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Protective Effects of Aqueous Extract of *Ocimum gratissimum* on Prostate Functions in Hormonal Induced Enlarged Prostate in Adult Rats

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Authors' contributions

This work was carried out in collaboration between all authors. Author UMN designed the study, performed the statistical analysis, wrote the protocol, and wrote the first draft of the manuscript. Authors OPN and EMU managed the analyses of the study. Author EMA managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Background: Benign prostatic hyperplasia (BPH) is a histological disease characterised by an increased number of epithelial cells and stromal cells within the prostate gland. We investigated the effect of aqueous leaf extract of *Ocimum gratissimum* on BPH induced animal model.
Methods: BPH was induced in male rats weighing 250-350 g through exogenous administration of testosterone and estradiol. A total of 30 rats were divided into five groups. One group was used as a control, and the other groups received subcutaneous injections of the two hormones. Groups 1 to 2 were treated orally with different doses of extract and group 3 received finasteride, group 4 was left

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untreated, and group 5 served as normal control. After forty-five days of treatment with the extract, the animals were sacrificed blood collected through cardiac puncture for biochemical analysis. The prostate glands were harvested and processed for paraffin embedding and stained with H and E.
Results: Treatment with the extract and finasteride resulted in significant ($P < 0.05$) decrease in prostate-specific antigen (PSA), estradiol and prolactin and testosterone when compared to BPH control. Also, there was a significant increase in the protein content of the prostate gland when compared to BPH control. Prostate weight was significantly ($P < 0.05$) reduced in treated groups compared to BPH control. This was supported by the histological examination of the prostate gland.
Conclusion: Therefore, *Ocimum gratissimum* was effective in reducing PSA, prolactin, testosterone, estradiol and prostate weight induced BPH in a rat model, and may be useful for the clinical treatment of patients with BPH.

Keywords: Estradiol; Ocimum gratissimum; prostate gland; PSA; testosterone.

1. INTRODUCTION

Benign prostatic hyperplasia (BPH) is the result of a gradual overgrowth of the prostate gland, a gland that lies at the base of the bladder and encircles the urethra [1]. The enlarged prostate gland impinges on the urethra, and therefore BPH is generally associated with impairment in urinary function [2]. It is reported that 80% of men aged >80 years suffer from BPH [3,4]. Considering the high incidence of BPH and the effect this condition has on the quality of life, treatment of this disease is a priority for public health [5]. The aetiology of BPH is complicated and remains unclear; however, recent novel observations highlight the key role of ageing [6], hormonal alterations [7], metabolic syndrome [8] and inflammation [9].

At present, pharmacotherapy remains the modality of choice for BPH treatment and may be roughly divided into three groups: α-blockers, 5α -reductase inhibitors and alternative therapies [10]. Pharmaceutical treatments of BPH have been classified as follows: α-1 inhibitors to improve urination; 5-α reductase inhibitors that reduce the prostate gland size [11]. The representative drug, finasteride is 5-α reductase inhibitor used for BPH, but it is associated with a variety of side effects [12].

However, these prescription medications may have adverse side effects, including orthostatic hypotension, decreased libido and ejaculatory or erectile dysfunction [13]. Due to these risks, natural products that appear to have limited adverse events are becoming increasingly important in the treatment of BPH [14]. Previous studies have shown that a number of natural products, including saw palmetto [15], *Sphaeranthus indicus*, *Pygeum africanum* and *Hypoxis rooperi*, possess anti-BPH potential [16].

Studies on *Ganoderma lucidum* by [17] indicated that the plant can be used as a clinically effective medicine for the management of prostatic hyperplasia. Also [18] established that *Urtica dioica* (stinging nettle) can be an effective drug for the management of BPH. *Sphaeranthus indicus* has been proved to have the capacity to attenuate testosterone-induced prostatic hypertrophy in albino rats [19]. Studies by [20] indicated the potential of *Echinops echinatus* in management of BPH by the reduction of blood PSA, testosterone and prostate body weight ratio. General screening studies by [21] demonstrates that 5α-reductase inhibitory activity of certain herbs such as *Ganoderma lucidum*, *Urtica dioica*, *Caesalpinia bonducella*, *Tribulus terrestris*, *Pedalium murex*, *Sphaeranthus indicus*, *Cuscuta reflexa*, *Citrullus colocynthis*, *Benincasa hispida*, *Phyllanthus niruri* and *Echinops echinatus* are useful in the management of androgenic disorders which include BPH.

Ocimum gratissimum of the family *lamiaceae,* popularly known as scent leaf is a perennial plant commonly used as spice [22]. *Ocimum gratissimum* is a plant distinguished for its therapeutic value [23], and generally, the plants of genus *Ocimum* are rich in antioxidant compounds such as phenolic and are much valuable for their curative potentials [24,25]. *In vitro* studies have shown that the aqueous extracts of *Ocimum gratissimum* (OG) inhibit the proliferation of several cancer cell lines, especially prostate adenocarcinoma (PC-3) cells. Therefore, OG leaf extracts may harbor novel cancer-fighting compounds that need to be isolated, purified and characterised [26].

Several studies have indicated the potential of *O. gratissimum* in inhibiting growth of cancer, protecting the body against radiation and can

mop up free radicals [27]. It is has been reported that crude extract of *Ocimum gratissimum* restrains the proliferation, movement, attachment, growth and morphogenesis of cancerous cells of the breast, [28] at the same time others investigations have demonstrated that it suppresses lung cancer multiplication by activation of apoptosis [29]. *Ocimum gratissimum* contain different compounds such as alkaloids, saponins, tannins, anthraquinone, flavonoids, steroids, terpenoids and cardiac glycosides [30] which makes it useful in traditional medication. This study investigated the usefulness of the leaf extract of *Ocimum gratissimum* in the management of the experimentally hormone-induced BPH in Wistar rats. The results will contribute to the search for locally available phytotherapeutic agents that can help in managing this debilitating disease especially in among the poor ones.

2. MATERIALS AND METHODS

2.1 Plant Material

Fresh leaves of *Ocimum gratissimum* was harvested from a garden in Okuku in Yala Local Government of Cross river State, South-South, Nigeria. The plant was identified at the herbarium unit of the Department of Biological Sciences, University of Calabar. Their fresh leaves were washed with clean water and dried under the shade for six days. Their dried leaves were milled using pestle and mortar to get a powder that was used for extraction.

2.1.1 Preparation of extract

The powered sample of *Ocimum gratissimum* 100 g was soaked into 100 ml of distilled water, this was filtered after 48 hours and filtrate was concentrated in hot air oven. The solutions were diluted with corn oil, to produce a solution 100 mg/ml. The administration of extract was totally by gavage. Proper concentrations were administered by the use of oropharyngeal canula and calibrated hypodermic syringe.

2.2 Hormones

Testosterone propionate Brand name: Ricostrone; a product of Greenfield pharma, Jiangsu Co Ltd., China. Estradiol valerate (by Medipharm Ltd., 108-Kotlakhpat industrial Est; Lahore, India. Testosterone propionate (T) and estradiol valerate E_2 (puregynon depot) were used for the induction of prostate gland enlargement at a dose of 400 µg T and 80 µg E_2 [31]. This was administered to the rats for three weeks subcutaneously in the inguinal region after which a few rats were sacrificed and inspected for gross examination of prostate gland enlargement. All Chemicals used in this study were of analytical grade and were obtained from reputable companies.

2.3 Animals

A total of thirty (30) Wistar rats weighing between 250-350 g were obtained from the animal house of the Faculty of Basic Medical Sciences, University of Calabar, Nigeria. The rats were used for the experiment. The rats were acclimatized for two weeks before the experiment commences. The rats were exposed to approximately 12-hour light/dark cycles under humid tropical conditions, given tap water and feed *ad libitum*, and were housed in standard plastic cages (five per cage) throughout the 45-day duration of the study. The animal room was well ventilated with a temperature range of 27-29ºC. The Cross River University of Technology, Calabar, Nigeria, Animal Ethics Committee approved the study before the experiment and certified all experimental protocols.

2.3.1 Induction of BPH

BPH was induced by exogenous administration of testosterone and estradiol in staggered doses (three times a week respectively) for three weeks according to [31] with modification by [32].

2.3.2 Animal grouping and treatment

The animals were divided into five (5) groups each comprised of six (6) male rats. Four groups were induced with BPH which were grouped as group 1 to group 4). Groups 1 and 2 received 50 and 100mg kg^{-1} body weight (bw) of *Ocimum gratissimum* extract; group 3 received finasteride (orthodox drug) at 0.1mg kg^{-1}; all by gavages for forty five days, group 4 was left untreated for forty five days before sacrifice to assess possible reversal of the exogenous induction and group 5 served as normal control. The animals were weighed prior to the commencement of the experiment and subsequently every week till the end of the experiment. The fluid and water intake was taken daily till the end of the experiment.

2.4 Determinations of Biochemical Parameters

After 45 days, the rats were anaesthetized by a brief exposure to trichloromethane vapour and bled by cardiac puncture. The sera were carefully separated and used for the determination of various biochemical analyses. Each rat's carcass was promptly dissected and the prostate glands were carefully excised. Two prostate glands per group were randomly selected and their dorso-lateral lobes were dissected out and immediately processed for histology. The other three prostate glands pre group were freed of external fascias, washed in cold normal saline, blotted with filter paper and weighed on a sensitive balance. Subsequently, they were homogenized in ice-cold normal saline and the homogenates was used for the determination of the protein content of the prostate gland.

2.4.1 Determination of PSA

Serum PSA was determined using ready to use Enzyme Immunoassay commercial manufactured kit by Teco Diagostic Laboratory, USA. The ELISA test is based on the principle of solid phase enzyme linked immunosorbent assay, where the antibody to be measured is incubated with specific antigen coupled to a solid phase [33]. PSA molecule was sandwiched between solid phase (rabbit anti-PSA antibody) and enzyme linked antibodies (monoclonal anti-PSA conjugated to Horse raddish peroxidase). After removing the unbound-labelled antibodies, TMB was added as substrate for the conjugated enzyme to digest resulting into colour complex that is proportional to the concentration of PSA in the serum [34].

2.4.2 Determination of serum prolactin, testosterone and estradiol concentrations

A solid phase enzyme immunoassay (EIA) quantitative method was employed for the determination of the concentration of each hormone in the serum. The prolactin protocol utilizes two antibodies directed against distinct antigenic determinants of the prolactin molecule as described by [35]. The testosterone protocol was based on the method of [36] and involves the competition of testosterone in serum and enzyme-labeled testosterone for binding with anti-testosterone antibody immobilized on the microwell surface. The estradiol protocol also utilizes the competitive binding principle as described by [37].

2.4.3 Determination of protein content of the prostate gland

Cupric ions, in an alkaline medium, interact with protein peptide bonds resulting in the formation of coloured complex. The protein content of the prostate gland was determined using the modified Biuret method of [38]. Briefly, 3.9 ml of deionized water and 4.0 ml of Biuret reagent were added to 0.1ml of the aliquot and allowed for 30 minutes at room temperature to develop. A standard and blank were also prepared by adding 4.0 ml of Biuret reagent and 3.9 ml of deionized water to 0.1ml of standard albumin and water respectively. Subsequently, the absorbance of the test and standard were read against the blank at 540 nm using a UV/VIS spectrophotometer.

2.5 Histological Studies

The prostate gland was washed in 0.9% physiological (normal) saline before it was fixed in 10% formal saline for 48 hours. It was later transferred into 70% alcohol, two changes for two hours each and to 90% alcohol, two changes for two hours each. This was then transferred to absolute alcohol of two changes each for two hours. The tissue was then removed to a mixture of equal volumes of alcohol and xylol, and then transferred to two changes of xylol for two hours each to produce clear tissue. The clear tissue was then transferred to molten paraffin wax of melting point 52°C. The wax was kept at this temperature in a thermostatically controlled bath with two changes of bath at one hour each. The tissue was later embedded in molten paraffin wax and allowed to solidify. The embedded block was trimmed and sections were cut from the block at 5 micron meter each. The tissue was the floated on water bath and mounted in clean albumenized slide. It was allowed to dry in an incubator for 24 hours at 37ºC and was later stained with H and E (hematoxylin and eosin) and was mounted in Canada balsam. Microscopic examinations of the sections were then carried out under a light microscope.

2.6 Statistical Analysis

The experimental data were analysed for statistical significance by one-way analysis of variance and post hoc comparison using the SPSS version. The Independent Samples t test was used to compare the means of two independent groups. All data were reported as

mean ± SD and statistical significance was accepted at $P < 0.05$.

3. RESULTS

3.1 Weekly Body Weight

The effect of oral administration of extract and standard drug (finasteride) on body weight is presented in Table 1. The BPH-control group exhibited a decline in body weight when compared with normal control. The animals showed significant weight loss and reduced appetite after three weeks of BPH induction. The extract and standard drug treated groups showed an increase in body weight when compared with the BPH control group. Administration of extract or standard drug (finasteride) improved the body weight near normal level when compared with normal control. In the untreated group, weight decrease occurred.

3.2 Prostate Gland and Prostate/Body Weight (P/PW)

The average weight of the prostate gland and prostate/body weight were highest in the BPH control group compared with normal control group. Therefore, BPH control group showed significant ($P< 0.05$) increase in prostate gland and prostate/body weight when compared to normal control (Table 1). The extract and standard drug treated groups showed a decrease in prostate gland and prostate/body weight when compared with the BPH-control group. Administration of extract or standard drug (finasteride) reduced the prostate gland and prostate/body weight to near normal.

3.3 Protein Content of the Prostate Gland

The content of protein in the rats' prostate gland was at highest in BPH control group and lowest in the normal control group. There was significant ($P<0.05$) rise in protein content of the prostate in BPH-control group when compared with the value obtained for normal control (Table 1). Treatment of BPH induced groups with extract and standard drug brought a decrease in protein content of the prostate in different groups. Protein content of the prostate gland of all the treated groups was statistically similar to the normal control group.

3.4 Effect of extract on PSA Concentration of BPH-induced Rats

Table 2 showed the plasma PSA concentration in the treated (extract and finasteride) and control groups. There was a significant ($P< 0.05$) elevation of PSA concentration in the BPH control group when compared with the treated groups and normal control.

3.5 Effect of Extract on Testosterone Concentration of BPH-induced Rats

Table 2 showed the plasma testosterone concentrations in the treated (extract and finasteride) BPH induced rats relative to the control groups. In the BPH control group the level of testosterone was significantly ($P< 0.05$) higher when compared with the normal group. However, the hormone level decreased significantly in the treated groups when compared with the BPH control ($P< 0.05$).

3.6 Effect of Extract on Estradiol Concentration of BPH-induced Rats

Table 2 showed the plasma estradiol concentrations in the treated and control groups. In the BPH control group the concentration of estradiol was significantly ($P < 0.05$) higher than the normal control. The hormone level decreased significantly in the treated groups when compared with the BPH control ($P< 0.05$).

3.7 Effect of Extract on Prolactin Concentration of BPH-induced Rats

Table 2 showed the plasma prolactin concentrations in the treated and control groups. In the BPH control group the concentration of prolactin was significantly higher than the normal control. The concentrations of prolactin decreased significantly ($P< 0.05$) in the all the treated groups when compared with the BPH control. The mean concentrations of prolactin was statistically similar ($P< 0.05$) when compared the normal group and each of the treated group.

3.8 Histological Observations of the Effect OG and Finasteride in BPH-Induced Rats

3.8.1 Prostate of BPH-induced rats treated with 50 mg OG

Treatment with the extract showed decreased glandular stroma and large intra-glandular gap. The reduction was slight when compared with the BPH control group. Glandular secretions were seen with some fatty deposits in Fig. 1 (A).

3.8.2 Prostate of BPH induced rats treated with 100 mg OG

Treatment with high dose showed gland degeneration and are covered with flattened epithelial cells and stromal multiplication was rather diminished when compared to the BPH control group (D). Shrinking and loss of tissue and deposits of fats are seen in Fig. 1 (B).

3.8.3 Prostate of BPH induced rats treated with finasteride

Finasteride group in Fig. 1(C). diminished the hyperplasia of epithelial cell, showing a reduction in epithelial cover width when compared with BPH control group. Cells reduced in size but appear normal. The treatment diminished the hyperplasia of the epithelial cell, indicative of diminished epithelial layer thickiness when compared with BPH control group in Fig. 1 (D).

3.8.4 Prostate of BPH-induced rats without treatment

It was observed that an increase in the gland, stroma and epithelial volume with infoldings occurred when compared with the normal control (E). The surroundings of ducts were solidified and almost all the ducts have huge involutions pushing into the lumen. In Fig. 1 (D), hyperplasia is significantly seen in the stroma and glandular epithelium compared to the normal control group.

3.8.5 Prostate of rats of normal rats

The connective tissue linking the acini and the ducts were lean and compacted around the acini and ducts of the glands. The tissues were tightly packed. The epithelium was cube-shaped and normal in size in the tubules and columnar with involutions into the lumen in the oval acini. Within these glands were seen prostatic secretions. The prostate showed the fibromuscular stroma within which was embedded the glandular tissue in Fig. 1(E).

4. DISCUSSION

Many herbal medicines have been used for the treatment of numerous chronic and severe diseases. Plant based therapy is widely given in men with symptomatic BPH in Western Europe, where physicians prescribe herbal products in the same manner as they prescribe drugs. For example, in Italy plant based products are prescribed 5 times more often than a-blocking

Table 1. Effect of extract of OG and finasteride body weight, prostate gland weight and protein content

Group	BW (g)	PW (mg)	P/BW ratio (mg/g)	PC (g/dl)
BPH + 50mg OG	304.40±8.23^{b}	802.00±308.41^{ab}	2.62±0.97^{b}	6.06±0.46^{d}
BPH + 100mg OG	317.80±9.60^{bc}	1010.00±406.50^{b}	3.18±1.28^{b}	5.66±0.42^{cd}
BPH + FINASTERIDE	320.40±8.99^{c}	632.00±234.88^{ab}	1.98±0.75^{ab}	4.89±0.39^{b}
BPH CONTROL	270.40±8.93^{a}	2214.00±275.37^{c}	8.17±0.87^{c}	8.61±0.46^{e}
NORMAL CONTROL	322.20±13.99^{c}	418.00±70.50^{a}	1.30±0.20^{a}	4.24±0.29^{a}

Values are expressed as Mean ± SD. Benign prostate hyperplasia (BPH), Ocimum gratissimum (OG), body weight (BW), prostate weight (PW), prostate/body weight ratio P/BW) and protein content (PC) . Identical superscript (i.e. a) means there is no significant difference between the comparing group P>0.05. Non- identical superscripts (i.e. a, b, c, d, and e) means there is significance between the comparing groups at P < 0.05.

Table 2. Effect of extract of OG and finasteride PSA, testosterone, estradiol and prolactin

Group	PSA (ng/ml)	Testosterone (ng/ml)	Estradiol (ng/ml)	Prolactin (ng/ml)
BPH + 50mg OG	3.97±0.66^{cd}	4.52±0.48^{c}	521.25±1.50^{bc}	6.03±0.45^{a}
BPH + 100mg OG	3.85±0.43^{bcd}	4.50±0.45^{c}	520.71±9.03^{bc}	6.00±0.19^{a}
BPH + FINASTERIDE	2.54±0.39^{a}	3.86±0.34^{ab}	510.27±4.96^{ab}	5.79±0.55^{a}
BPH CONTROL	9.20±0.69^{e}	5.18±0.29^{d}	663.72±22.34^{d}	7.40±0.40^{b}
NORMAL CONTROL	3.79±0.15^{bcd}	3.66±0.56^{a}	499.27±11.06^{a}	5.77±0.10^{a}

Values are expressed as Mean ± SD. Benign prostate hyperplasia (BPH), Ocimum gratissimum (OG). Identical superscript (i.e. a) means there is no significant difference between the comparing group P>0.05. Non- identical superscripts (i.e. a, b, c, d, e) means there is significance between the comparing groups at P < 0.05.

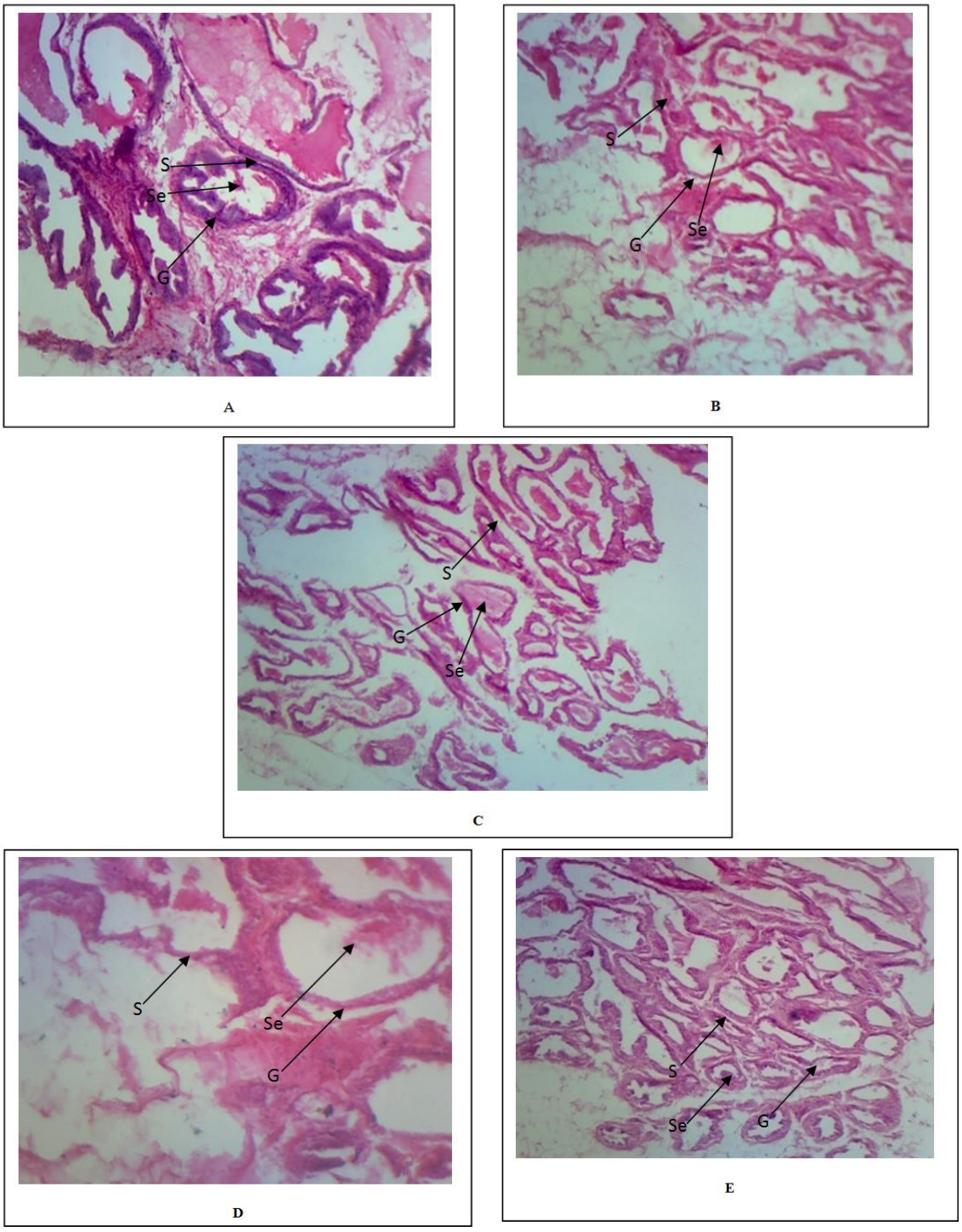

Fig. 1. Histopathological observations of the effect of aqueous extract of *Ocimum gratissimum* on induced prostatic hyperplasia in rats (x200). G, Gland: S, Stroma; Se, Secretion. (A) BPH treated with 50mg OG; (B) BPH treated with 100 mg OG; (C) BPH treated with Finasteride; (D) BPH Control; (E) Normal control

agents or finasteride and in Germany more than 90% of all medications prescribed for symptomatic BPH involve phytotherapy [39]. Traditional medicine is a promising area of research in BPH/LUTS therapy. Although phytotherapy is widely used in most countries, only few plants received scientific or medical trust [40]. This study investigated the effect of administration of leaf extract of *Ocimum gratissimum* on testosterone and estradiol induced enlarged prostate gland in adult rats.

In this study, treatment of BPH with *Ocimum gratissimum* for 45 days significantly inhibited the development of benign prostatic hyperplasia, as evidenced by a reduction in elevated prostate weight and P/PW ratio, serum testosterone, PSA estradiol and prolactin levels in the serum and by histopathological analysis. Similar pattern were recorded by [18,19,20] which showed that extracts of *Sphaeranthus indicus, Urtica dioica* and *Echinops echinatus,* reduced the increase in weight of the prostate gland and P/BW ratio after oral treatment at different doses compared with negative control. Prostatic weight increase is considered as one of the important biomarkers of BPH enlargement [41]. The enlargement of the organ is seen as more of histological diagnosis characterized by proliferation of the cellular elements of the prostate which involves the stromal and epithelial components [42].

The histopathology of the BPH control showed glandular proliferation with extensive stroma and unremarkable fibro-muscular matrix. A contrast was however observed after forty-five days of treatment with *Ocimum gratissimum* /finasteride where extensive shrinkage of glands with marked increase in density of the fibro-muscular matrix was observed. The extract therefore, seems to have effectively attenuated the prostatic hyperplasia. It was also apparent that treatment with the extract/finasteride boosted appetite that was otherwise suppressed during BPH induction. This is in line with some studies which showed that animals with BPH had a significant increase in prostate gland weight compared with normal control animals, whereas those of animals treated with finasteride or others herbal remedies for the management of BPH had significantly reduced the weight compared with BPH animals [43,44]. However, any reduction in the mass of the prostate gland would translate to a reduction in the irritative symptoms of BPH which are usually the most bothersome symptoms [45].

Increase in cell number of the prostate gland would come with a corresponding increase in its weight which will result to increase in the protein content of the tissue [46]. This might explain the observed elevation of protein content in the prostate tissue which reduced with the treatment. The prostate PSA level which was elevated following BPH induction was observed to have decreased markedly after forty-five days of administration of *Ocimum gratissimum* /finasteride. PSA, a glycoprotein found in serum is said to serve as a semi-quantitative indicator of prostatic cancer and also predictor of BPH [47]. However, much remains unknown about the interpretation of PSA levels as it pertains to test's ability to discriminate cancer from benign prostate conditions, and the best course of action following a finding of elevated PSA. PSA level is noted to increase in both benign and malignant lesions of the prostate gland but is usually marked in prostatic cancer [48].

The level of free testosterone in the blood is considered to be pivotal in BPH progression. Testosterone is known to promote the proliferation of prostate cells by the activity of type II 5-α-reductase, an enzyme responsible for the conversion of testosterone to a more potent androgen dihydrotestosterone (DHT) [49,50,51]. It was observed that the animals with BPH experienced elevated testosterone level while those treated for forty-five days with the extract recorded appreciable decrease in the hormonal level. This showed that the extract enhanced the mopping up of free testosterone in the system to prevent its conversion to a more potent DHT by 5-α-reductase found mainly within the stromal cells [52].

Androgens and estrogens significantly influence the development of BPH [53]. Experimental work has also identified age-related increases in estrogen levels that may increase the expression of DHT, the progenitor of BPH [54]. Aromatase, an enzyme which converts testosterone into estrogen, also increases with age in men [55]. BPH risk also increases with age and studies have identified high concentrations of estradiol in cells from hyperplastic prostate glands [56]. In this study there is elevated level of estradiol in the BPH control group and decreased level of it in the extract treated groups.

Prolactin (PRL) has been identified to have expression in rat and human prostate gland epithelium [57], and thus the prostate gland, in analogy with other tissues, can directly process

PRL by posttranslational glycosylation, phosphorylation, or proteolytic cleavage [58] into molecular derivatives, with different cellular targets and biological activities. PRL has been implicated to have effect in regulation of prostate gland development, growth, and differentiation [59]. Previous studies have revealed that the level of locally produced prostatic PRL is regulated by androgens [57]. There is observed significant decrease in level of prolactin in the treated groups when compared to the BPH control which shows significant increase when compared to the normal control and extract treated groups.

Symptom severity in BPH is known to correlate with overall health status such that any agent that can reduce the symptoms of BPH by reducing the mass of the prostate gland is usually useful. *Ocimum gratissimum* exhibited good prophylaxis because it inhibited BPH progression in simultaneous induction with the extract treatment.

5. CONCLUSION

Traditional medicine has remained a pillar component in healthcare systems of resource-poor economies. In this investigation, *Ocimum gratissimum* extract effectively reduced the size of the enlarged prostate gland, serum PSA exogenously induced. These beneficial effects of the extract justified that it can be helpful in the management of BPH and other related cases.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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