www.toxicologydigest.org.ng

Njar et al., Toxicology Digest Vol. 5 (1): 57- 67 (2026)

Toxicology Digest

Anti-androgenic and Anti-inflammatory Effects of *Corchorus Olitorius* Leaf Extract in Testosterone-Induced Benign Prostatic Hyperplasia: Biochemical and GC-MS Analysis

Precious Asu Njar[1], **Victor Eshu Okpashi**[1] , Bayim P-R. Bayim[1], Tabe Ntui Ntui[2], Jerome Gbang Okputu[3], Michael Mayehm Mbom[1]

[1] Department of Biochemistry, University of Cross River State, Calabar, Nigeria
[2] Department of Industrial Chemistry, University of Cross River State, Calabar, Nigeria
[3]Department of Medical Biochemistry, University of Calabar, Nigeria

DOI: https://doi.org/10.71637/toxicologydigest.vol5no1.52

Correspondence: *vic2reshu@gmail.com*

Abstract

Background: Benign prostatic hyperplasia (BPH) is an androgen-dependent disorder characterized by progressive prostate enlargement, inflammatory activation, and altered androgen metabolism. Although 5-alpha reductase inhibitors are effective, long-term therapy may be associated with adverse effects, prompting interest in plant-based alternatives. **Objective:** This study evaluated the effects of the methanol leaf extract of *Corchorus olitorius* on testosterone-induced BPH in adult male Wistar rats and identified its bioactive constituents using gas chromatography-mass spectrometry (GC-MS). **Methods:** Twenty-five male Wistar rats were divided into five groups: Normal Control (NC), BPH-induced untreated (TP), Finasteride-treated (TPF), and extract-treated groups receiving *C. olitorius* leaf extract at 100 mg/kg (E100) and 400 mg/kg (E400). BPH was induced using testosterone propionate (5 mg/kg subcutaneously for 21 days). Serum testosterone, dihydrotestosterone (DHT), prostate-specific antigen (PSA), 5-alpha reductase, and interleukin-6 (IL-6) were quantified using enzyme-linked immunosorbent assay. The prostatic index was calculated. Statistical analysis employed ANOVA at $p < 0.05$. **Results:** Testosterone induction significantly increased prostate weight, prostatic index (178.5%), DHT, PSA, 5-alpha reductase, and IL-6, while reducing serum testosterone ($p < 0.05$). Treatment with *C. olitorius* extract significantly restored testosterone (1.21 ± 0.02 ng/mL at 400 mg/kg) and reduced DHT (48.38 ± 4.16 pg/mL), PSA (5.57 ± 0.20 pg/mL), 5-alpha reductase (0.24 ± 0.01 pg/mL), and IL-6 (197.99 ± 15.23 pg/mL). GC-MS analysis identified phytosterols, terpenoids, and unsaturated fatty acids, including β-sitosterol, stigmasterol, phytol, oleic acid, and linoleic acid. **Conclusions:** *Corchorus olitorius* leaf extract attenuates testosterone-induced BPH by modulating androgenic and inflammatory pathways and suggests potential as a complementary phytotherapeutic candidate.

Keywords: Prostate, Dihydrotestosterone, Prostate-specific antigen, 5-alpha reductase, *Corchorus olitorius*, Phytomedicine.

Date Received: 27/03/2026
Date Accepted: 25/05/2026
Date Published:06/07/2026

INTRODUCTION

Benign prostatic hyperplasia (BPH) represents one of the most common urological conditions affecting ageing men worldwide, with histological evidence present in approximately 50% of men by age 50 and increasing to 80% by age 80 (Roehrborn *et al*., 2018). This androgen-dependent disorder is characterised by non-malignant proliferation of stromal and epithelial cells within the prostate transition zone, resulting in progressive glandular enlargement and lower urinary tract symptoms that significantly impair quality of life. The pathogenesis of BPH is fundamentally linked to androgen metabolism. Testosterone, the primary circulating androgen, undergoes irreversible conversion to dihydrotestosterone (DHT) by the enzyme 5-alpha reductase (Khvostova *et al.,* 2014). DHT possesses approximately five-fold greater affinity for androgen receptors compared to testosterone, thereby amplifying androgenic signalling that drives cellular proliferation (Nicholson & Ricke, 2011). Beyond androgenic stimulation, emerging evidence implicates chronic inflammation as a critical contributor to BPH progression. Inflammatory mediators, particularly interleukin-6 (IL-6), promote stromal proliferation, extracellular matrix deposition, and fibrosis, creating a self-perpetuating cycle of tissue remodelling and hyperplasia (Oseni *et al*., 2023).

Current pharmacological management of BPH includes 5-alpha reductase inhibitors such as finasteride, which effectively reduce DHT synthesis and prostate size (Zolotukhin *et al*., 2022). However, prolonged administration of these agents may be associated with adverse effects, including decreased libido, erectile dysfunction, and psychological disturbances (Ganzer *et al.,* 2015). These limitations, coupled with the chronic nature of BPH requiring long-term therapeutic intervention, have stimulated interest in phytotherapeutic alternatives with favourable safety profiles. *Corchorus olitorius*, commonly known as jute mallow or "*ewedu*" in West Africa, is a leafy vegetable traditionally consumed for its nutritional and medicinal properties. The plant is rich in phytosterols, terpenoids, and unsaturated fatty acids with documented antioxidant, anti-inflammatory, and anti-androgenic activities (Islam, 2013). Despite its widespread traditional use, the potential role of *C. olitorius* in BPH management remains inadequately investigated, while *Corchorus olitorius* is traditionally used for various urological and inflammatory conditions; no controlled preclinical or clinical studies have systematically evaluated its specific anti-proliferative, anti-androgenic, or anti-inflammatory effects on benign prostatic hyperplasia (BPH). Key gaps include a lack of mechanistic insights into its action on prostatic tissues, the absence of standardised bioactive markers for BPH, and zero randomised trials assessing its safety and efficacy in BPH patients. Therefore, this study was designed to evaluate the effects of the methanol leaf extract of *Corchorus olitorius* on testosterone-induced BPH in adult male Wistar rats and to identify its bioactive constituents using gas chromatography-mass spectrometry (GC-MS) analysis.

METHODOLOGY

Plant Collection and Extraction: Fresh leaves of *Corchorus olitorius* were collected from Ikom Local Government Area, Cross River State, Nigeria, in March 2023. The plant material was authenticated by a botanist in the Department of Plant Science and Biotechnology, University of Cross River State, where a voucher specimen was deposited for reference. The leaves were washed, shade-dried at ambient temperature (25 ± 2°C) for fourteen days, and subsequently pulverised using an electric grinder. The powdered material (500g) was subjected to cold maceration in 2.5 L of absolute methanol for 72 hours with occasional stirring. The mixture was filtered through Whatman No. 1 filter paper, and the filtrate was concentrated using a rotary evaporator at 45°C under reduced pressure. The resulting crude extract yield of 46% was stored in an airtight container at 4°C until further use.

Ethical Approval: All experimental procedures involving animals were approved by the University of Cross River State Research Ethics Committee with UCRE2314, and conducted in accordance with internationally accepted guidelines for the care and use of laboratory animals.

Experimental Animals: Twenty-five adult male Wistar rats weighing between 150 and 200 g were obtained from the Ogoja Local Government Area of Cross River State, Nigeria. The animals were transported to the Animal House Facility of the University of Cross River State, where they were

housed in standard polypropylene cages under controlled environmental conditions (12-hour light/dark cycle, temperature 25 ± 2°C, relative humidity 55-60%). All animals had *ad libitum* access to commercial pelletized feed and clean drinking water throughout the experimental period. The rats were acclimatised for ten days before the commencement of the study to allow for adaptation to the laboratory environment.

Induction of Benign Prostatic Hyperplasia: Benign prostatic hyperplasia was induced by subcutaneous injection of testosterone propionate (5 mg/kg body weight) dissolved in olive oil as a vehicle. Injections were administered in the inguinal region once daily for twenty-one consecutive days. Successful induction of BPH was confirmed after 21 days by measuring serum prostate-specific antigen (PSA) levels and calculating the prostatic index in selected animals, as described by Arene *et al.* (2022). Prostate weight was measured to determine the onset of BPH. The administration of testosterone propionate (TP) is recognised as a standard approach for inducing BPH in a rat model, as the introduction of exogenous androgens is essential for promoting prostate growth and development. Prostate weight serves as a standard, measurable, and highly sensitive primary endpoint for assessing the onset and severity of BPH (Park *et al*., 2023). This is attributed to the direct and proportional relationship between androgen levels and prostate enlargement.

Experimental Design and Grouping: The study duration spanned 47 days, comprising 10 days of acclimatisation, 21 days of BPH induction, 2 days for confirmation of prostatic enlargement, and 14 days of treatment administration. Following confirmation of BPH induction, animals were randomly assigned to five experimental groups (n = 5 per group) based on their average body weights:

Group I (Normal Control): Received no testosterone propionate and no extract; administered vehicle only.

Group II (BPH Control): Received testosterone propionate only (5 mg/kg/day) for 21 days, followed by no treatment.

Group III (Positive Control): Received testosterone propionate (5 mg/kg/day) followed by finasteride (5 mg/kg/day) orally for 14 days.

Group IV (Extract Low Dose): Received testosterone propionate (5 mg/kg/day) followed by C. olitorius leaf extract (100 mg/kg/day) orally for 14 days.

Group V (Extract High Dose): Received testosterone propionate (5 mg/kg/day) followed by *C. olitorius* leaf extract (400 mg/kg/day) orally for 14 days.

All treatments were administered via oral gavage once daily between 8:00 and 9:00 AM throughout the treatment period.

Blood Sample Collection: Blood samples were collected at two time points: following confirmation of BPH induction and at the end of the experimental period after treatment. Animals were fasted overnight before blood collection and anaesthetised using ketamine hydrochloride (50 mg/kg body weight) administered intraperitoneally. Blood samples were obtained via cardiac puncture using sterile syringes and needles, transferred into plain sample bottles, and allowed to clot at room temperature for 30 minutes. Serum was separated by centrifugation at 3,000 rpm for 15 minutes, carefully aspirated into labelled Eppendorf tubes, and stored at -20°C until biochemical analysis. However, pre-treatment blood was obtained via the tail vein.

Prostate Gland Collection and Prostatic Index Determination: Following blood collection, animals were euthanised by cervical dislocation under deep anaesthesia. The prostate glands were carefully dissected, freed from adherent connective tissue and fat, and immediately weighed using a digital analytical balance. The prostatic index was calculated according to the following formula:

$$Prostate\ Index\ (PI) = \frac{\text{Prostate weight} \times 100}{\text{Body weight}}$$

$$Percentage\ increase = Mean\ PI\ of\ Induced\ Group - \text{Mean PI of Normal Control Group} \times 100$$

Biochemical Analysis: Serum concentrations of testosterone, dihydrotestosterone (DHT), prostate-specific antigen (PSA), 5-alpha reductase, and interleukin-6 (IL-6) were quantified using enzyme-linked immunosorbent assay (ELISA) kits obtained from Elabscience Biotechnology Inc., USA. All assays were performed according to the

manufacturer's protocols using an automated ELISA plate reader. Samples were analysed in duplicate, and the mean values were recorded.

Gas Chromatography-Mass Spectrometry Analysis: The methanol extract of *Corchorus olitorius* leaves was subjected to GC-MS analysis for identification of bioactive constituents. Analysis was performed using an Agilent Technologies 7890B Gas Chromatograph coupled with a 5977A Mass Selective Detector. The system was equipped with an HP-5MS capillary column (30 m × 0.25 mm inner diameter, 0.25 µm film thickness). Helium served as carrier gas at a constant flow rate of 1.0 mL/min. The injector temperature was maintained at 250°C with an injection volume of 1.0 µL in splitless mode. The oven temperature program was initially set at 50°C for 2 minutes, increased to 150°C at 10°C/min, then to 280°C at 5°C/min, and finally held at 280°C for 10 minutes. Mass spectra were recorded at 70 eV ionisation energy over the mass range of 50-550 m/z. Identification of compounds was achieved by comparing mass spectra with the National Institute of Standards and Technology (NIST) library database.

Statistical Analysis:

Statistical analysis was performed using SPSS version 27.0 for Windows (IBM Corporation, USA). Results were expressed as mean ± standard deviation. Differences between groups were evaluated using one-way analysis of variance (ANOVA) followed by Tukey's post-hoc test for multiple comparisons. Statistical significance was set at $p < 0.05$.

RESULTS

Gas chromatography-mass spectrometry analysis of the methanol extract of *Corchorus olitorius* leaves revealed the presence of thirty distinct phytochemical compounds, as presented in Table 1. Among these, fifteen compounds with documented relevance to BPH management were identified based on their retention times, peak areas, and mass spectral fragmentation patterns.

The chromatographic profile revealed that β-sitosterol constituted the most abundant phytosterol (9.74%), followed by palmitic acid (7.34%), oleic acid (6.97%), stigmasterol (5.89%), and campesterol (5.30%). The extract also contained notable quantities of phytol (3.83%), linoleic acid (4.31%), and various other terpenoids and sterols with documented anti-inflammatory and anti-androgenic properties.

Table 2: Group 1 (Normal control): Average body weight = 289.5 g – the highest among all groups. Group 2 (BPH control): Average body weight = 199.59 g – markedly lower than normal control (approx. 31% reduction). Group 3: 282 g, very close to the normal control, Group 4: 219.5 g, moderately reduced compared to the normal control, but higher than the BPH control. Group 5: 233.8 g, also moderately reduced, though slightly heavier than Group 4. Therefore, BPH induction (Group 2) caused significant body weight loss. Groups 4 and 5 showed partial restoration of body weight toward normal, while Group 3 maintained near-normal body weight. On prostate Weight, Group 1: 1.222 g, baseline physiological prostate weight. Group 2: 2.35 g, nearly double that of the normal control. Group 3: 1.075 g, slightly lower than the normal control. Group 4: 1.2 g – very close to normal control (1.222 g), indicating effective suppression of prostate growth. And Group 5: 1.2 g, identical to Group 4, also near-normal prostate weight. Thus, all treatment groups (3, 4, 5) prevented the excessive prostate enlargement seen in Group 2. Group 3 even achieved a prostate weight slightly below normal. . Group 1 (Normal control): PI = 0.423%, reference value. Group 2 (BPH control): PI = 1.178% – a 178.5% increase relative to normal. Group 3: PI = 0.381%, a 9.9% decrease relative to normal. Group 4: PI = 0.574% – a 29.3% increase relative to normal. While elevated compared to Group 1, this is still far less than the BPH control (1.178%), while Group 5: PI = 0.513%, had 21.3% increase relative to normal. Similar to Group 4, this represents a modest elevation above baseline but is markedly lower than the BPH control.

Table 3 presents a detailed summary of how testosterone-induced benign prostatic hyperplasia (BPH) and subsequent therapeutic interventions altered serum levels of key analytes, including testosterone, dihydrotestosterone (DHT), prostate-specific antigen (PSA), 5-alpha reductase, and the inflammatory cytokine interleukin-6 (IL-6). Among the treatments, finasteride (designated as TPF) proved highly effective in reversing prostatic

Table 1 GC-MS Fingerprint of *Corchorus olitorius* Leaf Extract

Peak No.	RetentionTime, RT (min)	Phytochemical Identified	Area %	Class of Compound	Documented Biological Activities
14	6.014	5-Hydroxymethylfurfural	1.12%	Furfural derivative	Antioxidant
17	8.039	Neophytadiene	0.78%	Diterpene	Anti-inflammatory, antioxidant
18	8.304	6,10,14-trimethyl, 2-Pentadecanone,	1.09%	Ketone	Anti-inflammatory
19	9.123	1-Hexadecanol	2.06%	Fatty alcohol	Antioxidant, antimicrobial
20	9.673	Palmitic acid (Hexadecanoic acid)	7.34%	Saturated fatty acid	Anti-inflammatory, antioxidant
21	10.115	Oleic acid	6.97%	MUFA	Anti-inflammatory, membrane-stabilising
22	10.504	Phytol	3.83%	Diterpene alcohol	Inhibits 5-α reductase, an anti-androgenic antioxidant
23	11.476	Linoleic acid	4.31%	PUFA	Anti-inflammatory, cytokine modulation
24	12.724	Stigmasterol	5.89%	Phytosterol	Anti-proliferative, lipid modulator
25	13.458	β-Sitosterol	9.74%	Phytosterol	Potent 5- α reductase inhibitor
26	14.122	Campesterol	5.30%	Phytosterol	Antioxidant, anti-inflammatory
27	14.771	Squalene	1.97%	Triterpene	Antioxidant, anti-inflammatory
28	15.640	Ergosta-5,22-diene-3-ol	2.38%	Phytosterol	Anti-inflammatory, anti-hyperplastic
29	16.084	Lanosterol	1.63%	Triterpenoid sterol	Anti-edematous, anti-inflammatory
30	16.800	Cycloartenol	1.42%	Triterpenol sterol	Anti-oxidant, anti-proliferative

Table 2 Effects on Body Weight, Prostate Weight, and Prostatic Index

Groups	**Average Weights of Rats (g)**	**Average Weights of Prostate (g)**	**Mean of Prostatic Index (PI)**	**Percentage change in prostatic index relative to normal control**
1	289.5g	1.222g	0.423%	
2	199.59	2.35g	1.178%	178.5% increase
3	282g	1.075g	0.381%	9.9% decrease
4	219.5g	1.2g	0.574%	29.3% increase
5	233.8g	1.2g	0.513%	21.3% increase

Table 3 Serum Testosterone, Dihydrotestosterone (DHT), Prostate-Specific Antigen (PSA), 5-A Reductase, and Interleukin-6 (IL-6) of the Five Experimental Groups

GROUPS	TEST (ng/mL)	DHT (pg/mL)	PSA (pg/mL)	5-α reductase (pg/mL)	IL-6 (pg/mL)
NC	1.29 ±0.01[a]	40.26 ±2.87[a]	1.63 ±0.21[a]	0.21 ±0.01[a]	125.92 ±8.06[a]
TP	0.97 ±0.02[b]	64.68 ±2.58[b]	7.26 ±0.41[b]	0.28 ±0.01[b]	279.62 ±18.78[b]
TPF	1.08 ±0.02[c]	51.25 ±2.08[c]	2.89 ±0.07[c]	0.24 ±0.01[c]	159.49 ±7.61[a,c]
E100	1.14 ±0.01[d]	54.56 ±3.10[c]	6.28 ±0.35[d]	0.25 ±0.01[c]	234.31 ±16.91[c]
E400	1.21 ±0.02[e]	48.38±4.16[a,c]	5.57 ±0.20[d]	0.24 ±0.01[c]	197.99 ±15.23[c]

Values expressed as mean ± SD, n = 5. Different superscript letters (a-e) denote significant differences between groups at $p < 0.05$. NC: Normal Control; TP: BPH Control; TPF: Testosterone + Finasteride; E100: Testosterone + Extract 100 mg/kg; E400: Testosterone + Extract 400 mg/kg

NC: Normal Control; TP: BPH Control (testosterone only); TPF: Testosterone + Finasteride; E100: Testosterone + Extract 100 mg/kg; E400: Testosterone + Extract 400 mg/kg

enlargement. This was reflected in a prostatic index of 0.381%, which not only returned prostate size to near-normal levels but actually fell 9.9% below the value measured in the normal control group. The leaf extract of *Corchorus olitorius* also reduced prostatic enlargement, and its effect was clearly dose-dependent. In animals receiving the low dose (E100), the prostatic index was 0.574%. Although this value remained 35.7% above that of the normal control, it represented a substantial 51.3% reduction relative to the untreated BPH control group. At the high dose (E400), the prostatic index fell further to 0.513% to 21.3% above normal control, but a marked 56.5% lower than the BPH control.

DISCUSSION

The present study investigated the effects of *Corchorus olitorius* leaf extract against testosterone-induced benign prostatic hyperplasia in adult male Wistar rats, with parallel identification of bioactive constituents through GC-MS analysis. The findings demonstrate that this commonly consumed leafy vegetable possesses significant anti-androgenic and anti-inflammatory properties capable of attenuating experimental BPH.

Phytochemical Composition and Bioactive Constituents: Gas chromatography-mass spectrometry analysis revealed that the methanol extract of *Corchorus olitorius* leaves contains a diverse array of phytochemicals with established relevance to BPH management. The predominance of phytosterols, particularly β-sitosterol (9.74%), stigmasterol (5.89%), and campesterol (5.30%), is particularly noteworthy. β-Sitosterol has been extensively documented as a competitive inhibitor of 5-alpha reductase, with clinical studies demonstrating its efficacy in improving urinary symptoms and flow measures in BPH patients (Habib & Wyllie, 2004). The mechanism involves structural similarity to cholesterol, allowing phytosterols to interfere with androgen synthesis and receptor binding. The presence of phytol (3.83%), a diterpene alcohol, adds further therapeutic relevance, as phytol has been shown to inhibit 5-alpha reductase activity and suppress androgen receptor expression in prostatic tissues (Park *et al*., 2025). The unsaturated fatty acids identified, including oleic acid (6.97%) and linoleic acid (4.31%), contribute to anti-inflammatory effects through modulation of cytokine production

and prostaglandin synthesis (Saleem *et al.,* 2012). Neophytadiene (0.78%) and squalene (1.97%) possess antioxidant properties that protect against oxidative stress-induced tissue damage characteristic of BPH progression (Kim *et al*., 2014). The synergistic combination of these compounds likely underlies the therapeutic effects observed in this study.

Serum Testosterone: Testosterone propionate administration (TP) resulted in significantly reduced serum testosterone levels (0.97 ± 0.02 ng/mL) compared to normal controls (1.29 ± 0.01 ng/mL), reflecting feedback suppression of endogenous testosterone production and receptor saturation. Treatment with finasteride (TPF) elevated testosterone to 1.08 ± 0.02 ng/mL. Both extract-treated groups showed further increases, with E100 achieving 1.14 ± 0.01 ng/mL and E400 reaching 1.21 ± 0.02 ng/mL, the latter approaching normal control values. The dose-dependent elevation in testosterone following extract administration suggests effective inhibition of testosterone conversion to DHT.

Dihydrotestosterone: As the primary mediator of androgen-induced prostatic growth, DHT levels were markedly elevated in the BPH control group (64.68 ± 2.58 pg/mL) compared to normal controls (40.26 ± 2.87 pg/mL). Finasteride treatment significantly reduced DHT to 51.25 ± 2.08 pg/mL. The extract-treated groups demonstrated dose-dependent DHT reduction, with E100 achieving 54.56 ± 3.10 pg/mL and E400 attaining 48.38 ± 4.16 pg/mL. Notably, the high-dose extract group showed DHT levels statistically comparable to both normal control and finasteride-treated groups, indicating effective anti-androgenic activity.

Prostate-Specific Antigen: Serum PSA, a sensitive biomarker of prostate epithelial proliferation and inflammation, increased dramatically in the BPH control group (7.26 ± 0.41 pg/mL) relative to normal controls (1.63 ± 0.21 pg/mL). Finasteride treatment substantially reduced PSA to 2.89 ± 0.07 pg/mL. Both extract doses significantly attenuated PSA elevation, with E100 yielding 6.28 ± 0.35 pg/mL and E400 producing 5.57 ± 0.20 pg/mL. The dose-dependent reduction in PSA indicates anti-proliferative activity of the extract.

5-Alpha Reductase: The enzyme responsible for converting testosterone to DHT showed significantly increased activity in the BPH control group (0.28 ± 0.01 pg/mL) compared to normal controls (0.21 ± 0.01 pg/mL). Finasteride treatment reduced 5-alpha reductase levels to 0.24 ± 0.01 pg/mL. Both extract doses produced comparable reductions (E100: 0.25 ± 0.01 pg/mL; E400: 0.24 ± 0.01 pg/mL), with the high-dose group showing levels identical to finasteride treatment. These findings confirm that *C. olitorius* extract contains compounds capable of inhibiting 5-alpha reductase activity.

Interleukin-6: As a key mediator of inflammatory processes in BPH, IL-6 levels were substantially elevated in the BPH control group (279.62 ± 18.78 pg/mL) compared to normal controls (125.92 ± 8.06 pg/mL). Finasteride treatment reduced IL-6 to 159.49 ± 7.61 pg/mL. The extract-treated groups showed significant, dose-dependent reductions in IL-6, with E100 achieving 234.31 ± 16.91 pg/mL and E400 attaining 197.99 ± 15.23 pg/mL. The marked anti-inflammatory effect observed at the higher dose indicates the presence of potent immunomodulatory compounds in the extract.

Anti-Hyperplastic Effects: The successful induction of BPH was evidenced by the 178.5% increase in prostatic index in testosterone-treated animals compared to normal controls. This finding aligns with established BPH models wherein exogenous testosterone provides substrate for 5-alpha reductase-mediated conversion to DHT, resulting in androgen receptor hyperactivation and subsequent epithelial and stromal proliferation (Carson & Rittmaster, 2003). The reduction in body weight observed in the BPH control group may reflect the catabolic effects of chronic androgen overstimulation or inflammatory stress associated with prostatic hyperplasia (Arene *et al*., 2022). Treatment with *Corchorus olitorius* extract produced dose-dependent attenuation of prostatic enlargement, with the high-dose (400 mg/kg) group showing a 56.5% reduction in prostatic index

relative to untreated BPH animals. Although complete normalisation was not achieved, the magnitude of reduction approaches that of finasteride, the standard pharmaceutical drug used for comparison. The dose-responsive pattern suggests that higher concentrations of bioactive compounds, particularly phytosterols, exert correspondingly greater inhibition of androgen-mediated growth signals. These observations are consistent with reports that phytosterol-rich plant extracts reduce prostate weight in experimental BPH models through competitive inhibition of 5-alpha reductase and downregulation of androgen receptor expression (Mbaveng *et al.,* 2020).

Modulation of Androgenic Markers: The androgenic pathway in BPH centres on the conversion of testosterone to the more potent DHT by 5-alpha reductase, with subsequent activation of genes promoting cellular proliferation. In the present study, testosterone administration resulted in the expected reduction in serum testosterone (reflecting feedback inhibition and receptor saturation) coupled with elevated DHT levels. The observation that *C. olitorius* extract restored testosterone toward normal levels while simultaneously reducing DHT provides compelling evidence of 5-alpha reductase inhibition. The high-dose extract group achieved DHT levels (48.38 ± 4.16 pg/mL) statistically comparable to both normal control and finasteride-treated groups, which indicates potential for anti-androgenic activity. This effect is attributable primarily to β-sitosterol and other phytosterols identified in the extract, which compete with testosterone for the active site of 5-alpha reductase (Habib & Wyllie, 2004). Phytol may contribute additionally through transcriptional regulation of enzyme expression (Park *et al.,* 2025). The preservation of serum testosterone, rather than its suppression, represents a potential advantage over synthetic 5-alpha reductase inhibitors, which can reduce circulating testosterone through feedback mechanisms. Prostate-specific antigen, a kallikrein-related protease produced by prostate epithelial cells, serves as a sensitive biomarker of prostate epithelial activity and inflammation. The marked elevation in PSA following testosterone induction reflects both increased epithelial cell mass and heightened secretory activity per cell. The dose-dependent reduction in PSA observed with extract treatment indicates suppression of epithelial proliferation and function. The persistence of PSA levels above normal despite treatment suggests that while extract therapy attenuates hyperplasia, it does not completely abrogate epithelial activity, a finding consistent with the residual elevation in prostatic index.

Anti-Inflammatory Activity: Chronic inflammation is recognised as a critical component of BPH pathogenesis, with inflammatory infiltrates present in the majority of surgical specimens from BPH patients (Oseni et al., 2023). Inflammatory mediators, particularly IL-6, promote stromal cell proliferation, extracellular matrix deposition, and fibrotic remodelling, creating an environment conducive to progressive glandular enlargement. The elevated IL-6 levels observed in testosterone-treated animals (279.62 ± 18.78 pg/mL) confirm inflammatory activation as a component of this experimental model. Treatment with *Corchorus olitorius* extract significantly reduced IL-6 in a dose-dependent manner, with the high-dose group achieving a 29.2% reduction relative to untreated BPH animals. This anti-inflammatory effect likely reflects the combined action of multiple extract constituents. Linoleic acid modulates inflammatory signalling through peroxisome proliferator-activated receptor (PPAR) activation and nuclear factor-kappa B (NF-κB) inhibition (Saleem *et al.,* 2012). Neophytadiene and squalene possess antioxidant properties that reduce oxidative stress-triggered inflammatory cascades (Kim *et al*., 2014). Phytosterols, including β-sitosterol and stigmasterol, have been shown to suppress pro-inflammatory cytokine production in various experimental models (Chakraborty & Bandyopadhyay, 2016). The reduction in IL-6 correlates with improved prostate weight parameters, supporting the concept that anti-inflammatory activity contributes to the overall therapeutic effect. This dual action on androgenic and inflammatory pathways distinguishes phytotherapeutic approaches from conventional

single-target agents and may offer advantages in addressing the multifactorial nature of BPH.

Comparison with Standard Therapy: Finasteride, a competitive inhibitor of type II 5-alpha reductase, served as the positive control in this study. As expected, finasteride effectively reduced prostate weight, prostatic index, DHT, PSA, and 5-alpha reductase activity while modestly elevating serum testosterone. The 400 mg/kg dose of *C. olitorius* extract produced effects comparable to finasteride on several parameters, including DHT reduction and 5-alpha reductase inhibition, while demonstrating superior testosterone preservation. However, finasteride achieved greater PSA reduction than either extract dose, suggesting more complete suppression of epithelial activity. This difference may reflect the higher potency of synthetic inhibitors or the presence of multiple active compounds in the extract with varying mechanisms of action. The clinical significance of this difference requires further investigation, as moderate PSA reduction may be sufficient for symptomatic improvement without complete epithelial suppression.

STUDY LIMITATIONS AND RECOMMENDATION

Several limitations of this study are hereby acknowledged. First, the absence of histopathological examination limits conclusions regarding effects on tissue architecture, stromal-epithelial ratio, and inflammatory infiltrates, which can be taken as further investigation. Second, the relatively small sample size (n = 5 per group) may limit statistical power for detecting subtle differences between treatment groups. Third, the use of a single extract type (methanol) may not capture the full therapeutic potential of aqueous or other solvent extracts that more closely approximate traditional consumption patterns. Fourth, the study duration (14 days of treatment) may be insufficient to assess long-term efficacy or potential toxicity. Therefore, future studies should incorporate histopathological evaluation, extend treatment duration, investigate dose-response relationships across a broader range, and explore combinations with standard therapies. Mechanistic studies examining androgen receptor expression, downstream signalling pathways, and inflammatory mediator profiles would further elucidate the molecular basis of observed effects.

CONCLUSION

The findings of this study demonstrate that the methanol leaf extract of *Corchorus olitorius* demonstrates biochemical evidence suggesting potential therapeutic relevance. These effects are mediated through modulation of androgenic pathways, including inhibition of 5-alpha reductase activity and reduction of dihydrotestosterone concentrations, coupled with anti-inflammatory activity evidenced by decreased interleukin-6 levels. The therapeutic activity is attributable to the diverse array of phytochemicals identified by GC-MS analysis, particularly phytosterols (β-sitosterol, stigmasterol, campesterol), diterpenes (phytol, neophytadiene), and unsaturated fatty acids (oleic acid, linoleic acid). The dose-dependent nature of the observed effects, with the 400 mg/kg dose approaching the efficacy of finasteride on several parameters, supports the therapeutic potential of this commonly consumed vegetable. These findings provide a scientific basis for the traditional use of *Corchorus olitorius* and suggest its potential as a phytotherapeutic alternative or adjunct in the management of benign prostatic hyperplasia. Further studies, including histopathological evaluation and clinical trials, are warranted to translate these experimental observations into clinical applications.

CONFLICT OF INTEREST

The Authors declare no conflict of Interest.

FINANCIAL SUPPORT

This research received no external funding.

REFERENCES

Arene, E., Ajemba, M., Ugo, C., Ojukwu, C., & Anyadike, I. (2022). Anti-inflammatory potentials of aqueous sourpulp extracts on induced benign prostatic hyperplasia in adult

male Wistar rats. *Saudi Journal of Medical and Pharmaceutical Sciences*, 8(8), 397-402.

Azzouni, F., Godoy, A., Li, Y., & Mohler, J. (2012). 5-alpha reductase inhibitors in benign prostatic hyperplasia and prostate cancer. *Clinical Medicine Insights: Reproductive Health*, 6, 1-15.

Carson, C., & Rittmaster, R. (2003). The role of dihydrotestosterone in benign prostatic hyperplasia. *Urology*, 61(4), 2-7.

Chakraborty, S., & Bandyopadhyay, M. (2016). Phytosterols and their anti-inflammatory properties: A review. *Journal of Functional Foods*, 23, 528-539.

Ganzer, C. A., Jacobs, A. R., & Iqbal, F. (2015). Persistent sexual, emotional, and cognitive impairment post-finasteride. *American Journal of Men's Health*, 9(3), 222-228.

Habib, J., & Wyllie, A. H. (2004). Germ cell tumors: The paradigm of successful targeted therapy. *European Journal of Cancer,* 40(5), 633-644.

Islam, M. (2013). Biochemistry, medicinal and food values of jute (*Corchorus capsularis L*. and *C. olitorius L*.) leaf: A review. *International Journal of Science, Technology and Engineering*, 2(11), 35-44.

Khvostova, E. P., Khvostova, E. P., Otpuschennikov, A. A., Pustylnyak, V. O., Pustylnyak, V. O., Gulyaeva, L. F., & Gulyaeva, L. F. (2014). Gene Expression of Androgen Metabolising Enzymes in Benign and Malignant Prostatic Tissues. *Hormone and Metabolic Research*, *47*(2), 119–124. https://doi.org/10.1055/S-0034-1374631

Kim, H. P., Son, K. H., Chang, H. G., & Kang, S. S. (2014). Anti-inflammatory plant flavonoids and cellular action mechanisms. *International Journal of Molecular Sciences*, 15(10), 17269-17290.

Mbaveng, A., Kuete, V., & Efferth, T. (2020). Fatty acids and sterols from medicinal plants: Biological activities and role in disease modulation. *Frontiers in Pharmacology*, 11, 595.

Nicholson, T. M., & Ricke, W. A. (2011). Androgens and estrogens in benign prostatic hyperplasia. *Differentiation*, 82(4-5), 184-199.

Nieschlag, E., Behre, H. M., & Nieschlag, S. (2010). Testosterone: Action, deficiency, substitution, (4th ed.). Cambridge University Press.

Oseni, S., Naar, C., Pavlovic, M., Asghar, W., Hartman, J., Fields, G., Esiobu, N., & Kumi-Diaka, J. (2023). The molecular basis and clinical consequences of chronic inflammation in prostatic diseases: Prostatitis, benign prostatic hyperplasia, and prostate cancer. *Cancers*, 15(12), 3110.

Park S, Hwang YH, Baek EB, Hong EJ, Won YS, Kwun HJ (2023). Inhibitory effects of Hydrocotyle ramiflora on testosterone-induced benign prostatic hyperplasia in rats. *Int Urol Nephrol.* **55**(1):17-28. doi: 10.1007/s11255-022-03362-7.

Park, S., Lee, H., Kim, Y., & Choi, Y. (2025). Protective effects of plant-derived phytochemicals on testosterone-induced benign prostatic hyperplasia through anti-inflammatory and anti-proliferative mechanisms. *Pharmacy*, 92(1), 13.

Roehrborn, C. G., McConnell, J. D., & Barry, M. J. (2018). Medical treatment of benign prostatic hyperplasia. *European Urology*, 73(3), 381-391.

Saleem, M., Adhami, V. M., Zhong, W., Longley, B. J., Lin, C. Y., Dickson, R. B., Reagan-Shaw, S., Jarrard, D. F., & Mukhtar, H. (2012). A novel dietary fatty acid prevents prostate tumorigenesis. *Cancer Prevention Research*, 5(1), 18-27.

Wang, Z., Wu, Y., & Wang, Y. (2017). Fibroblast growth factors in benign prostatic hyperplasia. *Prostate Cancer and Prostatic Diseases*, 20(3), 313-317.

Wang, Z., Wang, K., Ong, H., Lee, C., & Jonathan, P. (2023). 5-alpha reductase inhibitors and prostate management: Implications for prostate size and clinical ambiguity. *BMC Urology*, 23, 16.

Zolotukhin, O. V., Esin, A., & Madykin, Yu. Yu. (2022). Pathogenetic justification of the use of 5-alpha reductase inhibitors in the treatment of benign prostatic hyperplasia. *Experimental and Clinical Urology, 15*(3), 94–101. https://doi.org/10.29188/2222-8543-2022-15-3-94-101