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ORIGINAL ARTICLE

Effect of Garcinia Cambogia Extract on Body Weight, and Evaluation of Histological, Physiological, and Biochemical Changes in the Prostate Gland of Adult Albino Wistar Rats: An Anatomical Perspective

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ABSTRACT

Background: As obesity's prevalence has increased recently and is related to a number of disorders such as diabetes, hypertension, cardiovascular, hyperlipidemia, fatty liver, osteoarthritis, and mental health issues, it has been deemed a public health issue. Hydroxycitric acid, a phytochemical found in Garcinia cambogia, plays a significant role in weight loss by inhibiting fat synthesis and weight gain. Garcinia cambogia also contains an antioxidant, Garcinia hydroxybiflavanonol (GB1) which has the potential to improve testosterone levels.

Aim: To measure and compare the body weight of adult albino Wistar rats, to evaluate the histological changes on epithelium of prostatic acini and to compare the testosterone levels among the groups after Garcinia cambogia extract administration.

Methods: A randomized controlled experimental study was performed at Postgraduate Medical Institute (PGMI), Lahore on 24 male albino Wistar rats, in which 3 groupings were formed with eight rats each, aged of 6 to 8 weeks where group A was considered as control group, B (given a sub-toxic dose of about 778 mg/kg weight of Garcinia cambogia) and C (given a toxic dose which was 1244 mg/kg body weight of Garcinia cambogia) for 28 consecutive days through gavage method. The data obtained from the Group A was compared with data gained from the Group B and C. Results were analysed using SPSS version 25.0 The cutoff for statistical significance was $p \leq 0.05$.

Results: Significant weight loss in Garcinia cambogia treated groups in comparison with Control group.Animals in Garcinia cambogia treated groups had remarkably lower mean body weights than those in group A.Cellular vacuolization and markedly elevated testosterone levels were documented in the treated groups.

Conclusion: Garcinia cambogia was found to raise testosterone levels and have a positive effect on obesity in this study.

Keywords: Garcinia cambogia, hydroxycitric acid, garcinia hydroxybiflavanonol, obesity, hypertension

INTRODUCTION

Garcinia cambogia is an edible fruit which is most commonly found in places like Southeast Asia, Central Africa, and India[1]. Garcinia cambogia contains a variety of phytochemicals, including flavonoids, benzophenones, xanthones, and garcilon, which make it a potent antioxidant with antitumor and anti-inflammatory properties[2], but hydroxycitric acid is the most significant active ingredient that plays a key role in weight loss by preventing the accumulation of body fat[3], encouraging the body to oxidize more carbohydrates and reducing appetite[4].

According to Andueza et al.[2], HCA works by impeding the enzyme ATP citrate lyase, which is responsible for the biosynthesis of cholesterol, fatty acids, and triglycerides. HCA's inhibitory effect decreases the acetyl-CoA pool, thereby reducing the two-carbon units needed for the early stages of cholesterol and fatty acid production. By enhancing serotonin production—a neurochemical that controls eating patterns and desire—HCA also decreases hunger[5].

HCA (α-β-dihydroxy tricarboxylic acid) is a vital ingredient found in the rind of the Garcinia cambogia fruit and is known for its ability to aid in weight loss[6]. The actions of HCA are correlated with a decrease in food intake through regulation of serotonin levels, activation of hepatic glycogenesis, reduction of plasma insulin and leptin levels, and decreased rates of glucose uptake in tissues, which collectively boost energy expenditure[2]. Garcinia cambogia in combination with probiotics has been found to be highly effective in reducing weight[7].

A research study performed by El-Shaer[8] revealed that Garcinia cambogia extract contains biflavonoids (hydroxybiflavanonol, GB1) and xanthones with antioxidant properties, which have the potential to reverse oxidative stress and oxidative DNA damage, a process implicated in the pathogenesis of benign prostatic hypertrophy.

The dosage of Garcinia cambogia for weight loss ranges from 15 to 30 mg HCA/kg body weight when administered orally per day. The principal component, hydroxycitric acid, is absorbed by the gastrointestinal tract and enters two metabolic pathways that alter carbohydrate metabolism and reduce food intake, thereby acting as an anti-obesity agent. It increases fat oxidation and reduces lipogenesis by controlling serotonin levels[9,10]. Garcinia cambogia, when administered according to body weight, produces no serious side effects; however, some obese individuals have reported experiencing upper respiratory, gastrointestinal, and headache issues[11]. The main adverse effect associated with excessive Garcinia cambogia usage is severe testicular damage characterized by deterioration of germ cells, which has been measured at a dosage of 1244 mg HCA/kg body weight per day[12].

MATERIALS AND METHODS

This study was designed as a randomized controlled experimental investigation conducted over a one-year period at the Anatomy Department of PGMI, Bird Wood Street, Lahore. The protocol was reviewed and approved by the institutional animal care and use committee at PGMI, Lahore, and University of Health Sciences (UHS), Lahore ethical review committee approval letter ref no. (UHS/Educations/126-18/2749) all procedures were performed in strict accordance with internationally accepted ethical guidelines for the use of laboratory animals.

Inclusion and Exclusion Criteria: Only healthy male adult albino Wistar rats, aged between 6 and 8 weeks and weighing between 140 and 150 grams, were included in the study. Animals were examined for any clinical signs of illness or congenital abnormalities during a seven-day acclimatization period; any rat

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exhibiting behavioral or health anomalies was excluded to ensure the validity of the experimental results.

Animal Procurement and Housing: Twenty-four male adult albino Wistar rats meeting the inclusion criteria were procured from the Animal House of PGMI, Lahore. The rats were housed in hygienic polycarbonate cages in a controlled environment maintained at 26 ± 2ºC with relative humidity of 60 ± 10% and a 12-hour light/dark cycle. During a seven-day acclimatization period, the animals were provided with standard rat chow and water ad libitum, and each animal's health and behavior were closely monitored.

Study Design and Randomization: Following the acclimatization period, the rats were randomly allocated into three equal groups (n = 8 per group) using a computer-generated randomization schedule. Group A served as the control group and received distilled water via oral gavage. Group B was administered a sub-toxic dose of Garcinia cambogia extract at 778 mg/kg body weight, while Group C received a toxic dose of 1244 mg/kg body weight. All treatments were administered once daily by gavage for 28 consecutive days.

Treatment Protocol: The dosing regimen was established based on previous literature to assess both the therapeutic efficacy and potential adverse effects of Garcinia cambogia extract. The extract was freshly prepared in distilled water prior to each administration. Group A received only distilled water as a vehicle control. Groups B and C received their respective doses of Garcinia cambogia extract, allowing for a controlled evaluation of the dose-dependent metabolic, histological, and biochemical outcomes.

Ethical Considerations: All experimental procedures were conducted in accordance with the ethical standards defined by University of Health Sciences (UHS), Lahore ethical approval letter ref no. (UHS/Educations/126-18/2749), and adhered to internationally recognized guidelines for animal research. Every effort was made to minimize animal suffering and reduce the number of animals used. The welfare of the animals was rigorously monitored throughout the acclimatization and experimental phases, and any animal exhibiting undue distress or illness was humanely euthanized. The study design ensured that the scientific objectives were met while respecting the ethical obligations toward the use of live animals in research.

Sample Collection and Biochemical Analysis: On day 29—one day after the final dose—the animals were deeply anesthetized using an approved anesthetic protocol and subsequently sacrificed. Approximately 3 mL of blood was collected from each animal via cardiac puncture using sterile disposable syringes. The blood was allowed to clot at room temperature and then centrifuged to separate the serum. The serum was aliquoted into cryovials and stored at −20ºC until further analysis. Serum testosterone levels were quantified using a validated Enzyme-Linked Immunosorbent Assay (ELISA) kit, following the manufacturer's instructions.

Statistical Analysis: All data were analyzed using SPSS version 25. Continuous variables such as initial and final body weights, relative tissue weight indices, and serum testosterone levels were compared among the three groups using one-way analysis of variance (ANOVA). When significant differences were detected, post-hoc pairwise comparisons were conducted. A two-tailed p-value of ≤ 0.05 was considered statistically significant, ensuring a rigorous assessment of the study outcomes.

RESULTS

Table 1 shows that the difference in the final body weight was extremely remarkable in Garcinia cambogia treated groups when compared with control group A, with p value of less than 0.001. The end body weight of the control group (A) was 148.4 ± 2.88 grams, which was higher significantly when compared with Group B (141.9 ± 1.96 grams) provided with sub toxic dose of Garcinia cambogia and Group C (140.1 ± 2.42 grams) given toxic dose of Garcinia cambogia (Fig 1).

Table 2 comparisons manifests that the mean final body weight differences between group A and B was remarkably significant having a p-value of < 0.001, while the difference between group A and C was also highly significant with a p-value of < 0.001, while the difference between group B and C was not significant with a p-value of 0.344.

The one-way Anova is relevant for the comparison of relative tissue weight index between the control and experimental groups B and C (< 0.001), as seen in Table 3. The control Group A relative tissue weight index was 0.324 ± 0.013, which was significantly higher when compared with Group B, with a value of 0.306 ± 0.017, and Group C, with the value of 0.250 ± 0.019, respectively (Fig. 2).

Table 4 comparisons reveals that the mean relative tissue weight index differences between group A and C was considerably significant having a p-value of < 0.001, while the difference between group B and C was also highly significant with a p-value of < 0.001, while the difference between group A and B was not significant with a p-value of 0.082.

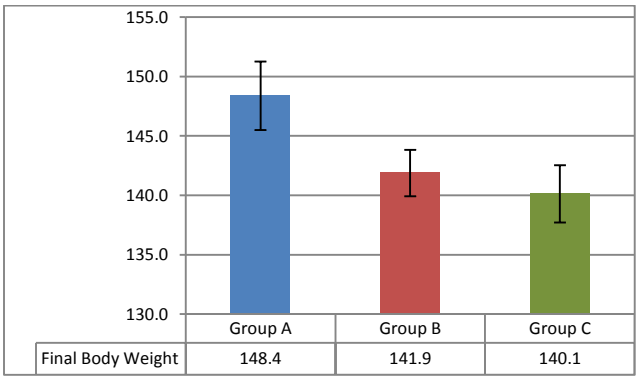

Fig. 1: Bar chart showing comparison of mean final body weight (g) among groups

Table 1: Comparison of initial body weight (g) and final body weight (g) among groups

Parameters	Group A	Group B	Group C	p-value
Initial body weight (gm)	145.3 ± 3.24	145.6 ± 2.07	147.0 ± 2.14	0.366
Final body weight (gm)	148.4 ± 2.88	141.9 ± 1.96	140.1 ± 2.42	< 0.001

*One way ANOVA
*p value ≤ 0.05 is considered statistically significant

Table 2: Pair wise comparison of mean final body weight (g) among groups

Group	Group	Mean Difference	Std. Error	p-value
A	B	6.5000*	1.2229	< 0.001
	C	8.2500*	1.2229	< 0.001
B	C	1.7500	1.2229	0.344

*p value ≤ 0.05 is considered statistically significant

Table 3: Comparison of relative tissue weight index among group

Parameters	Group A	Group B	Group C	p-value#
Relative tissue weight index	0.324 ± 0.013	0.306 ± 0.017	0.250 ± 0.019	< 0.001*

#One way ANOVA
*p value ≤ 0.05 is considered statistically significant

Table 4: Pair wise comparison of relative tissue weight index among groups

Group	Group	Mean Difference	Std. Error	p-value
A	B	0.0187	0.0082	0.082
	C	0.0739	0.0082	< 0.001*
B	C	0.0552	0.0082	< 0.001*

*p value ≤ 0.05 is considered statistically significant

Table 5 shows that there was no cellular vacuolization in control group A. In group B (given sub toxic dose of Garcinia cambogia), cellular vacuolization was present in prostatic acini of 6

Albino rats (75.0%) while in group C (given toxic dose of GC), all 8 Albino rats (100%) had shown cellular vacuolization (Table. 5; Fig. 3).

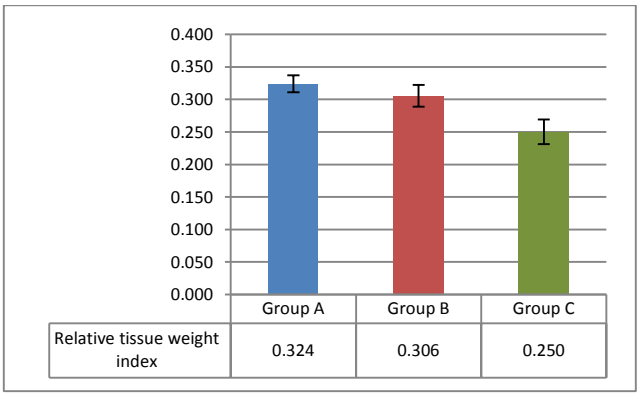

Fig. 2: Bar chart showing comparison of mean relative tissue weight index among groups

Table 6 reveals that one-way ANOVA is relevant for the comparison of Testosterone levels between the control and experimental groups B and C (< 0.001). The testosterone level of group C (given a toxic dose of GC) was 6.65 ± 0.12 ng/ml, which was higher reasonably when compared with Control group A (6.26 ± 0.16 ng/ml) and group B (6.46 ± 0.16) provided with sub toxic dose of GC (Fig 4). Similarly, the testosterone level (ng/ml) between group B and C showed a significant difference.

Table 7 comparisons reveal that the Testosterone level differences between group A and C were exceptionally

Table 5: Distribution of Cellular vacuolization among groups

Vacuolization	Group A n (%)	Group B n (%)	Group C n (%)	p-value
Absent	8 (100.0%)	2 (25.0%)	0 (0.0%)	< 0.001*
Present	0 (0.0%)	6 (75.0%)	8 (100.0%)	

Fisher's exact test
*p value ≤ 0.05 is considered statistically significant

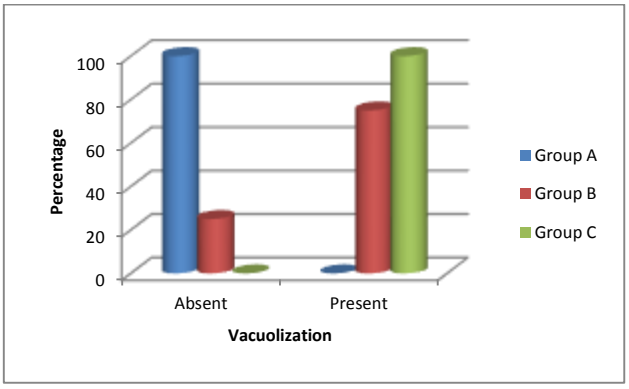

Fig. 3: Bar chart showing distribution of vacuolization among groups

Table 6: Comparison of Testosterone level (ng/ml) among groups:

Parameters	Group A	Group B	Group C	p-value#
Testosterone level (ng/ml)	6.26 ± 0.16	6.46 ± 0.16	6.65 ± 0.12	< 0.001*

One-way ANOVA
*p value ≤ 0.05 is considered statistically significant

Table 7: Pairwise comparison of Testosterone level (ng/ml) among groups

Group	Group	Mean Difference	Std. Error	p-value
A	B	0.2063*	0.0749	0.031
	C	0.3937*	0.0749	0.000
B	C	0.1875	0.0749	0.052

*p value ≤ 0.05 is considered statistically significant

significant having a p-value of < 0.000, while the difference between group A and B was also highly significant with a p-value of < 0.031, while the difference between group B and C was also significant with a p-value of 0.052.

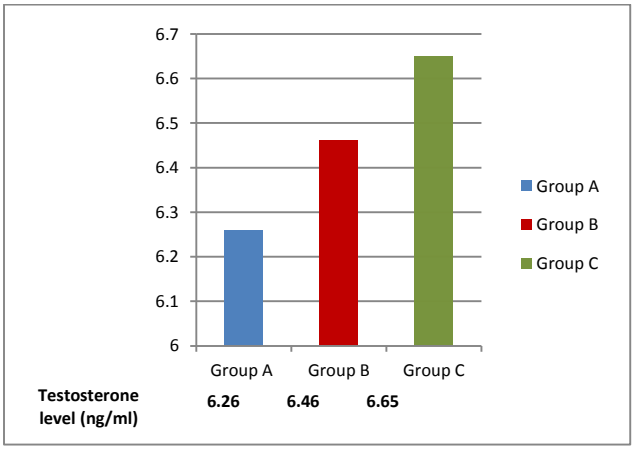

Fig. 4: Bar chart showing comparison of Testosterone level (ng/ml) among groups.

DISCUSSION

A remarkable weight loss in Garcinia cambogia administered group B & C statistically explained that hydroxycitric acid (HCA) competitively impedes the actions of ATP citrate lyase. HCA's inhibitory activity decreases the aggregates of acetyl-CoA, which lowers malonyl-CoA concentration and thus prevents the body from storing fat[13]. By enhancing the production of serotonin—a neurotransmitter that regulates appetite control and eating behaviour—HCA also reduces the feeling of hunger[14]. The findings were consistent with research by Gogoi et al.[13], who found that feeding albino Wistar rats lipogenic diets together with HCA remarkably decreases food consumption, weight gain, epididymal fat, the feed efficiency ratio, and serum triglyceride levels. The specific outcome of HCA intake was the decreased appetite in HCA-fed rats[15].

In another study conducted by Semwal et al. (2015), it was found that in rats fed an atherogenic diet, administration of Garcinia cambogia led to increased serum non-esterified fatty acid levels, thereby showing its anti-obesity activities. They concluded that serum non-esterified fatty acid concentrations are elevated when Garcinia cambogia is administered at higher doses. This probably occurs because of enhanced degradation of fats[16].

Marked loss in weight and reduction in visceral fat, fatty tissue, total cholesterol, and glycemic profile were observed when albino rats were administered 200 milligrams of HCA per kilogram per day for 8 weeks[17]. This might be due to the regulation of serotonin levels by HCA, which correlates with increased fat oxidation, enhanced satiety, and reduced gluconeogenesis [10]. A study performed by Mathapati et al. (2022) showed significant differences in body weights between healthy controls and HCA-treated groups after 60 days of treatment with Garcinia cambogia[18,19].

A study performed by Mirani in 2020 had similar results, documenting cellular vacuolization (the process of forming vacuoles inside or adjacent to cells) as an indicator of cellular injury among the subtoxic and toxic dose groups treated with Garcinia cambogia. Crescioli et al. (2018) investigated that herbal products containing Garcinia cambogia induced liver injury and reported that the release of inflammatory markers, for example, TNF-α (tumor necrosis factor-α) and MCP-1 (monocyte chemoattractant protein-1), leads to impaired liver functions. They elaborated that the underlying mechanism of Garcinia cambogia-induced hepatocellular injury is the excessive production of

reactive oxygen species due to lipid peroxidation and raised mRNA levels of oxidative stress-related genes[20,21].

The research study further revealed that rats treated with Garcinia cambogia showed an increase in serum testosterone levels as a result of the biflavonoid and xanthone present in Garcinia cambogia[22]. These compounds are potent antioxidants capable of increasing testosterone production, a key hormone involved in the production and maturation of spermatozoa in the seminiferous tubules of the testis[23]. Another study proved that Garcinia cambogia contains an antioxidant, Garcinia hydroxybiflavanonol (GB1), which has the potential to improve the reproductive hormone profile and cytoarchitecture of male rats with testicular histopathology[1]. An animal study on rats reported that kolaviron, a bioflavonoid complex from Garcinia cambogia, decreased prostate weights compared with the normal control and reversed the histoarchitecture of the prostates of BPH rats[8]. Results were similar to those of a study by Erukainure et al.(2021), which revealed that Garcinia cambogia caused an increase in sperm count, motility, luteinizing hormone levels, testosterone levels, and antioxidant enzyme activities[25].

CONCLUSION

Garcinia cambogia extract has been proven to be an antiobesity agent by reducing food intake and lipogenesis and increasing fat oxidation. The prevalence of obesity can be controlled by the use of a normal dose of Garcinia cambogia, and the diseases such as diabetes, hypertension, cardiovascular disease, fatty liver, osteoarthritis, and mental health issues, which are associated with obesity, can be reduced, and the major public health issues can be resolved. As Garcinia cambogia extract possesses anti-inflammatory, anticancer, and strong antioxidant properties, it can improve the patients of prostatic hypertrophy by reversing oxidative stress and oxidative DNA damage. Although Garcinia cambogia extract has been used in conventional medicine for a long time but well well-controlled human and animal studies are still needed to appraise its reliability and effectiveness.

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