/S/11/CPCSEA and approval for animal studies were obtained from Institutional Animal Committee (IAEC) of Vidyabharati College of Pharmacy, Amravati, SGB Amravati University.

2.2 Drug and chemicals
Orlistat was purchased from Amravati Pharmacy store. All the treatment (test drug, standard drug and the vehicle) were given by oral route with the help of oral gavage. Drug and vehicle were given in the form of liquid suspension which is freshly prepared at the time of administration to the animal.

2.3 Plant material
The crude drug extract of plant were purchased from Natural Hub Pvt. Ltd ,New Delhi.

2.4 Phytochemical analysis
The extract would be then subjected to different phytochemical tests for flavonoids, indole alkaloids, chrysin, coumarin.

2.5 Acute toxicity testing
Acute toxicity testing of extract of Passiflora Incarnata carried out according to the fixed-dose procedure of OECD Guideline 420.
2.6 Anti-obesity study
The rats were divided into five groups. Group I (controlled group) administered with normal diet, Group II (untreated obese rats) High fat diet, Group III (obese rats receiving high fat diet with orlistat), Group IV and V (receiving 200 mg/400 mg of body weight of test extracts respectively). Orlistat was used as the standard anti-obesity throughout the experimentation. They were carefully monitored every day. Animals described as high fat diet were deprived of food for at least 12 hours but allowed to free access for drinking water. Body weight measurement was done on day 1st, 7th, 14th and 21st of the study. Body weight measurement were measure by weighing machine.
On day 42, animals were light anaesthetized, and blood was collected by retro-orbital puncture by glass capillary. After that animal were sacrificed with an overdose of ether and examined grossly. Livers were isolated from each group of animals, weighed immediately and liver tissues were embedded in formalin for histopathology study.

2.6 Treatment Protocol:

<table>
<thead>
<tr>
<th>Sr. no.</th>
<th>Group</th>
<th>No. of Animals</th>
<th>Treatment and Dose</th>
<th>Route Administration</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>I</td>
<td>6</td>
<td>Normal Diet</td>
<td>Oral</td>
</tr>
<tr>
<td>2</td>
<td>II</td>
<td>6</td>
<td>High fat Diet</td>
<td>Oral</td>
</tr>
<tr>
<td>3</td>
<td>III</td>
<td>6</td>
<td>High fat Diet + Orlistat</td>
<td>Oral</td>
</tr>
<tr>
<td>4</td>
<td>IV</td>
<td>6</td>
<td>High fat Diet + Moderate dose of <em>Passiflora incarnata</em> (200mg)</td>
<td>Oral</td>
</tr>
<tr>
<td>5</td>
<td>V</td>
<td>6</td>
<td>High fat Diet + High dose of <em>Passiflora incarnata</em> (400mg)</td>
<td>Oral</td>
</tr>
</tbody>
</table>

Table no.2 Treatment Protocol

2.7 Clinical signs
After dosing, all animals were observed for tremor, convulsion, aggression, lethargy, abdominal breathing, grooming, licking and sniffing.

A. Body weight
Body weight (g) of the study animals in each group was recorded on day 1 and then every 7 week.

B. Food intake
The process of measurement of solid food consumption was done by weighing the different food items deposited in each cage each day, and determining the weights of the food remaining the day after. These needed some corrections, as part of the food was tainted with droppings and urine. The identifiable pieces of food were cleaned and their actual weight was determined. The food intake of each animal was determined daily and the results were expressed as a mean energy intake for each group of rats in kilocalorie per week (kcal/week).

Total energy intake kcal week = Mean food consumption X Calorie from chow

C. Biochemical parameters
On day 42, blood was collected by retro-orbital punctures by glass capillary under light anaesthesia. Blood was kept for 30 min for coagulation and then serum was separated by centrifugation at 4000 rpm (revolutions per minute). Changes in blood parameters like levels of glucose, total cholesterol and triglyceride were measured from serum samples using biochemical kits available in the market.

2.8 Statistics
The data obtained from the screenings were subjected to statistical analysis following one-way ANOVA followed by Dunnett Comparison Test to assess the statistical significance of the results using GraphPad Prism-5 software.

3. RESULT

3.1 Clinical signs
All groups were treated with *Passiflora incarnata* for 7w. immediately after dosing, rats removed husk by forepaw and sat on a husk free space for 30 min. This was observed in all Passiflora incarnata treated groups. No clinical signs like tremors, convulsions, piloerection were observed.

3.2 Effect of *Passiflora incarnata* on food intake (calorie intake)
There was a significant increase in calorie intake per week among the HF diet-fed rats as compared to the normal diet-fed rats. However, the rats treated with orlistat showed a less significant decrease in calorie intake per week. But rats treated with *Passiflora incarnata* showed a significant effect in food intake.

3.3 Effect of *Passiflora incarnata* on body weight
Consumption of HF produced a significantly increased in body weight as compared to the consumption of normal diet (normal control group) after 1 w of treatment and continued up to 7 w. Treatment with *Passiflora incarnata* at a dose of 200 and 400 mg/kg body weight significantly reduced body weight as compared to the HF control group. After 4 w, *Passiflora incarnata* at a dose of 200 mg/kg and after 3 w *Passiflora incarnata* at a dose of 400 mg/kg showed significant reduction in body weight as compared to HF control group. However, treatment with orlistat also reduced body weight, significantly as compared to HF control group.
3.4 Effect of *Passiflora incarnata* on histopathology of rat liver

The section from liver showed that the central veins, portal triads surrounded by cords of normal looking hepatocytes. Congestion, macrovesicular fatty changes, necrosis and inflammation, were not present in normal rat liver. Histopathology of the liver in rats fed on HF diet showed focal distortion of the normal architecture of liver, focal areas of inflammatory cells infiltration, macrovesicular fatty changes and focal areas of necrosis. Rats those were treated with orlistat along with HF diet showed loss of architecture, inflammation, congestion, sinusoidal dilation and necrosis. It also showed fatty changes. Liver section of rats treated with *Passiflora incarnata* (200 mg/kg) along with HF diet showed mild congestion focal, macrovesicular fatty changes, mild kupfer cells proliferations and focal infiltration of inflammatory cells. However, it was not extensive in compared to HF diet control group (fig. 6D). Liver section from rats treated with *Passiflora incarnata* (400 mg/kg) in addition to HF diet showed regeneration of hepatocytes toward normal architecture compared to HF diet control group.

3.5 Measurement of Blood Parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Control Group</th>
<th>HFD</th>
<th>Orlistat</th>
<th><em>Passiflora incarnata</em> 200 mg/kg</th>
<th><em>Passiflora incarnata</em> 400 mg/kg</th>
</tr>
</thead>
</table>

All data are expressed as mean ± SEM for group of 6 rats in each. One-way Anova followed by Dunnett’s multiple comparisons. Values are statistically Significant *P < 0.0001 for Final body weight as compared with Positive control. The results of the statistical analysis indicated a significant difference in body weight between the treatment and control groups at the 14th week (p < 0.0001). This significant p-value suggested that the treatment had a notably decreased the rats' body weight compared to the positive control group. These findings highlight the potential efficacy of the *Passiflora incarnata* in modulating weight progression in rats.
Table no.3: Effect of *Passiflora incarnata* on blood parameter in obese rats.

All data are expressed as mean ± SEM for group of 6 rats in each. One-way Anova followed by Dunnett’s multiple comparisons. Values are statistically Significant *P <0.0001 for Blood parameter as compared with Positive control.

The results of the statistical analysis indicate the effect of *Passiflora incarnata* treatment on the selected blood parameters related to obesity in rats. Depending on the outcomes, the study reports significant changes in various blood parameters, such as reductions in total cholesterol levels, triglycerides, blood glucose, etc in the treatment group compared to the positive control group.

3.6 Effect of *Passiflora incarnata* on histopathology of liver in rats fed on high fat (HF) diet
The current study was conducted by using HF diet and other biomarkers of obesity induced by a HF diet is a clear sign of the anti-obesity effect. The observed weight reduction suggests that treatment with Passiflora incarnata showed significant reduction in body weight, abdomen circumference, food intake, total cholesterol measurement, triglyceride and glucose level measurement as compared to the normal control group. Treatment with Passiflora incarnata at a dose of 200 and 400 mg/kg/day, significantly reduced the increase in body weight and other biomarkers of obesity induced by a HF diet is a clear sign of the anti-obesity effect.

4. DISCUSSION
Throughout history, science has invested enormous time and effort in the search to understand the physiological basis of obesity. Crucial to this research is the inquiry of how does our body control ingestion, digestion, absorption, and metabolism and how nutrients are distributed among various tissues, organs, and system. Obesity is a major international public health threat and economic burden. Over the last 3 decades, the prevalence of overweight and obesity has increased rapidly. The latest World Health Organization estimates that 1.6 billion adults (aged 15 years and above) were overweight and 400 million were obese in 2005. These figures are predicted to rise to 2.3 billion overweight and over 700 million obese adults by 2015.

The present study investigated the effect of Passiflora incarnata on various parameters associated with obesity, including body weight, total cholesterol, triglycerides, HDL (high-density lipoprotein), LDL (low-density lipoprotein), VLDL (very-low-density lipoprotein), SGOT (serum glutamic-oxaloacetic transaminase), SGPT (serum glutamic-pyruvic transaminase), total bilirubin, and blood glucose levels. The analysis of body weight revealed that treatment with Passiflora incarnata had a significant effect on weight reduction. This is a promising finding, as obesity is characterized by excess body weight, and interventions aimed at weight management are crucial in combating obesity-related complications. The observed weight reduction suggests that Passiflora incarnata may have potential anti-obesity properties.

To evaluate the morphological alterations in adipose tissue and organs linked to obesity, histopathology analysis was done. The histological analysis showed that the treatment group had significantly improved over the control group. Adipocyte size decreases, adipose tissue inflammation, and indications of adipose tissue hypertrophy were noted in the therapy group. These results support the promise of Passiflora incarnata as an anti-obesity medication by showing that treatment with it may successfully reduce the pathological alterations linked to obesity.

As stated earlier plant and herbs are the foundation of the traditional system. Plants have shown considerable improvement in parameters of obesity devoid of any visible adverse effects. Hence, they are being widely used in treating obesity. In order to find effective anti-obesity treatments, different animal models of obesity have been used. Rat models with HF-induced obesity, cafeteria diet-induced obesity are considered useful for evaluation of the anti-obesity effect of drugs. The supplementation of HF in their diet is an imperative factor which leads to the development of obesity. The current study was conducted by using HF diet-induced obesity model in rats. HF diets have been previously reported to increase energy intake and cause obesity in humans as well as animals. The following parameters were used for anti-obesity assessment of Passiflora incarnata. It includes the effect on body weight, abdomen circumference, food intake, total cholesterol measurement, triglyceride and glucose level measurement retroperitoneal adipose tissue weight, liver weight and histopathology of the liver. It is known that obesity results from an imbalance between energy intake and expenditure. Further, the composition and variety of cafeteria or high-fat foods also exert a synergistic effect on the development of obesity. The results of the present study showed that rats fed with HF which is rich in energy and high carbohydrate for seven weeks elicited a significant increase in body weights. HF control group showed a significant increase in food intake as compared to normal control group. Animals treated with Passiflora incarnata have shown a significant effect on parameters of obesity as compared to HF control group. Treatment with Passiflora incarnata at a dose of 200 and 400 mg/kg/day, significantly reduced the increase in body weight and other biomarkers of obesity induced by a HF diet is a clear sign of the anti-obesity effect.

A lipase inhibitor which reduces the fat digestion and thereby its absorption is one of the commonly accepted approaches in decreasing calorie intake. Pancreatic lipase hydrolyzes fats into fatty acid and monoacylglycerols. These are the absorbable forms of fats. Hence, inhibiting of pancreatic lipase may result in stopping hydrolysis of fat into absorbable fat units. Orlistat, an approved anti-obesity drug currently marketed. It prevents obesity and hyperlipidaemia by increasing fat excretion in faeces and by inhibiting the pancreatic lipase. The Passiflora incarnata significantly reduced abdomen circumference as compared to HF control group.
The reduction in body weight corresponded with that of reduction in abdomen circumference. In obese animals and humans, it is seen that there is an increase in levels of serum lipids (for e.g. total cholesterol and triglycerides). Thus, alteration in the levels of lipid can be used as an index of obesity. It is known that the high lipid content (hyperlipidemia) leads to many life-threatening conditions such as heart disease, stroke and other vascular diseases. A decrease in calorie intake, especially from fat consumption, is one of the essential steps in the treatment of obesity. Obesity is also the most common cause of dyslipidemia. The excess lipid supply in a state of obesity leads to higher triglyceride stores in non-adipose tissues e.g. muscle, liver and pancreas [20]. Treatment with *Passiflora incarnata* has caused significant changes in the blood parameters like decreased levels of lipids like total cholesterol, triglyceride and carbohydrate like glucose. The results of the present study showed that rats fed with HF foods for seven weeks produced a significant increase in weight of retroperitoneal adipose tissue and serum lipid levels. Furthermore, HF diet also induced a fatty liver with the build-up of hepatic triglycerides [21]. The *Passiflora incarnata* produced a significant decrease in liver weight and the retroperitoneal adipose tissue weight as compared to the HF diet control group. The rate of reduction of body weight was similar to that in the retroperitoneal adipose tissue weight.

The microscopic examination of a liver section of HF diet treated group showed various degrees of pathological changes such as fatty degeneration cloudy swelling and necrosis of hepatic cells. The abnormal reconstructions of the lobular architecture, the appearance of widespread fibrosis, in addition, nodular lesions of the hepatic parenchyma are the main characteristics of liver cirrhosis [22,23]. The histopathology study showed that rats treated with orlistat along with HF diet showed cirrhosis like condition presenting toxic symptoms on continuous administration of orlistat. The histopathology study showed that *Passiflora incarnata* attenuated the hepatocellular necrosis and led to a reduction in inflammatory cells infiltration. *Passiflora incarnata* treated group showed recovery of damaged liver cells. Earlier various authors have reported that the saponins showed strong inhibitory effects on the lipase secreted from the pancreas in vitro and prevented an increase in body weight which was induced by HF diet in vivo [25,26]. Thus, *Passiflora incarnata* might be responsible for the reduction in weight gain as compared to animals in HF control group.

Furthermore, the study examined blood glucose levels, as impaired glucose metabolism is a common feature of obesity and can lead to type 2 diabetes. The findings showed a significant reduction in blood glucose levels following *Passiflora incarnata* treatment. [27] This suggests that the treatment may have beneficial effects on glucose regulation, potentially mitigating the risk of developing diabetes in obese individuals.

Overall, the findings of this study indicate that *Passiflora incarnata* has potential anti-obesity effects based on the observed reductions in body weight, total cholesterol, triglycerides, LDL, VLDL, and blood glucose levels. Additionally, the improvement in liver function markers suggests a hepatoprotective effect. These results support further exploration of *Passiflora incarnata* as a potential therapeutic agent for obesity perspective and related metabolic disorders. However, it is important to conduct additional studies to elucidate the underlying mechanisms and determine optimal dosages and treatment durations to ensure safety and efficacy.

### 5. CONCLUSION AND FUTURE PERSPECTIVES

#### Conclusion

The present study was conducted to assess the anti-obesity effect of Passion flower and stem isolated from dried plant of *Passiflora incarnata*. Chrysine, the active component isolated from this plant showed marked anti-obesity effect in rats fed on HF diet in a dose-dependent manner. *Passiflora incarnata* leads to decrease in body weight, abdominal circumference, lipid profile, fat deposition indicating the anti-obesity potential of this component equipotent to orlistat without any toxic effect on the liver in HF-fed rats. Antioesity effect of *Passiflora incarnata* can be seen through the inhibition of intestinal absorption of dietary fat, blocking the fat accumulation and synthesis of fat and its hypolipidemic activity. The present study confirms the basis for the use of this plant (*Passiflora incarnata*) in the traditional medicine for treatment of obesity. In future, this work can be extended by including more obesity models to confirm the anti-obesity potential of *Passiflora incarnata* for the meaningful and tangible conclusion.

#### Future perspectives

Our understanding of the mechanisms underlying the anti-obesity properties of *Passiflora incarnata* and its active component, chrysine must be further developed. Clarifying the precise molecular pathways impacted by *Passiflora incarnata* therapy, such as AMPK activation, adipogenesis modulation, and lipid metabolism regulation, could be the subject of further research. The therapeutic targets and potential synergistic effects of the numerous bioactive chemicals found in *Passiflora incarnata* would be significant insights gained from this.

Long-term studies are also required to assess long-term efficacy and safety in the context of managing obesity. To determine its therapeutic relevance, it will be essential to evaluate how extended treatment affects body weight maintenance, lipid profiles, glucose metabolism, and potential side effects.

For the results seen in animal models to be validated, human research must be include *Passiflora incarnata*’s efficacy as a treatment agent can be determined by carrying out carefully planned clinical trials on obese people. Its effects on body weight, lipid profiles, glucose metabolism, and other pertinent parameters could be assessed in these trials, along with additional variables including dosage, treatment duration, and potential drug interactions.

*Passiflora incarnata* may provide additional positive effects when combined with other anti-obesity strategies, such as pharmaceutical or lifestyle changes, according to research. *Passiflora incarnata* may be used in combination with other natural substances or medications to treat obesity in a comprehensive and individualised manner.

Overall, the results of this study provide a basis for further research into the putative anti-obesity properties of *Passiflora incarnata*. To fully comprehend its therapeutic potential, optimise treatment protocols, and translate these findings into clinical practice for the effective management of obesity and its associated complications, further research efforts, including mechanistic studies, long-term trials, and human studies, will be necessary.

### 6. ACKNOWLEDGMENT

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