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Assessing the therapeutic potential of Banana blossom extract in ameliorating Mifepristone-Induced Polycystic Ovarian Syndrome in Rat Model

Research Article

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Abstract

Background: Polycystic ovarian syndrome (PCOS) is a syndrome defined by ovarian dysfunction which is marked primarily by elevated hormone levels and the presence of polycystic ovaries discovered on ultrasonography. Polycystic ovarian syndrome is an extremely prevalent lifestyle disorder that affects 6 out of 10 women. The management of polycystic ovarian syndrome is largely unclear. This study examines the possible use of Banana Blossom an herbal therapy in a rat model of polycystic ovarian syndrome caused by the medication mifepristone. Methods: For 13 days, female Wistar rats were given 20mg/kg b.w. of mifepristone daily to induce PCOS, which was verified by the sustained estrous cycle. The rats received treatment with Banana Blossom extract orally for 21 days at a dosage of 200, 400 and 800mg/kg b.w. after PCOS induction and standard treatment was metformin. Physical, biochemical parameter and oxidative stress marker was carried out using standard procedure. Result: The PCOS rats reported a significant decline ($P<0.001$) in uterine weight, HDL, SOD as well as GSH levels along with a significant rise ($P<0.001$) in body weight, periovarian fat, LDL, triglycerides, MDA and glucose level. Banana Blossom extract reversed these effects, with the 800mg/kg b.w. dose providing the most significant improvements in oxidative stress markers and biochemical parameters. Conclusion: After analysing the data, one can conclude that the banana blossom ethanolic extract exhibited an improved therapeutic effect on mifepristone induced polycystic ovarian syndrome in female Wistar rats.

Keywords: Polycystic Ovarian Syndrome, Banana blossom extract, Mifepristone, Metformin, In-vivo studies.

Introduction

Polycystic Ovarian Syndrome (PCOS) is identified by certain characteristics certified by ultrasound that show a distinctive morphology of the ovaries. These characteristics are often accompanied by disruptions in menstrual cycles commonly marked by infrequent or absent periods (oligo- or amenorrhea) and/or indications of heightened androgen levels such as excess body hair (hirsutism), acne or hair loss (alopecia). (1) PCOS is an extremely prevalent and complex endocrine state that impacts women of reproductive maturity with a predicted incidence ranging from 4 % to 12 %. (2) Various theories have arisen to explain the origins of PCOS. The traditional "central hypothesis" suggests a core irregularity within the hypothalamus and pituitary whereas the "ovarian hypothesis" proposes a primary dysfunction in steroid production within the ovary. (3) Infertility serves as the primary factor driving this syndrome characterized by chronic anovulation, hyperandrogenaemia and an erroneous balance of luteinizing hormone also known as LH and follicle–stimulation hormone (FSH).(4) Furthermore, metabolic abnormalities associated with the syndrome including dyslipidemia, weak glucose tolerance, diabetes mellitus and insulin resistance might persist throughout an individual's lifetime. (5) While a significant proportion of luteinizing hormone (LH) to follicle– stimulating hormone (FSH) and a greater incidence of Gonadotropin-Releasing Hormone (GnRH) are acknowledged as pivotal factors in PCOS. The exact etiology and pathology of this condition remains incompletely understood. (6)

A variety of treatments are utilized to address polycystic ovarian syndrome encompassing lifestyle modification and weight loss, oral contraceptives, cyclic progestins and clomiphene citrate, gonadotropin, GnRH analogues and naltrexone among others. (7) Reported side effects of these therapies include severe conditions such as arthritis as well as discomfort in joints or muscles along with psychological disturbances. (8) Hence, contemplating an alternative strategy such as phytotherapy could be worthwhile.

Bananas are widely enjoyed fruits globally due to their taste, rich nutritional profile and promising health advantages. (9) The banana is a substantial, perpetual single–cot herb classified beneath the genus Musa a component of the *Musaceae* family. (10) The flowers of bananas are abundant in phytochemicals and showcase various beneficial properties such as antioxidant, anti-inflammatory and potential anticancer effects. (11)

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Banana Blossom stands out as a wealthy supplier of nutritious protein, fiber from the diet, vitamins and elements such as iron, magnesium and copper. Moreover, it serves as a notable source of flavonoids. (12) Banana Blossom boasts 5.74g of dietary fiber per 100g. Dietary fiber plays a crucial role in safeguarding our bodies against obesity, reducing blood cholesterol levels and maintaining normal blood glucose and insulin levels. (13) Based on several literature review it was found that various phytochemicals were present in banana blossom which were able to bring the parameters of various diseased states to normal conditions. Since no studies has been carried out using banana blossom, the main objective was to find out the therapeutic effect of banana blossom extract on Mifepristone induced PCOS in female Wistar rats.

Materials and methods

Plant Material

The Banana Blossom from the banana plant *Musa paradisica L* (Galani V et al., 2019) was collected from the local farm in Mudal, Dist. – Kolhapur, Maharashtra, India. An authentication expert from Shri B. M. K. Ayurveda Mahavidyalaya Belgaum, identified and authenticated the specimen which was deposited under CFR/Auth/31/2024.

Extract Preparation

The 100-gram quantity of dried banana blossom was transferred to a 1 L conical flask which was subsequently stuffed with 500 ml of 80% ethanol as the solvent. The flask was subsequently set on the orbital shaker for optimized agitation-based extraction. Following two straight days of extraction the mixture unwanted filtering over Whatman No. 1 filter paper. The remaining residue was extracted afresh with the corresponding amount of 80% ethanol at least twice, until the filtrate appeared colourless. The corresponding extract was concentrated at reduced pressure utilizing a rotary evaporator in a 50°C-water bath. (14)

$$\% \text{ Yield of Extract} = \frac{\text{Weight of Extract (gm)}}{\text{Weight of samples (gm)}} \times 100$$

Animals

The accomplished experimental technique has been carried out on healthy female Wistar rats weighing between 150 to 200gms. These rats were housed under standard laboratory conditions setting at room temperature with a regular pelleted meal, water ad libitum with a 12-hour light/dark cycle. After a seven-day acclimating period, rats were assigned at random among the experimental groups. Ethical clearance was obtained from the Institutional Animal Ethics Committee (Reg. No.221/Po/Re/S/2000/CPCSEA) at KLE College Of Pharmacy, Belagavi, before commencing the experiment.

Chemicals

Mifepristone was purchased from Merk Millipore. Metformin was purchased from Marksans Pharma Limited and all chemicals utilised were of an analytical grade.

Mifepristone Induced PCOS In Female Rats

In 4-day estrous cyclic rats, the antiprogesterone mifepristone was given at a dose of 20mg/kg over 13 consecutive days commencing on the first day of estrous. (15) To investigate and apprised the progression of PCOS in rats, a daily vaginal smear test was conducted to assess irregular cycles followed by oral administration of mifepristone. When an anovulatory cystic ovaries status identical to those associated with polycystic ovary disease had been established through stretched vaginal cornification stage the animals were grouped for further treatment.

Estrous Cycle Determination

Every animal cage was delivered to the experimental room each morning between 8:00 and 9:00 a.m. for thirteen consecutive days. To obtain vaginal secretion a plastic pipette containing 10µL of normal saline solution (NaCl 0.9%) was gently entered into the rat's vagina paying attention not to penetrate deeply. Following collection, one glass slide according to the animal cage was implemented to hold the vaginal fluid. Each rat has a single drop collected using a clean tip. The unstained sample was analysed with a light microscope with applied 10x and 40x objective lenses. (16)

Experimental Design

Table 1: Experimental design plan

Animal groups (n=6)	Treatment
Group I (Normal Group)	Normal food and distilled water
Group II (Control Group)	Received 20mg/kg mifepristone (p.o) for 13 days
Group III (Standard Group)	Received 20mg/kg mifepristone (p.o) for 13 days After 13 days receives Metformin for 21- days. (p.o)
Group IV (Treatment I)	Received 20mg/kg mifepristone for 13 days After 13 days, receives 200 mg/kg extract for 21 days (p.o)
Group V (Treatment II)	Received 20mg/kg mifepristone for 13 days After 13 days, receives 400 mg/kg extract for 21 days (p.o)
Group VI (Treatment III)	Received 20mg/kg mifepristone for 13 days After 13 days, receives 800 mg/kg extract for 21 days (p.o)

Drugs were orally administered using water as vehicle by oral gavage every day for a period of 34 days. Blood glucose levels were measured using a blood sample taken from the tail vein on the 13th as well as the 35th day. The glucose level was measured with a glucometer. On the 35th day, the animals were euthanized and blood samples were gathered from each via retroorbital puncture into a sterile simple Eppendorf tube coated by anticoagulant for further hormonal estimation. Additionally, ovaries were extracted for histopathological examination.

Weight of the body, ovary, uterus and periovarian fat

The body weight of the rats measured at the 0th, 7th, 14th, 21st, 28th and 35th day. On 35th day animals were sacrificed and the weight of right as well as left ovary, uterus and periovarian fat were measured.

Estimation Of Biochemical Parameters

Diagnostic kits (AGD Biomedicals p. Ltd Mumbai) were used to assess biochemical markers like LDL, HDL and Triglycerides.

Serum Testosterone Level

Serum testosterone level were analysed in Jeewan Diagnostic Lab.

Assessment Of Oxidative Stress

Superoxide dismutase (SOD)

The potential of the enzyme to block the auto-oxidation of pyrogallol regulates SOD efficiency. The level of SOD was measured spectrophotometrically at absorbance 420nm. (17)

Malondialdehyde (MDA)

The level of MDA was measured spectrophotometrically at absorbance 530nm. (18)

Glutathione (GSH)

GSH is a primary non-protein thiol and an endogenous antioxidant serves to contract and balance the damage caused by free radicals. The level of GSH was measured spectrophotometrically at absorbance 412nm. (19)

Statistical Analysis:

These are the mean ± SEM values that are given. For statistical analysis, including ANOVA and Tukey's multiple comparison tests, GraphPad Prism version 8.02 was implemented. P values < 0.001 were regarded as significant.

Results

Percentage Yield of Banana Blossom Extract

The percentage yield of banana blossom extract was found to be 4.65%.

Estrous cycle by vaginal smear

Estrous cycle determination was carried out by pipette smear technique. It shows four phases of cycles i.e. proestrous, estrous, metaestrous and diestrous.

Effect of Banana Blossom Extract on Body Weight in Mifepristone Induced PCOS in Rats

The changes in body weight of animals from different groups were compared on the 1st, 7th, 14th, 28th, and 35th days. In relation to normal rats, a significant (P<0.001) rise in body weight in the rats that received mifepristone were seen. In contrast, from day 14 to day 35 the treatment group receiving dosages of 200, 400 and 800mg/kg b.w. had significantly reduced body weight than the group acquired mifepristone (P<0.001, P<0.001, P<0.001). Additionally, the standard group treated with metformin had a body weight that was identical to the normal group and significantly (P<0.001) lower than the group treated with mifepristone.

Figure 1: Phases of estrous cycles

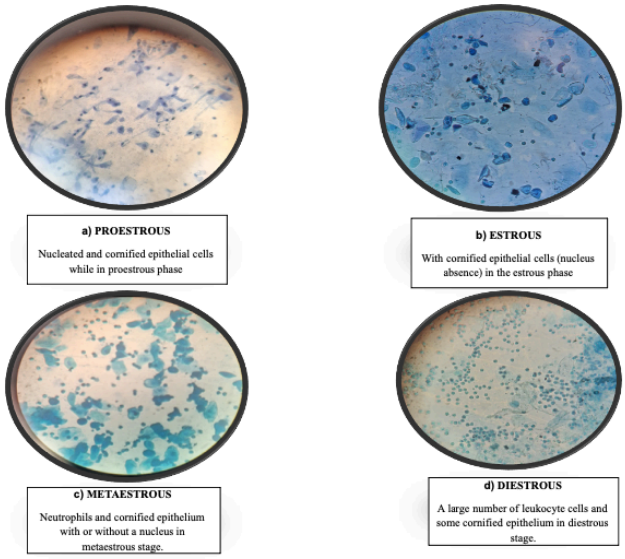
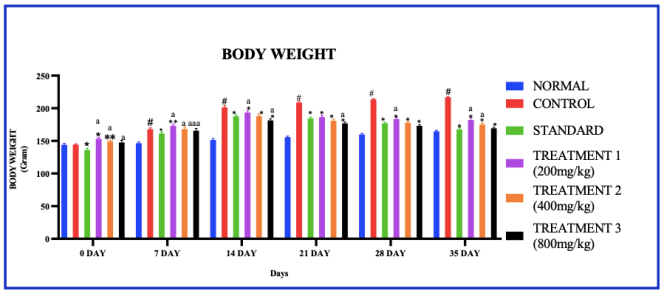


Figure 2: Effect of Banana Blossom Extract on Body Weight in Mifepristone Induced PCOS in Rats



Every value in every group has been indicated as mean ± SEM (n=6) using two-way ANOVA along with Tukey's multiple comparison test. the normal group compared with the disease control: p<0.001#. the disease control group contrasts to treatment and standard: p<0.001*, p<0.001*. the standard group compared with treatment: p<0.001a.

Effect of Banana Blossom Extract on relative Ovarian Weights, Uterine Weight and Weight of Periovarian Fat in Mifepristone Induced PCOS Rats:

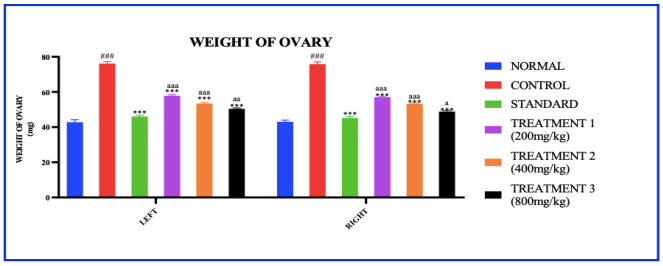
After the PCOS occurred, the weight of the left and right ovaries increased (P<0.001) significantly contrasted to the normal group; the weight of the ovaries decreased (P<0.001) significantly concerning the PCOS control group, the treatment group with doses of 200, 400 and 800mg/kg; furthermore, the weight of the ovaries was considerably (P<0.001) lowered when comparison to the metformin-treated standard group.

The weight of the uterus was substantially lower (P<0.001) in the PCOS-induced group in contrast to the normal group. When contrasting the treatment groups with the PCOS control group with dosages of 200, 400 and 800mg/kg the weight of uterine raised significantly (P<0.001). In contrasting the rats with the PCOS control

group to the metformin–treated standard group, the uterine weight substantially (P<0.001) increased.

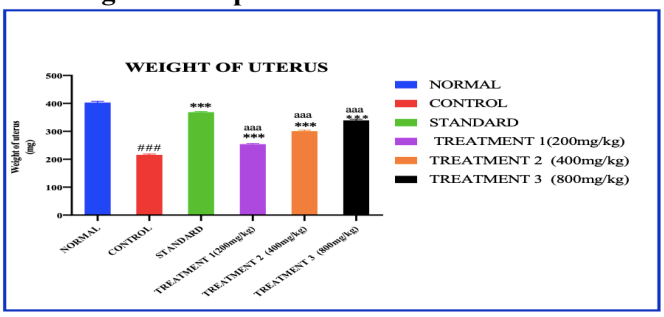
Weight of periovarian fat increased (P<0.001) substantially after PCOS induction comparable with the normal group. In contrast the PCOS control group, the treatment group receiving dosages 200, 400 and 800mg/ kg illustrated a substantial decrease (P<0.001) in the weight of periovarian fat. Also, periovarian fat was considerably (P<0.001) reduced standard group treated with metformin than the PCOS control group.

Figure 3: Effect of Banana Blossom Extract on relative Ovarian Weight in Mifepristone Induced PCOS in Rats



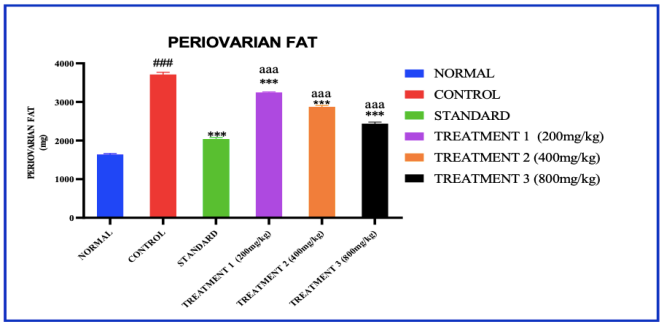
Every value in every group has been indicated as mean ± SEM (n=6) using two-way ANOVA along with Tukey's multiple comparison test. the disease control group is contrasted with the normal group: p<0.001###. the disease control group contrasted with the standard and treatment: p<0.001*** and p<0.001***. if assessing the standard group against treatment groups: p<0.001aaa.

Figure 4: Effect of Banana Blossom Extract on Uterine Weight in Mifepristone Induced PCOS in Rats



Every value in every group has been indicated as mean ± SEM (n=6) using one-way ANOVA along with Tukey's multiple comparison test. the disease control group is contrasted with the normal group: p<0.001###. the disease control group contrasted with the standard and treatment: p<0.001*** and p<0.001***. if assessing the standard group against treatment groups: p<0.001aaa.

Figure 5: Effect of Banana Blossom Extract on Weight of Periovarian Fat in mifepristone Induced PCOS in Rats



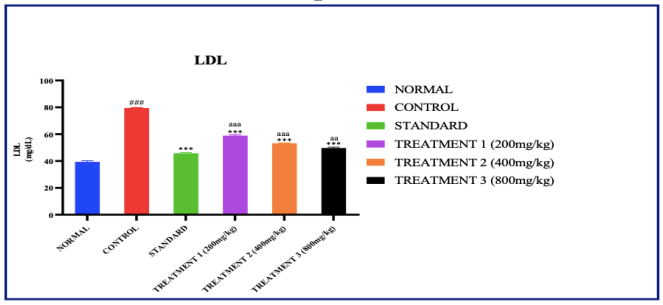
Every value in every group has been indicated as mean ± SEM (n=6) using one-way ANOVA along with Tukey's multiple comparison test. the disease control group is contrasted with the normal group: p<0.001###. the disease control group contrasted with the standard and treatment: p<0.001*** and p<0.001***. if assessing the standard group against treatment groups: p<0.001aaa.

Impact of Banana Blossom Extract on Lipid Profile in Rats with Mifepristone – Induced PCOS:

The finding verified that the usage of mifepristone led to a remarkable (P<0.001) reduction in HDL level and substantial (P<0.001) rise in serum levels of both TG and LDL when compared to the normal group.

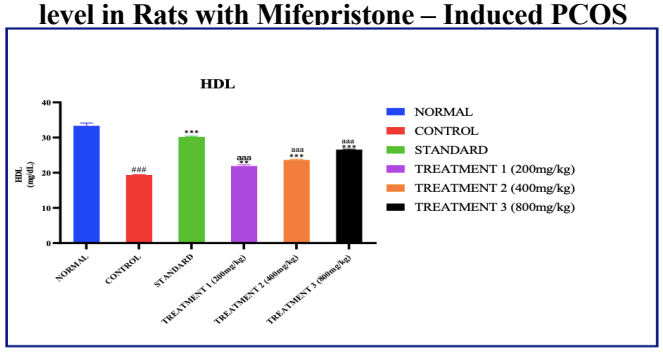
Concerning the PCOS control group, the treatment of metformin resulted in a substantial decline in TG (P<0.001) as well as LDL (P<0.001). As compared to the PCOS control group, the treatment group receiving 200, 400 and 800mg/kg had significantly lower levels of TG along with LDL (P<0.001) and also larger (P<0.001) amount of HDL.

Figure 6: Impact of Banana Blossom Extract on LDL level in Rats with Mifepristone – Induced PCOS



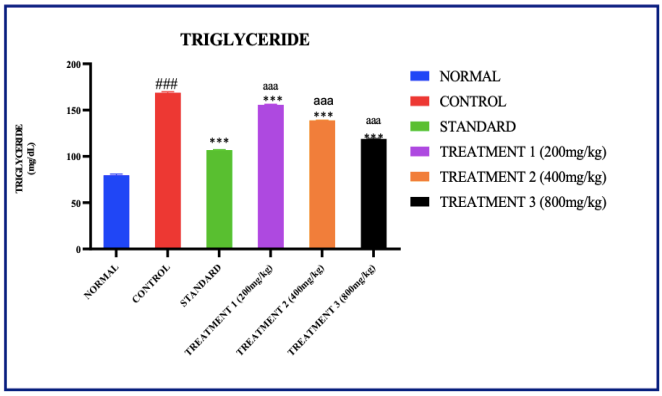
Every value in every group has been indicated as mean ± SEM (n=6) using one-way ANOA along with Tukey's multiple comparison test. the disease control group is contrasted with the normal group: p<0.001###. the disease control group contrasted with the standard and treatment: p<0.001*** and p<0.001***. if assessing the standard group against treatment groups: p<0.001aaa

Figure 7: Impact of Banana Blossom Extract on HDL level in Rats with Mifepristone – Induced PCOS



Every value in every group has been indicated as mean ± SEM (n=6) using one-way ANOVA along with Tukey's multiple comparison test. the disease control group is contrasted with the normal group: p<0.001###. the disease control group contrasted with the standard and treatment: p<0.001*** and p<0.001***. if assessing the standard group against treatment groups: p<0.001aaa

Figure 8: Impact of Banana Blossom Extract on Triglycerides level in Rats with Mifepristone – Induced PCOS



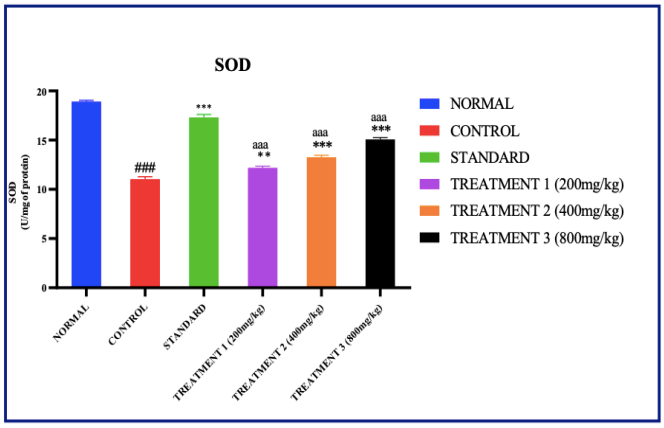
Every value in every group has been indicated as mean ± SEM (n=6) using one-way ANOVA along with Tukey's multiple comparison test. the disease control group is contrasted with the normal group: p<0.001###. the disease control group contrasted with the standard and treatment: p<0.001*** and p<0.001***. if assessing the standard group against treatment groups: p<0.001aaa.

Effect of Banana Blossom Extract on Oxidative Stress Marker in Mifepristone Induced PCOS in Rats:

In contrast to the normal group, other oxidative stress markers like SOD and GSH evaluated for the mifepristone–treated group showed a decreased response with a significant (P<0.001) correlation. Similarly, treatment with 200, 400 and 800mg/kg b.w. extract and the standard drug metformin proved to cause a significant raised (P<0.001).

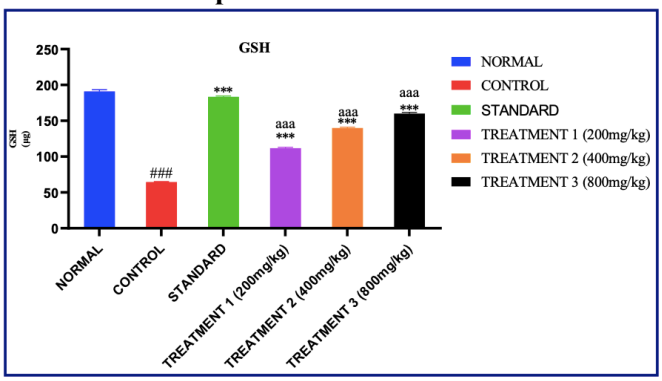
When mifepristone was administered, the malondialdehyde (MDA) level was determined to be considerably greater (P<0.001) in the disease control group than in the normal group. When compared to the mifepristone-treated group, The MDA level in rats treated with 200mg/kg b.w. reduced considerably (P<0.001), and then the MDA level in the rats treated with 400 as well as 800mg/kg b.w. decline considerably (P<0.001). Considering the standard group of rats with mifepristone, it was discovered that this group likewise showed a decreased response, which was significantly (P<0.001).

Figure 9: Effect of Banana Blossom Extract on SOD in Mifepristone Induced PCOS in Rats



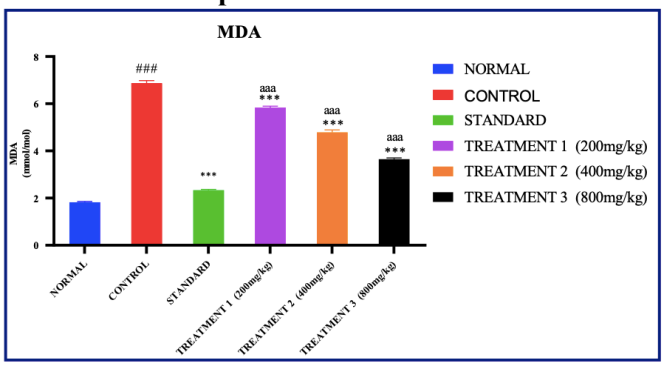
Every value in every group has been indicated as mean ± SEM (n=6) using one-way ANOVA along with Tukey's multiple comparison test. the disease control group is contrasted with the normal group: p<0.001###. the disease control group contrasted with the standard and treatment: p<0.001*** and p<0.001***. if assessing the standard group against treatment groups: p<0.001aaa

Figure 10: Effect of Banana Blossom Extract on GSH in Mifepristone Induced PCOS in Rats



Every value in every group has been indicated as mean ± SEM (n=6) using one-way ANOVA along with Tukey's multiple comparison test. the disease control group is contrasted with the normal group: p<0.001###. the disease control group contrasted with the standard and treatment: p<0.001*** and p<0.001***. if assessing the standard group against treatment groups: p<0.001aaa.

Figure 11: Effect of Banana Blossom Extract on MDA in Mifepristone Induced PCOS in Rats

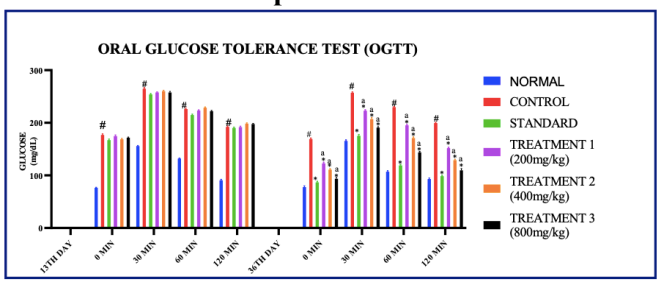


Every value in every group has been indicated as mean ± SEM (n=6) using one-way ANOVA along with Tukey's multiple comparison test. the disease control group is contrasted with the normal group: p<0.001###. the disease control group contrasted with the standard and treatment: p<0.001*** and p<0.001***. if assessing the standard group against treatment groups: p<0.001aaa.

Effects of Banana Blossom Extract on OGTT in Mifepristone Induced PCOS

In contrast to normal values, the blood sugar levels of untreated PCOS rats (0, 30, 60, and 120 min) were considerably higher (P<0.001). Similarly, contrasted to the PCOS control group, treatment with metformin indicated a highly significant (P<0.001) drop in the glucose level. In contrast to the PCOS control group, the treatment group receiving dosages of 200, 400 and 800mg/kg had a substantial reduction (P<0.001) in the glucose level at 30, 60and 120 minutes.

Figure 12: Effects of Banana Blossom Extract on OGTT in Mifepristone Induced PCOS

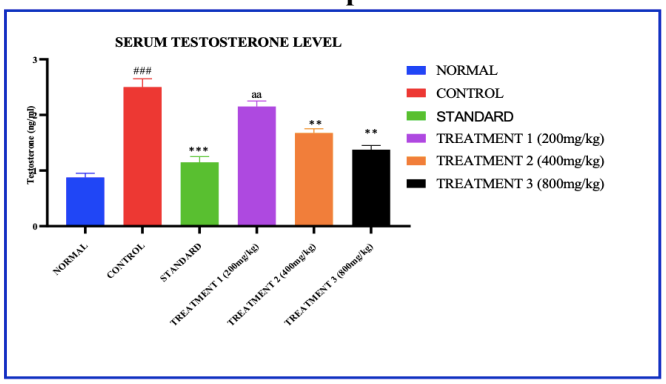


Every value in every group has been indicated as mean ± SEM (n=6) using two-way ANOVA along with Tukey's multiple comparison test. the normal group compared with the disease control: p<0.001#. the disease control group contrasts with the treatment and standard: p<0.001*, p<0.001*. the standard group compared with the treatment: p<0.001a.

Effects of Banana Blossom Extract on Serum Testosterone Level in Mifepristone Induced PCOS:

When mifepristone was administered, the serum testosterone level was determined to be considerably greater (P<0.001) in the disease control group than in the normal group. When compared to the mifepristone-treated group, the testosterone level in rats treated with 400 and 800 mg/kg b.w. decline considerably (P<0.01). Considering the standard group of rats with mifepristone, it was discovered that this group likewise showed a decreased response, which was significantly (P<0.001).

Figure 13: Effects of Banana Blossom Extract on Serum Testosterone Level in Mifepristone Induced PCOS

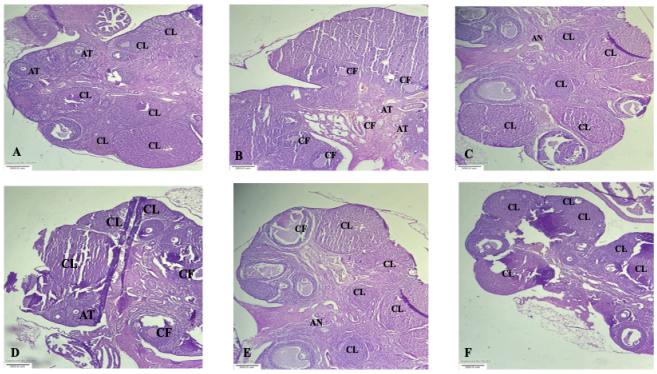


Every value in every group has been indicated as mean ± SEM (n=6) using one-way ANOVA along with Tukey's multiple comparison test. the disease control group is contrasted with the normal group: p<0.001###. the disease control group contrasted with the standard and treatment: p<0.001*** and p<0.001***. if assessing the standard group against treatment groups: p<0.001aaa

Effect of Banana Blossom Extract on Histological Analysis of Ovary

In the mifepristone model, ovaries from A) normal rats had rather healthy tissue architecture, including antral follicles and corpora lutea B). The rats with PCOS only had tiny cystic follicles and atretic oocytes C). The rats treated with metformin showed antral follicles and corpora lutea D). The rats treated with 200 mg/kg showed corpora lutea, cystic follicles and atretic oocytes E). Also, rats treated with 400mg/kg showed increased no of corpora lutea and lesser no of cystic follicles F). The rats treated with 800mg/kg showed raised no of corpora lutea and highly decreased cystic follicles

Figure 14: Effect of Banana Blossom Extract on Histological Analysis of Ovary



a: represent normal group with antral follicles and CL-corpora lutea, b: represent disease control group with CF-cystic follicle, AT- atretic oocytes, c: represent standard group with an- antral follicles and CL-corpora lutea, d: represent treatment1 group at dose 200mg/kg with CL-corpora lutea, at- atretic oocytes and CF- cystic follicle, e: represent treatment 2 group at dose 400mg/kg with CL-corpora lutea, AN- antral follicles and lesser no of CF- cystic follicles, f: represent treatment 3 group at dose 800mg/kg with AN- antral follicles and CL-corpora lutea.

Discussion

Polycystic ovarian syndrome is a heterogeneous disorder with features such as hyperandrogenism, anovulation, and obesity. (20) The antagonistic synthetic steroid RU486 has an exceptionally high specificity for glucocorticoids and progesterone receptors which inhibits progesterone action and promotes endocrine abnormalities that resemble PCOS. (4) Administration of mifepristone during the follicular phase thus disrupts typical follicular development, consequently delaying ovulation. (21) In this study, the aim was to examine how banana blossom extract impacts the biochemical parameter and oxidative stress marker in PCOS rats induced by RU486 (mifepristone).

Proestrous, estrous, metaestrous, and diestrous are the four steps that usually make up the estrous cycle. An estrous cycle usually somewhere between four and five days to complete. (22) Animals usually stay motionless throughout the diestrous phase of the estrous cycle, which is mostly reflected in leukocyte cells. (23) Female rats in the normal group in the current study demonstrated a regular estrous cycle. Rats with PCOS driven on by mifepristone developed a continual diestrous phase instead of a typical estrous cycle. This diestrous phase was eventually reversed and the normal estrous cycle was reestablished through treatment with banana blossom.

Reproductive health is severely affected by obesity while ovulatory infertility is primarily brought about by excess body weight. (24) Compared to normal rats, in the present investigation rats administered with mifepristone showed a substantial increase (P<0.001) in body weight. Additionally, in contrast to the group receiving mifepristone, the treatment groups received dosages of 200, 400, and 800mg/kg b.w. displayed a substantial reduction in body weight. Obese women with a greater abdominal fat distribution comprise roughly half of the PCOS population. The metabolic and reproductive cycles have been impacted by adipose tissue, primarily visceral adipose tissue, which has been recognized as an active endocrine organ. In contrast with the normal group, there was an enormous rise (P<0.001) in the weight of both ovaries and periovarian fat after induction of PCOS. Furthermore, contrasted to the normal group, the uterine weight was substantially (P<0.001) decline. If compared to the PCOS control group, the treatment group administered 200, 400, and 800mg/kg exhibited a substantial reduction (P<0.001) in the weight of the ovaries and periovarian fat and a significant rise (P<0.001) weight of uterine than normal group.

Regardless of obesity, lipid abnormalities were found to be closely connected with insulin resistance, Triglycerides (TGs) have recently been seen to rise, and this triglycerides build-up may be attributed to augmented lipogenesis, reduced elimination, or imposed fatty acid oxidation. The liver's heightened capacity to generate very low-density lipoprotein (VLDL) especially tends to occur in PCOS patients due to insulin resistance, could serve as the origin of an elevated concentration of plasma TGs. Moreover, a rise in HDL-C particle catabolism and LDL-C fabrication have been tied to insulin resistance. (25) Additionally throughout this investigation, dyslipidaemia was seen and characterized by elevated levels of triglycerides and LDL along with reduced levels of HDL in rats induced with PCOS. However, treatment with ethanolic extract of Banana Blossom modified this dyslipidaemia condition, resulting in rising HDL and reduced LDL as well as triglycerides levels.

One of the main transmissible traits associated with PCOS is oxidative stress; women with PCOS have a reduced level of antioxidants. (26) Elevated reactive oxygen species (ROS) have been associated with heightened steroid formation and metabolic activity in the female reproductive system. The oocyte and DNA may be disrupted as a result. Additionally, ovarian mesenchyme's irregular development may be linked to ROS. An elevated oxidative stress level might render ovarian mesenchyme overgrowth worse in situations such as PCOS. (27) The current investigation found that when mifepristone was administered, the response of SOD and GSH diminished and the MDA level risen with significantly (P<0.001) when compared to the normal group. Utilizing Banana Blossom significantly reduced MDA as well as rise the SOD and GSH level in the mifepristone-induced PCOS rat model.

PCOS is additionally correlated with hyperinsulinemia as well as insulin resistance, which are primary components of impaired glucose tolerance. This condition is linked to factors like Type 2 diabetes mellitus, aging, and obesity. It is noteworthy that those who are fat are more susceptible to experiencing both hyperinsulinemia and insulin resistance. (28) During this specific investigation, the levels of sugar in blood were considerably higher (P<0.001) in untreated PCOS rats (0, 30, 60, and 120min) when compared to the normal. The treatment group receiving dosages of 200, 400, and 800mg/kg demonstrated substantially (P<0.001) reduced glucose levels at 30, 60, and 120 minutes in comparison with the PCOS control group.

Results exhibit those rats with PCOS had remarkably greater testosterone levels than rats in the normal group. About identical quantities of testosterone are produced by the adrenal glands and the ovaries. The ovaries and adrenal glands directly secrete about half of testosterone, whereas the other half is created by peripheral conversion of circulating androstenedione which is produced by roughly equal amounts of ovarian and adrenal secretion. Elevated testosterone levels in PCOS are primarily caused by insulin resistance, abnormal ovarian function, increased LH production and adrenal overactivity. These elements cause hyperandrogenism which in turn causes hirsutism, acne, and thinning of the scalp—all common signs of PCOS. This rise correlates to women with PCOS experiencing elevated ovarian levels of insulin and insulin-like growth factor I (IGF-I), which impairs immature follicles leads to anovulation and triggers acne and hirsutism. (29) However, treatment with ethanolic extract of Banana Blossom at a dosage of 400 and 800mg/kg showed significantly (P < 0.01) decreased testosterone level.

The current study's histology results showed that banana blossom improved the ovarian tissue's morphology in PCOS-affected rats. There are reports that PCOS and ovarian damage are related. The ovarian sections of the PCOS rats exhibited a decrease in the quantity of corpus luteum as well as a proliferation of atretic and cystic follicles. According to histological examination, an extract of banana blossom at a dose of 800 mg/kg was more effective in collapsing cystic follicles in the ovaries.

Conclusion

The goal of this study was to assess the therapeutic effect of an ethanolic extract of banana blossom in mifepristone-induced polycystic ovarian syndrome in female Wistar rats. Ethanolic extract maximizes the extraction of bioactive compounds, ensures stability and bioavailability, allows for comprehensive bioactivity testing and also act as preservative. Looking at the results, one can indicate that the ethanolic extract of Banana Blossom revealed a better therapeutic effect against polycystic ovarian syndrome. However, banana blossom extract contains a variety of compounds and more research on fractionation and partial purification of the extract is needed to discover active phytoconstituent in the treatment of polycystic ovarian syndrome.

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Conflict of interest

The authors declare that they have no conflict of interest.

References

1. Homburg R. What is polycystic ovarian syndrome? A proposal for a consensus on the definition and diagnosis of polycystic ovarian syndrome. Human Reproduction. 2002 Oct 1;17(10):2495-9.
2. Fatima Q, Amin S, Kawa IA, Jeelani H, Manzoor S, Rizvi SM, Rashid F. Evaluation of antioxidant defense markers in relation to hormonal and insulin parameters in women with polycystic ovary syndrome (PCOS): a case-control study. Diabetes & Metabolic Syndrome: Clinical Research & Reviews. 2019 May 1;13(3):1957-61.
3. Salehi M, Bravo-Vera R, Sheikh A, Gouller A, Poretsky L. Pathogenesis of polycystic ovary syndrome: what is the role of obesity? Metabolism. 2004 Mar 1;53(3):358-76.
4. Murugesan BM, Muralidharan P, Hari R. Effect of ethanolic seed extract of Caesalpinia bonducella on hormones in mifepristone induced PCOS rats. Journal of Applied Pharmaceutical Science. 2020 Feb 2;10(2):072-6.
5. Talbott EO, Guzick DS, Sutton-Tyrrell K, McHugh-Pemu KP, Zborowski JV, Remsberg KE, Kuller LH. Evidence for association between polycystic ovary syndrome and premature carotid atherosclerosis in middle-aged women. Arteriosclerosis, thrombosis, and vascular biology. 2000 Nov;20(11):2414-21.
6. Sadeghi HM, Adeli I, Calina D, Docea AO, Mousavi T, Daniali M, Nikfar S, Tsatsakis A, Abdollahi M. Polycystic ovary syndrome: a comprehensive review of pathogenesis, management, and drug repurposing. International journal of molecular sciences. 2022 Jan 6;23(2):583
7. Krysiak R, Okopień B, Gdula-Dymek A, Herman ZS. Update on the management of polycystic ovary syndrome. Pharmacological Reports. 2006 Sep 1;58(5):614.
8. Reddy PS, Begum N, Mutha S, Bakshi V. Beneficial effect of Curcumin in Letrozole induced polycystic ovary syndrome. Asian Pacific Journal of Reproduction. 2016 Apr 1;5(2):116-22.
9. Thaweesang S. Antioxidant activity and total phenolic compounds of fresh and blanching banana blossom (Musa ABB CV. Kluai "Namwa") in Thailand. InIOP Conference Series: Materials Science and Engineering 2019 Oct 1 (Vol. 639, No. 1, p. 012047). IOP Publishing.
10. Sarker S, Shuvo SD, Takey M, Akter T, Hadaytullah M, Reza MS, Zubair MA. Determination of proximate composition, antioxidant activity, vitamin C, total phenolic and flavonoid content of banana blossom powder for optimization of its use. Annals: Food Science & Technology. 2022 Apr 1;23(2).
11. Govindaraj–E-mail J, Govindaraj-E-mail K, Vidyarekha U, Bhuminathan-E-mail S. A review on the therapeutic potential of Banana flower. Bioinformation. 2022;18(4):349-53.
12. Tasnim T, Das PC, Begum AA, Nupur AH, Mazumder MA. Nutritional, textural and sensory quality of plain cake enriched with rice rinsed water treated banana blossom flour. Journal of Agriculture and Food Research. 2020 Dec 1;2:100071.
13. Wahab NB, Ismail SN, Abisin MH. Physicochemical and Sensory Characteristics of Banana Blossom Nuggets. International Journal of Research and Innovation Management (IJRIM). 2020 Dec 4;6(1):56-66.
14. Sharma V, Shukla KV, Golani P. Traditional and medicinal effect of banana blossom. International Journal of Scientific Development and Research. 2019;45:377-81.
15. Linus AU, Shagal MH, Nkafamiya II. Phytochemical screening and antimicrobial activities of Musa acuminate calla (BANANA BLOSSOM). Journal of Chemical Society of Nigeria. 2023 Nov 14;48(5).
16. Saini N, Sodhi RK, Bajaj L, Pandey RS, Jain UK, Katare OP, Madan J. Intravaginal administration of metformin hydrochloride loaded cationic niosomes amalgamated with thermosensitive gel for the treatment of polycystic ovary syndrome: In vitro and in vivo studies. Colloids and Surfaces B: Biointerfaces. 2016 Aug 1;144:161-9.
17. Marcondes FK, Bianchi FJ, Tanno AP. Determination of the estrous cycle phases of rats: some helpful considerations. Brazilian journal of biology. 2002;62:609-14.
18. Nandi A, Chatterjee IB. Scavenging of superoxide radical by ascorbic acid. Journal of Biosciences. 1987 Mar;11:435-41.
19. Nadiger HA, Marcus SR, Chandrakala MV, Kulkarni DD. Malonyl dialdehyde levels in different organs of rats subjected to acute alcohol toxicity. Indian Journal of Clinical Biochemistry. 1986;1:133-6.
20. Ellman GL. Tissue sulfhydryl groups. Archives of biochemistry and biophysics. 1959 May 1;82(1):70-7.
21. Saiyed A, Jahan N, Makbul SA, Ansari M, Bano H, Habib SH. Effect of combination of Withania somnifera Dunal and Tribulus terrestris Linn on letrozole induced polycystic ovarian syndrome in rats. Integrative medicine research. 2016 Dec 1;5(4):293-300.
22. Jiang J, Wu RF, Wang ZH, Sun HC, Xu Z, Xiu HM. Effect of mifepristone on estrogen and progesterone receptors in human endometrial and endometriotic cells in vitro. Fertility and sterility. 2002 May 1;77(5):995-1000.
23. Nallathambi A, Bhargavan R. Regulation of estrous cycle by Cynodon dactylon in letrozole induced polycystic ovarian syndrome in Wistars albino rats. Anatomy & cell biology. 2019 Dec;52(4):511.

24. Byers SL, Wiles MV, Dunn SL, Taft RA. Mouse estrous cycle identification tool and images. PloS one. 2012 Apr 13;7(4):e35538.
25. Lim SS, Norman RJ, Davies MJ, Moran LJ. The effect of obesity on polycystic ovary syndrome: a systematic review and meta-analysis. Obesity Reviews. 2013 Feb;14(2):95-109.
26. Shoaib OM, Mustafa SM, Nourein IH. Serum lipid profile of polycystic ovary syndrome in Sudanese women. International Journal of Medical Science and Public Health. 2015 Nov 1;4(11):1.
27. Rajan RK, Balaji B. Soy isoflavones exert beneficial effects on letrozole-induced rat polycystic ovary syndrome (PCOS) model through anti-androgenic mechanism. Pharmaceutical biology. 2017 Jan 1;55(1):242-51.
28. Park KH, Kim JY, Ahn CW, Song YD, Lim SK, Lee HC. Polycystic ovarian syndrome (PCOS) and insulin resistance. International Journal of Gynecology & Obstetrics. 2001 Sep 1;74(3):261-7.
29. Kadium DA, Kaem GG, Saeq ZM, Safar ZA. The relationship between male testosterone hormone and some female hormones in women with polycystic ovary syndrome (PCOS). Journal of Contemporary Medical Sciences. 2016 Dec 1;2(5):20-4.

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