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Research Article

# Synergistic Effects of Flax seed and Soybean Extracts on Repro ductive Hormones and Internal Organ Weights in Female Albino Wistar Rats with Experimentally Induced Poly cystic Ovary Syn- drome

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## Abstract

Aims to shed more light on the potential role of plant-based phyto estrogens flax seed and soybean as dietary strategies to reduce the skeletal and hormonal alterations associated with poly cystic ovarian syndrome.Using female Albino Wistar rats, the experiment was carried out in the experimental animal unit of a medical research facility.Research Design it was split up into eight groups: control group (G1) the standard casein protein diet was given .G2 is given soybean extract at a 100mg/kg concentration.G3 is given soybean extract at a dosage of 150mg/kg.G4: 200mg/kg soybean extract injection Flax seed extract is administered to G5 at a 100mg/kg concentration. G6 consumes 150mg/kg flax seed extract for sustenance. G7Injection: 200mg/kg flax seed extract, and soybean extract at 200 flax seed G8:Synergistic betweenmg/kg . Poly ovary syndrome was induced in female rats using a validated cystic pharmacological model. The animals were administered letrozole at a dose of mg/kg body weight daily for 21 consecutive days via oral administration to 1 poly cystic induce a hormonal disorder that mimics the characteristics of .ovary syndromeThe study results proved that the combined treatment with soy extract and flax seed at a concentration of (200mg/kg) had a clear synergistic effect on sex hormones and the weights of internal organs in rabbits, compared to the G1. The results indicate that the combination of the two extracts may be more efficient than using each one individually, with no noticeable negative effects within the studied dosage limits, supporting the potential benefit of using them in future applied studies.

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## Introduction

Poly cystic ovarian syndrome (PCOS) women of reproductive age are affected by one of the most prevalent endocrine and reproductive disorders. It is distinguished by hyperparathyroidism and poly cystic ovarian morphology , and chronic an-ovulation in addition to complex hormonal and metabolic abnormalities. PCOS is increasingly recognized as a systemic disorder that may impact bone metabolism and skeletal health in addition to its reproductive symptoms [1]. The hormonal imbalance associated with PCOS, which includes elevated androgen levels and regulated estrogen secretion, has a substantial effect on bone remodeling processes. estrogen is essential for maintaining bone mineral density because it regulates the ratio of osteopathic bone formation to osteoclastic bone resorption. disruption of estrogen activity, either through shortage or altered receptor signaling, may have a negative impact on bone strength and structure. Additionally, insulin resistance and low-grade chronic inflammation, which are common in PCOS, may also contribute to abnormal bone metabolism[2]. The hormonal imbalance associated with PCOS, which includes elevated androgen levels and regulated estrogen secretion, has a substantial effect on bone remodeling processes. estrogen is essential for maintaining bone mineral density because it regulates the ratio of osteopathic bone formation to osteoclastic bone resorption [3]. disruption of estrogen activity, either through shortage or altered receptor signaling, may have a negative impact on bone strength and structure. Additionally, insulin resistance and low-grade chronic inflammation, which are common in PCOS, may also contribute to abnormal bone metabolism [4]. Flax seed is an important source of phytoestrogens, primarily lignans, in addition to having a high concentration of the omega-3 fatty acid alpha-linoleum acid (ALA). Intestinal bacteria transform lignans into entertainments, which have mild estrogen or anti-estrogen effects, depending on the hormonal environment. flax seed supplementation has been demonstrated in multiple studies to improve reproductive hormone profiles, especially the normalization of follicle-stimulating hormone (FSH) and luteinizing hormone (LH) ratios, which are critical to the physiologist of PCOS[5]. Furthermore, flax seed components have been associated with anti-inflammatory and antioxidant properties that may improve bone health by reducing bone resorption and increasing mineral density [6]. Animal models are widely used to study the mechanisms underlying PCOS and its systemic effects because they allow precise control of experimental variables and the production of the disease under controlled settings. in particular, female rats are a great experimental model for studying bone metabolism and reproductive endocrinology due to their physiological sensitivity to hormonal stimulation. Although these two foods have been demonstrated to have beneficial effects on hormone regulation and bone health in other animal models, there are still few studies comparing the effects of soy and flax seed on hormonal profiles and bone features in female rabbits with PCOS [7].Therefore, the current study aims to evaluate the effects of soybean and flax seed dietary supplementation on bone characteristics and hormonal parameters in female rats with PCOS. this study aims to shed more light on the potential role of plant-based phytoestrogens as dietary

strategies to reduce the skeletal and hormonal
alterations associated with poly cystic ovarian syndrome.

## Material and method

Using female Albino Wistar rats, the experiment was carried out in the experimental animal unit of a medical research facility. rats weighed between 198 and 256 g at the beginning of the trial, and there were80 of them at 3 months of age. in the animal facility, they were kept clean, kept at ambient temperature, kept at 54% humidity, and exposed to artificial light and darkness for 12 hours each day. they employed special cages made of plastic [8].

**Research Design** It was split up into eight groups:

G1:positive control group .the standard casein protein diet

G2 is given soybean extract at a 100mg/kg concentration.

G3 is given soybean extract at a dosage of 150mg/kg.

G4 200mg/kg soybean extract injection Flax seed extract

:G5100mg/kg flaxseed extract

G6 consumes 150mg/kg flax seed extract for sustenance.

G7 injection 200mg/kg flax seed extract.

G8 Synergistic between flax-seed and soybean extract at 200mg/kg

The doses were determined in mg/kg of body weight according to standard pharmaceutical guidelines. The individual dose for each animal was calculated using the following equation:

Dose (mg) = Dose (mg/kg) × Animal weight (kg).

Considering that the average weight of the rats was 150 g (0.15 kg), the calculated doses were as follows:

A dose of 100 mg/kg = 15 mg per rat.

A dose of 200 mg/kg = 30 mg per rat.

In the combined groups (mixture), each extract was given the specified dose individually.

The extracts were prepared at appropriate concentrations to ensure the volume was within acceptable limits for oral administration in rats, and the doses were given daily using an oral gavage throughout the duration of the experiment [9].

## Preparation of plant extracts

Soybean and flax seed were obtained from a reliable local source, cleaned of impurities, washed with distilled water, and then dried at room temperature. After that, the seeds were ground using an electric grinder to obtain a fine powder. The extracts were prepared using the solvent extraction method, where 100 g of the plant powder were soaked in 1000 ml of 70% ethanol for 48–72 hours with continuous stirring on an electric shaker at room temperature. After that, the mixture was filtered using filter paper to remove the solid residues[10].

The filtrate was concentrated using a rotary evaporator under low pressure and a temperature not exceeding 40–45 degrees Celsius to obtain a semi-solid extract. Then, the extract was left to dry completely in an incubator at a low temperature to obtain the dry extract. The extracts were stored in airtight glass containers at a temperature of 4 degrees Celsius until use [11]. Before use, the required amount of the extract was dissolved in an appropriate solvent to obtain the desired concentration, and the doses were prepared daily according to the animal's weight (mg/kg body weight)[12]

## Induced poly cystic ovary syndrome (PCOS

Poly cystic ovary syndrome was induced in female rats using a validated pharmacological model. The animals were administered letrozole at a dose of 1 mg/kg body weight daily for 21 consecutive days via oral administration to induce a hormonal disorder that mimics the characteristics ofpoly cystic .ovary syndrome

Letrozole was dissolved in a suitable solvent (0.5 %carbohydrate cellulose) to ensure solution homogeneity and ease of administration [13] The success of. inducing the syndrome was confirmed by monitoring the disruption of theoestrus cycle using microscopic examination of vaginal smears, in addition to the appearance of characteristic ,morphological changes in the ovaries such as an increase in the number of cystic follicles and a decrease in corpora lutea[14].

## Measuring the weights of internal organs

At the end of the experimental period, the animals were anaesthetic and then sacrificed humanely in accordance with the approved ethical guidelines. After that, the abdominal and thoracic cavities were carefully opened to extract the internal organs, which included the liver, heart, lungs, uterus, spleen and adrenal glands [15]. The excised organs were washed with a physiological saline solution (0.9% NaCl) to remove blood and tissue remnants, then gently dried using filter paper to remove surface moisture without damaging the tissues. Each organ was weighed separately using a sensitive electronic scale (Analytical balance) with an accuracy of up to 0.001 grams, and the weights were recorded in grams.For comparison purposes, the relative weight of each organ was calculated using the following equation:

Relative weight of the organ (%) = (Weight of the organ / Total body weight of the animal) × 100 [16].

## Measuring hormones in serum

Blood samples were collected from the rats at the end of the experiment after anaesthesia, by drawing blood from the vein . The samples were placed in tubes free of anticoagulants, then left to clot at room temperature for 20–30 min. After that, the serum was separated by centrifuge at 3000 rpm for 10–15 minutes [14].The serum was collected and stored in Endorphin tubes at a temperature of -20 degrees Celsius until hormonal analyses were conducted. The concentrations of the following hormones were measured:FSH (Follicle-Stimulating Hormone), LH (Luteinizing Hormone), Oestrogen, Prolactin, and TSH (thyroid-stimulating hormone), And this is done using the enzyme-linked immunodeficient assay (ELISA) technique according to the manufacturer's instructions for the test kit.This technique relies on the interaction of antibodies with the target hormone, where the intensity of the resulting colour is measured using an ELISA Reader at an appropriate wavelength, and the absorbance intensity is directly proportional to the hormone concentration in the sample[15].

## Statistical analysis

Use the Tuky test to indicate the difference between the eight groups at the level $P \leq 0.01$ [16].

## Results

Indicate the results table 1 shows that mice treated with liver, heart, lung, uterine,

spleen, and adrenal gland treatments showed notable variations in the weight growth of internal organs (G2, G3, G4, G5, G6 and G7) and weight of heart was 0.233, 0.242, 0.236 and 0.256g, respectively, compared to G1 0.206g, and weight of heart (0.205±0.03g), and weight of liver was 2.334, 2.346, 2.354 and 2.346g, respectively, compared to G1 1.654g. and weight the lungs 0.546, 0.546, 0.574, 0.582, 0.554, 0.567 and 0.586g respectively compared to G10.435g and uterus (0.082, 0.086, 0.087, 0.091, 0.092 and 0.093g respectively) compared to G1 (0.095g) adrenal gland weight increase (0.046, 0.047, 0.049, 0.054, 0.064 and 0.074g, respectively) compared to G1 (0.056g) Spleen significant weight increase 0.089, 0.082, 0.098, 0.095 and 0.92g respectively compared to G1 0.092g.

**Table 1: Effect of soybeans on the internal organ weights in female rats**

| Mean ±SD | | | | | | |
|---|---|---|---|---|---|---|
| Groups | liver | heart | lungs | Uterus | spleen | adrenal glands |
| G1 | 1.654±0.132$^{a}$ | 0.206±0.106$^{a}$ | 0.435±0.093$^{a}$ | 0.095±0.132$^{a}$ | 0.092±0.135$^{a}$ | 0.056±0.154$^{ab}$ |
| G2 | 2.334±.0.231$^{ab}$ | 0.225±0.123$^{b}$ | 0.546±0.132$^{b}$ | 0.082±0.154$^{b}$ | 0.089±0.147$^{b}$ | 0.046±0.164$^{a}$ |
| G3 | 2.346±0.196$^{b}$ | 0.233±0.143$^{a}$ | 0.574±0.324$^{ab}$ | 0.086±0.164$^{ab}$ | 0.085±0.164$^{ab}$ | 0.047±0.165$^{b}$ |
| G4 | 2.354±0.243$^{a}$ | 0.242±0.132$^{ab}$ | 0.582±0.165$^{b}$ | 0.087±0.145$^{a}$ | 0.082±0.185$^{b}$ | 0.049±0.134$^{ab}$ |
| G5 | 2.346±0.143$^{c}$ | 0.236±0.142 | 0.554±0.134$^{d}$ | 0.091±0.123$^{a}$ | 0.098±0.232$^{d}$ | 0.054±0.245$^{d}$ |
| G6 | 2.366±0.134$^{b}$ | 0.256±0.132 | 0.567±0.243$^{c}$ | 0.092±0.135$^{c}$ | 0.095±0.183$^{c}$ | 0.064±0.221$^{c}$ |
| G7 | 2.371±0.243$^{b}$ | 0.264±0.146$^{a}$ | 0.586±0.245$^{b}$ | 0.093±0.147$^{b}$ | 0.092±0.253$^{a}$ | 0.074±0.246$^{a}$ |
| G8 | 2.388±0.213$^{ab}$ | 0.299±0.143$^{ab}$ | 0.611±0.263$^{ab}$ | 0.089±0.123$^{ab}$ | 0.083±0.242$^{ab}$ | 0.092±0.232$^{ab}$ |
| P≤ 0.01 | ** | ** | ** | ** | ** | ** |

The sex hormones estrogen, FSH, LH, TSH and prolactin significantly increased in the treated groups, according to the results in table 2. G2, G3, G4, G5, G6, and G7 for estrogen exhibit a notable rise

with an average (112, 119, 122, 126, 128, and 130 ng/mL) compared to the control group G1 (109.54 ng/mL).the FSH hormone was an average of 123.64, 127.65, 129.64, 129.64,133.65 , 135.54, and 137.75 mIU/mL, respectively, compared to the control group (G1: 106.54 mIU/mL). LH indicates a significant increase was average (101.65, 102.97, 103.25, 105.98, 109.65, and 11.54 mIU/mL, respectively) compared to G1 (99.56±0.54 mIU/mL). , TSH indicates a significant increase was average (0.007±0.35, 0.009±0.53, 0.011±0.84, 0.012±0.34, and 0.013, 0.015 mIU/mL), respectively, compared to the G1 0.005 mIU/mL and prolactin indicate a significant increase was average (6.46, 6.46, 7.75, 8.56, 8.76, 9.09, and 9.94 ng/mL), respectively, compared to the G1 5.65 ng/mL.

**Table 2:** Effect of flax seeds on the Reproductive Hormones in female rats

| Mean ±SD | | | | | |
|---|---|---|---|---|---|
| Groups | FSH mIU/mL | Estrogen pg/mL | TSH mIU/mL | LH mIU/mL | Prolactin ng/mL |
| G1 | 106.54±0.53$^{a}$ | 109.54±0.32$^{a}$ | 0.005±0.65$^{a}$ | 99.56±0.14$^{a}$ | 5.65±0.15$^{ab}$ |
| G2 | 123.64±.0.73$^{ab}$ | 112.52±0.76$^{b}$ | 0.007±0.35$^{b}$ | 101.56±0.16$^{b}$ | 6.46±0.26$^{a}$ |
| G3 | 127.65±0.63$^{b}$ | 119.63±0.45$^{a}$ | 0.009±0.53$^{ab}$ | 102.97±0.26$^{ab}$ | 7.75±0.35$^{b}$ |
| G4 | 129.64 ±0.73$^{a}$ | 122.28±0.64$^{ab}$ | 0.011±0.84$^{b}$ | 103.25±0.36$^{a}$ | 8.56±0.44$^{ab}$ |
| G5 | 133.65 ±0.46$^{b}$ | 126.43±0.43$^{a}$ | 0.012±0.34$^{ab}$ | 105.98±0.37$^{b}$ | 8.76±0.56$^{a}$ |
| G6 | 135.54±0.36$^{a}$ | 128.63±0.35$^{b}$ | 0.013±0.28$^{b}$ | 109.65±0.44$^{b}$ | 9.09±0.63$^{a}$ |
| G7 | 137.75±0.14$^{a}$ | 130.64±0.46$^{a}$ | 0.015±0.35$^{a}$ | 111.54±0.56$^{a}$ | 9.94±0.74$^{b}$ |
| G8 | 142.54±0.23 | 135.34±0.49 | 0.018±0.44 | 119.23±0.68 | 10.34±0.85 |
| P≤ 0.01 | ** | ** | ** | ** | ** |

## Discussion

The results of this study indicate that the combined treatment with flax seed and soybean extracts at a concentration of 200 mg/kg produced a clear synergistic effect on the weights of internal organs (liver, heart, lungs) compared to the individual treatments [17]. This effect is likely due to the active biological properties of both extracts, as flax seed contains lignans and antioxidants, while soybeans are a rich source of isoflavones with estrogen-like activity[18]. This integration may contribute to reducing oxidative stress and improving metabolic functions, which positively reflects on tissue integrity and prevents hypertrophy or atrophy in organs. Regarding the liver, the improvement in its weight may indicate a reduction in fat accumulation or inflammation associated with metabolic disorders common in cases of poly cystic ovary syndrome. As for the heart and lungs, the effect may be due to the overall improvement in circulation and the reduction of the negative impacts of hormonal imbalance [19].

As for the level of sex hormones, the synergistic treatment showed a significant regulation in FSH and LH levels, indicating the restoration of balance in the hypothetical-pituitary-ovarian axis. The increase or modification in oestrogen levels may be due to the phytoestrogenic effect of isoflavones and lignans, which bind to oestrogen receptors and enhance hormonal function [20].

Regarding prolactin, a decrease in its level may reflect an improvement in pituitary gland function, while TSH regulation indicates an indirect effect on the thyroid gland, which may be related to an overall improvement in metabolic condition[21].

It is important to note that the synergistic effect surpasses the individual effects of each extract, supporting the idea that combining plant compounds with different mechanisms can lead to better therapeutic outcomes, especially in complex cases like poly cystic ovary syndrome [22].

## Conclusion

Further research is recommended to determine the optimal dosages, understand the precise biological mechanisms causing this effect, and assess long-term safety. The application of a 200% concentration of flax act may be useful in affecting the physiological state and hormonal efficiency of rats, it can be concluded.

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