International Journal of Medicinal Plants and Natural Products (IJMPNP)
Volume 4, Issue 3, 2018, PP 1-10
ISSN No. (Online) 2454-7999
DOI: http://dx.doi.org/10.20431/2454-7999.0403001
www.arcjournals.org

Physalis angulata Linn. (Solanaceae) Leaf Extract Boosts Fertility, Sperm Production and Haematological Parameters in Swiss Male Albino Rats

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Abstract:

Background Information: *The rate of male infertility owing to low sperm and unhealthy sperm production is increasing especially in developed and developing nations of the world. In Nigeria, it is estimated that one in every five males suffers low sperm count and or abnormal semen resulting in other marital problems. Therefore, the use of herbal formulations and medicinal plants has been made popular among the aforementioned parts of the world due to their low prices, accessibility, beliefs, and easy preparation among others for solving male infertility.*

Aim: *This present study was carried out in order to determine fertility enhancement, high and quality sperm production as well as blood indices enhancement efficacies of Physalis angulata leaf extract in 30 Swiss male albino rats.*

Method: *The leaf methanol extract of P. angulata was administered at doses of 250, 500, 1000 and 2000 mg/kg b.w orally for 28 days. The animals were grouped into 5 groups of 6 rats each denoted as GPI, GPII, GPIII, GPIV and GPV. GPI served as the control which were administered Spermovite Herbal formula™ capsule, GPII- GPV were administered 250, 500, 1000 and 2000 mg/kg body weight (b.w) P. angulata extract (PAE) respectively.*

Results: *Acute toxicity (LD_{50}) of the plant was found to be greater than 2000 mg/kg by OECD method. There were no liver congestion as well as organ abnormalities after 28 days of administering PAE at various doses. Most parameters investigated showed dose-dependent values and compared with the controls at $p<0.05$ (one-way ANOVA).*

Conclusion: *The study showed that P. angulata extract boosts fertility as well as high and quality sperm production in albino rats, thus can be extended to solve infertility and low sperm counts in humans. This plant extract has also been proven to be safe for use as an ethnobotanical oral prescription in tradtional medicine.*

Keywords: *Physalis angulata, Infertility, Sperm boosting, Haematological parameters.*

1. INTRODUCTION

Male infertility refers to the inability of an adolescence male in making his female partner pregnant. It usually depends on the quality of his sperm cells. Male and female infertilities are now a growing problem globally that affects one in every five males, and researchers estimated about one in every three cases is due to fertility problems in the male partner alone [1-2]. The general beliefs are that infertility is not usually treated but can occasionally be improved with healthy diets, herbal supplements, drugs and one's personal lifestyle. Male's infertility can have a plethora of causes, and may be due to genetic make-up, overall health, fitness level, presence of diseases and foods or dietary contaminants. Apart from these, a healthy lifestyle and diet are very important. Some foods and supplements are linked with high fertility advantages than others.

Male infertility factors contribute to about 30 % of all infertility cases, and it accounts for approximately 1/5 of all male infertility cases globally. There are four major causes of infertility and low sperm counts in males, viz: a hypothalamic or pituitary disorder which accounts for 1-2 %, gonad

disorder which accounts for 30-40 %, sperm swimming disorder which accounts for 10-20 %, and other unknown causes which accounts for 40-50 %. In a nutshell, male infertility often occurs due to abnormal sperm, low sperm counts, or ejaculation problem [3-4]. Male sperm can be termed abnormal for two main reasons associated with short life span of the sperm and sluggish movement after ejaculation. It is good to mention that sexual function and semen quality of males may affect fertility in the following areas:

Libido: This is also regarded as sex drive. It describes a man's urge to have sex. Those foods or additives that increase libido are referred to as aphrodisiacs, and natural products researchers have directed their focus on the need to incorporate these in man's daily diets as a measure to conquer problems arising from infertility linked with libido. *Erectile dysfunction*: This is popularly known as impotence. It is a condition when a man is unable to develop or maintain an erection for a long time or at all.

Sperm Count: A low sperm count is medically called *oligospermia*. It a biological or medical term that is used to describe a condition when the sperm count is very low, usually, less than 10 million/mL. *Azoospermia* is a situation where there are no sperm at all in a semen sample. In most cases, treatment options for males with low sperm count vary depending on the cause of the condition [7]. Surgery for example, is the most often treatment options for males suffering from swollen testis. However, many plant extract has been reported to have very promising results in experimental animals [8]. Low sperm count which occurs as result of sexually transmitted infections (STIs) of the urinary and reproductive tracts can be treated with antibiotics in order to clear the infections, but resistance has been reported to be developed by specific bacterium against certain antibiotics making this option futile. Hormonal therapy has also been advocated as a treatment option for low sperm count but this is very costly and results are not achieved as quickly as possible [9-10]. On final note, sperm within the range of 20 - 300 million/mL is considered normal while below 10 million is considered very low or poor. The total volume of sperm in males is usually 2 mL which is the normal value in a sexually active male. When there is a case of lower volume of sperm, it may be due to abnormality in the seminal vesicles, blockage of seminal ducts or excessive coiling of the prostate glands [11-13]. Certain factors such as genetic condition, use of alcohol, tobacco or other drugs, severe mumps infection after puberty, hernia repairs, hormone disorder, exposure to toxic chemicals, radiation, blockage from a previous infection, wearing restrictive or tight underwear, and injury to the groin area, can also cause low sperm count or lack of sperm in males [14-16].

Male sex hormone levels: Low levels of hormones such as testosterone, may be responsible for infertility in some males. Other hormones such as follicle stimulating hormones (FHS), and Luteinizing hormones (LH) also play crucial roles in determining the level of sperm production in males. Most often, semen analysis can be carried out putting into cognizance some of these parameters: *Morphology* : The size and shape of the sperm affect the sperms ability to reach and fertilize an egg. 30 % is considered a good amount of sperm that are shaped normal. *Sperm motility*: This is the movement and number of active sperm cells. This movement is rated from 0-4, where the score over 3 is considered good. The amount of active cells is rated in percentages from 1-100%, with 50 % considered the minimum. For a sperm to be considered healthy, the sperm cell must have the ability to swim after ejaculation. Hence, sperm motility is a measure of the percentage of moving sperm cells in a semen sample. Male infertility can also occur when there are problems with ejaculation[17-18].

Physalis angulata Linn. is an important genus of the Solanaceae family. It is an annual herb growing up to 100 cm tall, with procumbent or prostrate stem, glabrous or with a few short appressed hairs; stems sharply angled, hollow. Leaves arranged spirally, simple; stipules absent; petiole 2–11 cm long; blade ovate to lanceolate, 4–15 cm × 2.5–10 cm, base cuneate, apex obtuse, margin irregularly toothed or entire. Flowers axillary, solitary, erect or nodding, bisexual, regular, 5-merous; pedicel 6–12 mm long, elongated in fruit up to 22 mm; calyx campanulate, 5-lobed, 3–5 mm long, angled or ribbed, in fruit 2–4 cm long; corolla campanulate, 5–10 mm long, pale yellow with or without 5 dark spots; stamens inserted near the base of the corolla tube, filaments 1.5–5 mm long, anthers pale blue; ovary superior, 2-celled, style filiform, stigma head-shaped. Fruit a globose berry 10–16 mm in diameter, yellow, viscid, many-seeded, enclosed in the persistent, inflated bladdery calyx. Seeds kidney-shaped, 1.5–2 mm × 1–1.5 mm. Seedlings with epigeal germination [19].

Most of the species are herbaceous annuals or perennials, native tropical North and South America. Some species have edible fruits and tea make from its roots is considered within popular medicine. The medicinal uses of *Physalis* are numerous: a wide variety of species are used for asthma, urinary problems, rheumatism, and tumors. Their anti-inflammatory and anti spasmodic properties are also known [19]. Also some species of *Physalis* are used in local crafts, ornamental and food, the most common and most important use is in the preparation of sauces [19].

In Nigeria it is called *"Saada biri"* in Hausa language, and in English it referred to as: angular winter cherry, annual ground cherry, balloon cherry, bladder cherry, bush tomato, wild cape gooseberry, and wild cape gooseberry. It is uses in traditional medicine for treating various disease such as: entire plant is for childbirth, diuretic, fever, gonorrhoea, jaundice, liver diseases, malaria, nephritis, postpartum haemorrhage, rashes, skin sores, sleeping sickness, to prevent abortion, tumors. The fruits are recommended for infection, infertility, inflammation, postpartum infection, skin diseases. The leaves are also used for asthma, dermatitis, diuretic, earache, fever, gonorrhoea, haemorrhage, hepatitis, infections, inflammation, liver disorders, malaria, postpartum infection, rheumatism, skin diseases, to prevent abortion, worms (schistosomiasis). The root is used for diabetes, earache, fever, hepatitis, jaundice, liver disorders, malaria and rheumatism [20-23].

Phytochemical analysis of the plant showed that it contains the following metabolites: saponins (buds), flavonoids (leaves and shoots), polyphenols, tannins, and fisalin (fruit), with angulatin A (fruit), palmitic acid and stearate, elaidic acid (Seeds), alkaloids (roots), chlorogenic acid, $C_{27}H_{44}O$-H_2O (stems and leaves), tannins (fruit), cryptoxantin (fruit), and vitamin C and sugar (fruit) [24-26].

This present study was carried out in order to determine fertility boosting potential of *Physalis angulata* in terms of sperm production as well haematological parameters in Swiss male albino rats.

Figure1. *Pictorial view of P. angulata at Takum, Taraba State, Nigeria*

Source: *Ukwubile et al. (2018).*

2. MATERIALS AND METHODS

2.1. Plant Collection and Authentication

Fresh leaves of *Physalis angulata* were collected from a farm settlement in Takum, Taraba State and authenticated by Mr. Sunusi Namadi of the herbarium unit of the Department of Botany, Ahmadu Bello University Zaria, where a voucher specimen number of *ABU 2051* was deposited for the plant.

2.2. Preparation and Extraction of Plant Materials

Leaves of *P. angulata* were air-dried in the shade for two weeks after collection, and were reduced to powdered form using local mortar and pestle. 800 g of powdered leaf was then defatted in 1.5 L pet-

ether before extracting with 2000 mL methanol (Sigma Aldrich) in a Soxhlet extractor for 48 h at 60 ^{o}C. After the extraction, the mixture was filtered using a sieve of size 0.05mm and evaporated to dryness at 65^{o}C using a rotary evaporator. The percentage yield was then calculated, and was stored at 4^{o}C in the refrigerator for future usage [27]. The extract was dissolved in distilled water to give the final concentration of 250 mg /kg, 500 mg /kg, 1000 mg /kg and 2000 mg/kg b.w extract and administered orally by gavaged for the five groups of rats for 28 days.

2.3. Grouping and Induction of Oligospermia in Male Swiss Albino Rats

The method previously described by Mukram *et al*.[28] was used with slight modification. Briefly, thirty Swiss male albino rats were grouped into five groups of six rats per group. Prior to induction, the rats were weighed and grouped as follows: Group I served as the control, Groups II-V were the treatment groups. All rats in each group received 5 mg/kg b.w cyclophosphamide USP (Cytoxan®) orally once daily for seven days before treatment with the control drug and *Physalis angulata* extract (PAE). The groupings for the induction of cyclophosphamide (CP) were as follow:

Group I (control) administered only CP orally,

Group II was administered 5 mg/kg CP then, 250 mg/kg b.w PAE once daily,

Group III was administered 5 mg/kg CP then, 500 mg/kg b.w PAE once daily,

Group IV was administered 5 mg/kg CP then, 1000 mg/kg b.w PAE once daily, and

Group V was administered 5 mg/kg CP then, 2000 mg/kg b.w PAE once daily for 28 days.

At the end of the treatment, the rats were sacrificed and histopathological examination carried out on the testis as well as other vital organs for sub-chronic toxicity studies.

2.4. Treatment and Extract Administration Via Oral Route

Thirty Swiss male albino rats weighing between 150-200 g were maintained under standard environment conditions and fed with standard pellet diet and water *ad libitum*, and allowed to acclimatized in the laboratory for two weeks. After two weeks of acclimatization, they were grouped into five groups of six rats per group as follows:

Group I (control) was administered with Spermovite herbal formula once daily,

Group II was administered with 250 mg/kg b.w of *P. angulata* extract *(*PAE) once daily,

Group III was administered with 500 mg/kg b.w PAE once daily

Group IV was administered with 1000 mg/kg b.w PAE once daily, and

Group V was administered with 2000 mg/kg b.w PAE; orally once daily for 28 days.

Body weights of rats were recorded at the termination of the experiment. After the administration of the last treatment, the animals fasted overnight and then on the next day, they were sacrificed under light ether anaesthesia. Blood samples were collected by heart puncture for determination of testosterone, luteinizing hormone and follicle-stimulating hormone levels as well as blood parameters. The reproductive organs; testes, Epididymis, seminal vesicles and ventral prostate were removed and weighed. The testes were immediately fixed in Bolin's solution for morphometrical study [27].

2.5. Analysis of Haematological Parameters

The following parameters were analysed using automatic analyzer Mindray apparatus BC-3800 made in U.S.A: PCV, MCV, WBC, RBC, HB, Lymphocytes, Monocytes, MCHC, MCH, Platelets, etc, at Sancta Maria Integrated Laboratory (USAID Affiliate), Bali, Nigeria. This was aimed at determining the effects of the methanol extract of *P. angulata* extract on blood parameters of Swiss albino rats.

2.6. Determination of Body Weights for Percentage Weight of Rats

Body weights of experimental animals before and after experiments were measured using

electronic balance, following an overnight fasting. The body weights were used to calculate the daily weight gain by the animals [27].

2.7. Determination of Sex Organ Weights

All the controls and experimental groups of male rats were evaluated for their body weight. The animals were completely anaesthetized with anaesthetic ether (Swipha Pharm Ltd), sacrificed by cervical decapacitation and then testis as well as epididymis were carefully removed through the lower abdominal incision and separated from the epididymis, and then weighed using an electronic balance. The organ weight of each sex organs was determined as described by the protocol reported by [27].

2.8. Semen Collection from the Male Rats

The testicles were then removed through lower abdominal incision and testes were then separated from the epididymis. The right and left epididymis were trimmed off from the testes and semen were collected from the tail of the epididymis through an incision made with a razor blade. Sperm cells were sucked into Pasteur pipette from the caudal epididymis. Incisions were also flushed with 2 drops of 1% buffered sodium citrate kept at 37^{o}C[27] .

2.9. Morphometrical Analysis of Testes

Tissue samples from right testes were excised and processed for paraffin embedding sections. Serial sections with 5µm thickness were stained with haematoxylin and eosin and used for morphometrical studies under a light microscope. For measuring of seminiferous tubules diameter and germinal epithelium height, 90 round cross-sections of seminiferous tubules were randomly chosen in each rat. Then, using an ocular micrometer of light microscopy (Olympus BH, Japan, Tokyo), at a magnification of 40x, two perpendicular diameters of each cross-section of seminiferous tubules were measured and the mean of these was calculated. Also, germinal epithelium height in four equal distance of each cross-section of seminiferous tubules measured and the mean of these was calculated [27].

2.10. Determination of Sperm Morphology

Sperm morphology was also determined using eosin staining method. For this purpose, 10 µL of 1% eosin was added to a test tube containing 40 µL of sperm suspension and were mixed by mild agitation. Then, sperm was incubated at room temperature for 30 min for staining and then re-suspended with a Pasteur pipette. 200 sperm per rat were examined microscopically at 40x magnifications and the number of morphologically abnormal sperm was recorded to give the percent abnormal sperm [27].

2.11. Serum Hormonal Assay

Blood samples were left for 30 min to clot and then centrifuged for 10 min at 1000×g. The obtained clear sera were stored at -80 ^{o}C until testosterone, luteinizing hormone and follicle-stimulating hormone levels were measured by radioimmunoassay [27-29].

2.12. Statistical Analysis

Data were analyzed using SPSS version 22. Statistical analysis was done using analysis of variance (one-way ANOVA) followed by Pearson's correlation test. Data are expressed as mean ± SD at a significance level of $p<0.05$.

3. Results And Discussion

Physalis angulata is popularly known for its medicinal uses in Nigeria and other parts of Africa. This present study examined the effect of *P. angulata* leaf extract on fertility, sperm production and haematological parameters in Swiss male albino rats. From the data obtained, the plant is very safe for use as an ethnobotanical prescription in traditional medicine. This is because, the LD50 by OECD method was greater than 2000 mg/kg body weight (b.w). Histopathological studies on vital organs such as the liver, lung, heart and testis did not show any tissue congestion or necrosis in the animals after 28 days administration of *Physalis angulata* extract (PAE) orally even at the highest doses of 2000 mg/kg b.w.

There were significant increase in weight of the animals and vital organs after 28 days treatment (Table 1-3). Most of the blood parameters increases as the doses increased from 250 mg/kg b.w to

2000 mg/kg b.w PAE (Table 2). This results were compared statistically to the control at $p<0.05$ (one-way ANOVA). The increase in blood parameters suggests that the leaf extract has the potential to increase blood factors resulting in significance increase in the parameters (Table 2). It is possible that *P. angulata* extract contained constituents that helped to stimulate cells in the bone marrow and liver to produce blood, and blood production must have acted along the such receptor cell pathways to induce blood production in the rats. Moreover, it is evident that within the bone marrow, all the blood cells evolved from one type of unspecialized cell known as the stem cell. In the process of blood production, a division by the stem cell would result in the production of an immature RBC, WBC, and platelet-producing cells. Further division by these cells will then results in the formation of mature blood cells.

Therefore, PAE must have triggered an organ like kidney for instance to release erythropoietin, which is a hormone that stimulates the bone marrow to produce more red blood cells especially when oxygen is deficient in tissue [30]. Research has shown that certain conditions in humans may stimulate further production of blood cells. It is possible that the increase seen in most of the haematological parameters may be as result of low oxygen concentration in some of the organs as a result of the long use PAE in rats orally. There are increases in testis and epididymis weights, normal morphology, total sperm counts and serum testosterone and follicle stimulating hormone levels in the rats after 28 days oral administration of PAE. This result was comparable to the control groups treated with Spermovite Herbal capsule at $p<0.05$ (one-way ANOVA).

Thus, PAE has potential to increase sperm production and enhance male fertility in the examined rats *in vivo*. Testosterone hormone has been considered as the structural and metabolic backbone of male's sexually reproductive organs, and it is an essential factor to measure fertility in men. The increase in this hormone level is a good indication that PAE can boost the level of this sexual hormone, thus the plant can correct infertility in male. Testosterone level has also been shown to be directly proportional to the weights of testis and epididymis [30]. It can then be said that, the increase in weights of testis and epididymis was due to increased hormonal biosynthesis in along androgenic metabolic pathway as seen in significant increase in serum testosterone, luteinizing hormone, and follicle stimulating hormone levels in PAE treated groups (Table 4-5; Figure 3). Luteinizing hormone (LH) and follicle stimulating hormone (FSH) help in development, growth and regular functioning of testes and male reproductive glands. This present results were not different from the functions of these hormones in the rats *in vivo*. These increases in sperm producing cells were due to increased angiogenesis and plenty flow of blood to the testis [30].

Our study showed that almost all the fertility, sperm cell and haematological parameters increased in dose-dependent fashion in the treated groups. In addition, sperm count is usually used as a measure for sperm production, testicular viability and male fertility whereas, low sperm count as well as high percentage of abnormal sperm production in animals have been linked with infertility in males. The observed biological activities of *Physalis angulata* leaf extract maybe due to improved testicular oxidation because, the plant extract must have decreased some oxygen reactive species leading to sperm motility, normal sperm morphology, and increase sperm count in the rats. Thus, *P. angulata* leaf extract can boost fertility, sperm production and haematological parameters in Swiss male albino rats by stimulating cells in the animal's body towards production of the determined parameters. The plant extract can thus, be used to treat infertility in males, boost sperm production, and increase blood production in anaemic condition.

Table1. *Organ weight of rats after 28 days administration of PAE orally for toxicity*

		***Physalis angulata* extract animal dose (mg/kg b.w)**			
Organ (g)	**GP I**	**GP II 250**	**GP III 500**	**GP IV 1000**	**GPV 2000**
Heart	0.43±0.01	0.58±0.01	0.62±0.00	0.75±0.00	0.78±0.00
Liver	5.50±0.01	5.60±0.02	5.70±0.01	5.71±0.02	5.78±0.01
Kidney	0.51±0.01	1.20±0.01	1.24±0.01	1.28±0.01	1.33±0.01
Lung	1.13±0.01	1.15±0.01	1.20±0.01	1.27±0.01	1.30±0.01
Testis	1.20±0.01	1.25±0.01	1.28±0.01	1.32±0.01	1.36±0.01

Note: *results are mean ± SD of six rats in each group, $p< 0.05$ (one-way ANOVA).*

Table2. *PAE Effects on Haematological Parameters after 28 days Oral Administration*

		***Physalis angulata* extract group dose (mg/kg b.w)**			
Parameter	**GP I**	**GP II 250**	**GP III 500**	**GP IV 1000**	**GPV 2000**
PCV(%)	55.10±0.01	58.20±0.02	59.31±0.02	59.50±0.01	60.10±0.02
MCV(f/L)	42.60±0.02	43.6±0.02	43.8±0.02	46.60±0.02	49.10±0.02
MCH(pg)	15.10±0.01	15.82±0.10	15.83±0.01	16.40±0.1	16.91±0.01
MCHC(g/dL)	320.00±0.04	320.10±0.04	324.10±0.04	326.10±0.04	329.12±0.04
RBC(x 10^{12}/L)	5.80±0.40	5.78±0.30	5.82±0.40	5.81±0.40	5.24±0.20
RDW(%)	18.5±0.01	18.61±0.01	18.13±0.01	18.20±0.01	18.27±0.01
WBC(x10^{9}/L)	11.6±0.01	9.80±0.01	9.82±0.01	9.83±0.01	10.16±0.01
Hb (g/dL)	10.50±0.04	10.80±0.04	10.20±0.04	10.40±0.01	11.90±0.01
PLT (x 10^{9}/L)	140.30±0.04	141.10±0.04	240.30±0.01	310.25±0.01	354.10±0.01

Note: *results are mean ± SD of six rats per group, p< 0.05 (one-way ANOVA). MCV(mean corpuscular haemoglobin), MCHC(mean corpuscular haemoglobin concentration),RBC(red blood cell), Hb(haemoglobin count), PLT(platelets), WBC(white blood cells), PCV(packed cell volume),RDW(red blood cell distribution width).*

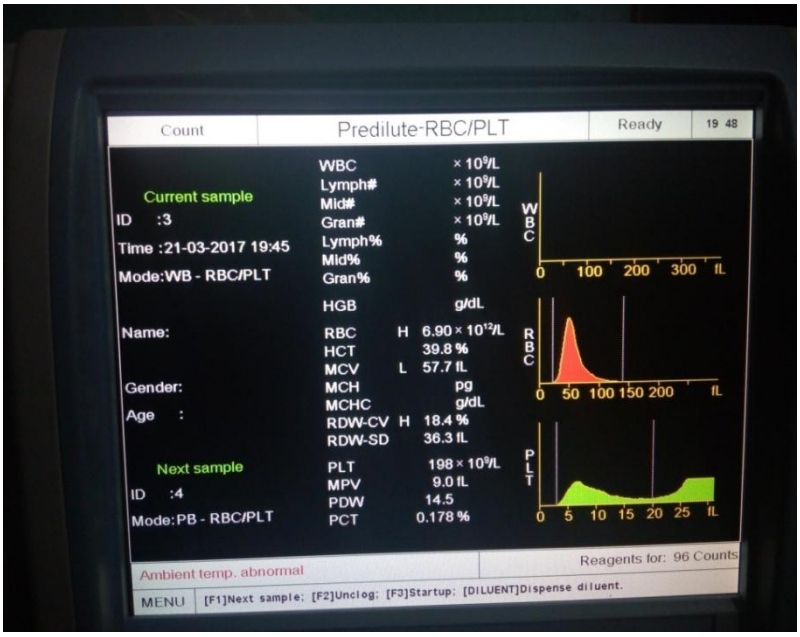


Figure2. *Mindray Haematology Auto analyzer*

Table3. *Weights of body, epididymis and testis of rats after 28 days oral gavaged of PAE*

Animal	**Initial body wt (g)**	**Final body wt (g)**	**WEP**	**WTE**
GP I(control)	150.0	155.0	6.5±0.01c	12.1±0.11a
GP II(250mg/kg)	151.0	169.1	7.2±0.01c	12.5±011a
GP III(500mg/kg)	158.0	171.0	10.5±0.20e	12.8±0.10b
GP IV(1000mg/kg)	168.2	168.4	12.2±0.10a	14.1±0.10b
GP V(2000mg/kg)	180.1	179.3	12.6±0.80d	14.8±0.90f

Note: *results are mean ± SD, n =6, numbers followed by the same alphabet are statistically significant at p<0.05 [Duncan's multiple range test (DMRT)], WOT (weight of testes), WOE (weight of epididymis*

Table4. *Oral administration of Physalis angulata extract on semen Profiles (%)*

Animal(mg/kg)	**Sperm motility**	**Normal morph.**	**Viability**	**Sperm count**	**Abnormal morph.**
GPI (control)	55.20±0.10a	60.51±0.10a	70.56±0.10a	73.88±0.10a	10.20±0.01d
GPII 250	59.20±0.10a	65.64±0.10a	77.31±0.20c	78.87±0.20c	7.21±0.01d
GPIII 500	80.41±0.20c	68.92±0.10a	82.66±0.20c	89.72±0.20c	3.11±0.02e
GPIV 1000	84.21±010a	79.15±0.20c	85.88±0.20c	92.22±0.20c	3.00±0.02e
GPV 2000	88.00±0.20c	86.33±0.20c	88.67±0.20c	98.51±0.20c	1.10±0.01d

***Note:** values are mean ± SD of original values at n= 6, and p< 0.05 (one-way ANOVA), GP (group), sperm count (million/mL), other parameters (%), numbers having the same letters are not significantly different at p<0.05 following DMRT, morph. (morphology).*

Animal(mg/kg)	Sperm motility	Normal morph	Viability	Sperm count	Abnormal morph
GPI (control)	55.20±0.10a	60.51±0.10a	70.56±0.10a	73.88±0.10a	10.20±0.01d
GPII 250	59.20±0.10a	65.64±0.10a	77.31±0.20c	78.87±0.20c	7.21±0.01d
GPIII 500	80.41±0.20c	68.92±0.10a	82.66±0.20c	89.72±0.20c	3.11±0.02e
GPIV 1000	84.21±010a	79.15±0.20c	85.88±0.20c	92.22±0.20c	3.00±0.02e

Table5. *Fertility hormonal assay of rats treated with Physalis angulata extract (PAE) orally*

Animal dose	Testosterone(µg/mL)	FSH (mIU/mL)	LH(mIU/mL)
GP I(control)	3.82±0.01a	12.22±0.10a	16.50±0.10c
GP II 250 mg/kg PAE	3.53±0.01a	8.54±0.20b	12.21±0.20b
GP III 500mg/kg PAE	7.84±0.20b	12.33±0.20b	16.34±0.10c
GP IV 1000mg/kg PAE	8.25±0.20a	11.10±0.10a	18.20±0.10c
GP V 2000mg/kg PAE	16.64±0.10c	15.78±0.20b	24.50±0.20b

Results are mean ± SD, n =6, numbers followed by the same alphabet are not statistically significant at p<0.05 [Duncan's multiple range test (DMRT)], FSH (follicle stimulating hormone), LH (luteinizing hormone).

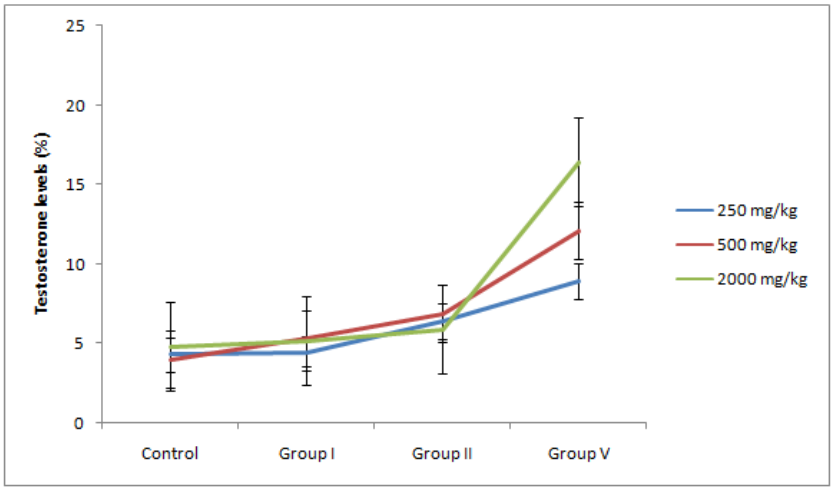
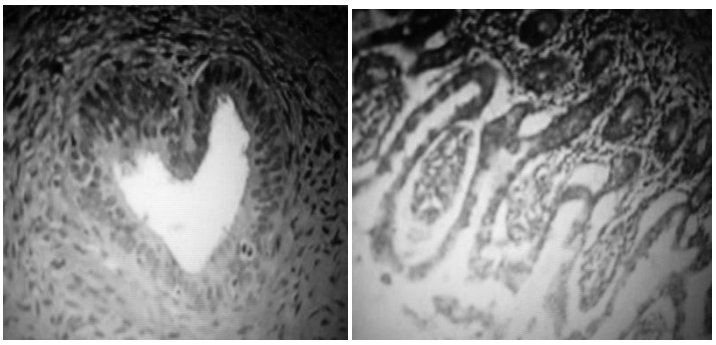
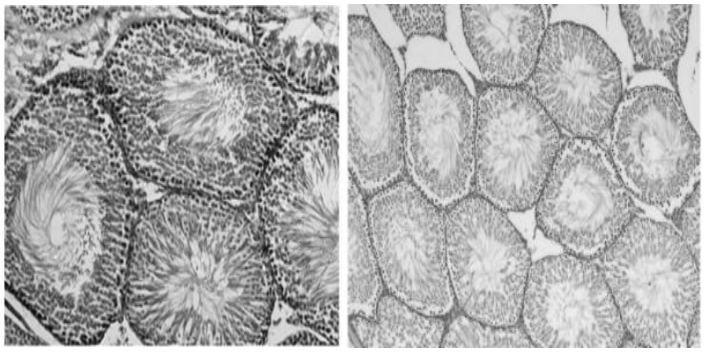


Figure3. *Effects of PAE on serum testosterone levels in rats with low and high doses*



(a) Control group **(b) Treated 250mg/kg b.w PAE**



(c) Treated 1000 mg/kg b.w PAE **(d) Treated 2000 mg/kg b.w PAE**

Figure3. *Effect of PAE concentrations on testis histology;* 400 x

4. CONCLUSION

Our findings from this study showed that Physalis angulata leaf displayed greater potential in boosting male reproductive cells thereby enhancing. The study further revealed that plant is very safe for use as ethnobotanical prescription for the treatment of infertility, low sperm count, and blood boosting in male albino rats. The results obtained from this study can therefore, be extended towards drug discovery aimed at treating male infertility, boost low sperm count and boost blood production.

ACKNOWLEDGEMENT

The authors are thankful to Mr. Bulus Auta for helping us purchased the Swiss male albino rats used in this study, and the management of Sancta Maria Health Clinic Bali, Nigeria for allowing us access to some facilities used in this study.

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Citation: *C. Ukwubile et al., "Physalis angulata Linn. (Solanaceae) Leaf Extract Boosts Fertility, Sperm Production and Haematological Parameters in Swiss Male Albino Rats", International Journal of Medicinal Plants and Natural Products (IJMPNP), vol. 4, no. 3, pp. 1-10, 2018. http://dx.doi.org/10.20431/2454-7999.0403001*