

## Review Article

# Flaxseeds and their Role in Polycystic Ovary Syndrome Treatment

C Jyothika<sup>1</sup>, T Raja<sup>2</sup>

<sup>1,2</sup>Arulmigu Kalasalingam College of Pharmacy, India.

## I N F O

**Corresponding Author:**

C Jyothika, Arulmigu Kalasalingam College of Pharmacy, India

**E-mail Id:** Chillapalijyoti100@gmail.com

**How to cite this article:**

Jyothika C, Raja T. Flaxseeds and Their Role in Polycystic Ovary Syndrome Treatment. J Adv Res in medc che 2024; 6(1): 26-31.

Date of Submission: 2024-04-19

Date of Acceptance: 2024-05-23

## A B S T R A C T

Polycystic Ovary Syndrome (PCOS) is an endocrine disorder predominantly affecting women of reproductive age. The clinical presentation of PCOS is highly varied and complex, involving irregular menstrual cycles, elevated androgen levels, and the presence of polycystic ovaries with enlarged follicles, which can result in infertility, endometrial cancer, and other related conditions. PCOS may also be characterized by thinning scalp hair and baldness, excessive hair growth on the face and other body parts (similar to male patterns), obesity, acne, and darkened skin patches on the neck, under the breasts, and in the groin area. Currently, there is no specific and effective treatment for PCOS, and medications can sometimes cause adverse effects or be contraindicated. Consequently, non-pharmacological therapies, such as nutritional supplements, herbal remedies, and other complementary treatments, are becoming increasingly important for managing PCOS. Flaxseed, a plant-based source known as one of the “superfoods,” is the richest dietary source of lignans and is high in  $\alpha$ -linolenic acid and omega-3 fatty acids. These nutrients offer potential health benefits, including reducing the risk of diabetes, cardiovascular diseases, cancer, and neurological disorders. This review highlights the beneficial properties of flaxseed, a remarkable functional food with numerous health advantages.

**Keywords:** Polycystic Ovary Syndrome, Oligomenorrhea, Hyperandrogenemia, polycystic ovaries, Herbal medicine, Complementary therapies, Flaxseed

## Introduction

Polycystic Ovary Syndrome (PCOS) is an endocrine disorder primarily affecting women of reproductive age<sup>1</sup>. The incidence of PCOS varies with age, and as reported by the Times of India in September 2022, it affects women aged 15-49 years. Globally, PCOS affects 4-20% (8-40 crore) of women, while in India, it affects 3.7% to 22.5% (1.3-7.9 crore) of women.

Elevated levels of male sex hormones, or androgens, are considered the primary cause of PCOS in females. Factors such as insulin resistance, low-grade inflammation, and heredity contribute to PCOS by increasing androgen secretion. The clinical manifestations of PCOS are complex and diverse, including 1. Irregular ovulation and menstrual dysfunction resulting in oligomenorrhea; 2. Hyperandrogenemia, leading to hirsutism, acne, and alopecia; 3. Polycystic ovaries with enlarged follicles, which

can result in infertility, endometrial cancer, and other associated diseases<sup>2,3</sup>. Additionally, Escobar-Morreale et al. (2018) noted that PCOS patients often experience serious reproductive dysfunctions, such as infertility and pregnancy-related complications<sup>4</sup>, while Hart (2008) reported issues with metabolic functions, including insulin resistance and type-2 diabetes, as well as psychological disorders like anxiety and depression<sup>5</sup>. Individuals affected by PCOS often exhibit symptoms and signs during late adolescence or early adulthood. These symptoms may include thinning scalp hair and baldness, excessive hair growth on the face and other areas typically seen in males, obesity, acne, and darkened skin on the neck, under the breasts, and in the groin areas. Currently, there is no specific and effective treatment for PCOS. Despite advancements in diagnosing, interpreting, and treating various critical human diseases and disorders, the understanding of PCOS diagnosis and treatment remains incomplete<sup>6</sup> and inconsistent among health professionals<sup>7</sup>.

At present, the treatment for PCOS is primarily symptomatic, involving lifestyle interventions and medications such as Metformin, Clomiphene, oral contraceptives, and antiandrogens<sup>8</sup>. However, these treatments often have limitations. This is likely because the etiology of PCOS is multifactorial, and no single treatment can address all the effects simultaneously. Moreover, some medications may be contraindicated for certain patients, causing adverse effects or proving ineffective<sup>9</sup>. As a result, non-pharmacological therapeutic modalities, including nutritional supplements, herbal remedies, and other complementary therapies, are becoming increasingly important in managing PCOS. It is well documented that nearly half of women with PCOS are obese, and thus, treatment often begins with weight loss through dietary restrictions<sup>10</sup> aimed at normalizing hormonal levels and reducing clinical symptoms<sup>11,12,13</sup>. Adlercreutz et al. (1987) and Monroe et al. (2007) reported that a high-fiber diet can alter the hormonal environment, potentially helping to normalize hormonal imbalances in PCOS patients. Adlercreutz et al. (1987) suggested that diets high in lignin can reduce levels of free circulating testosterone by binding testosterone in the enterohepatic circulation, facilitating its excretion. Additionally, Evans et al. (1995) found that lignin prevents the production of the enzyme 5  $\alpha$ -reductase, which is responsible for converting testosterone into dihydrotestosterone, a potent and biologically active form of testosterone.

Flaxseed is the richest source of dietary lignin, containing levels 800 times higher than other food ingredients<sup>14</sup>. It is recommended for normalizing excess male hormones in PCOS patients. Additionally, flaxseed is rich in  $\alpha$ -linolenic acid and omega-3 fatty acids, offering potential health benefits such as reducing the risk of diabetes, cardiovascular

diseases, cancer, and neurological disorders. Flaxseed is used as a functional food ingredient in milk and dairy products, juices, baked goods, and more. This review highlights the numerous health benefits of flaxseed, a remarkable functional food.

## Flaxseed: A Remarkable Superfood

The flaxseed plant, cultivated for over 7000 years in temperate regions of Europe and Asia<sup>15</sup>, bears the Latin name *Linum usitatissimum*, meaning "very useful"<sup>16</sup>. It is commercially valuable, with its stem providing high-quality fiber known as linen, its seeds used for producing flaxseed oil, and its by-products utilized in animal feed<sup>17</sup>. Recently recognized as a "superfood" due to its health benefits, flaxseed is rich in  $\alpha$ -Linolenic Acid (ALA), soluble fiber, Omega-3 essential oils, lignans like Secoisolariciresinol diglucoside (SDG), vitamins, and minerals (Anjum et al., 2013). It also contains higher levels of polyunsaturated fatty acids (PUFA) and lower levels of saturated fatty acids. The significant ALA content in flaxseed is beneficial for infant brain development, reducing blood lipids, and preventing cardiovascular diseases<sup>18</sup>.

Commercially, every part of the flaxseed plant finds use either directly or after processing. Incorporating flaxseed into the diet has been shown to help prevent serious diseases such as coronary diseases, cancer, diabetes, obesity, and disorders affecting the gastrointestinal tract, kidneys, and bones.

## Nutritional Facts of Flax Seeds

### Bioavailability of Flax Seeds

The plant lignans in the flax seed is converted into enterolignans (enterodiol and enterolactone) in the gastrointestinal tract which are known for pronounced beneficial effects on bone health, prostate health, breast health, menopausal health, hair loss, acne and inflammation. The mean bioavailability of enterolignans from whole flax seeds was seen to be 28% that of ground flax seed and that crushed flax seed to ground was 43 %. Crushing and milling of flax seed substantially improve the bioavailability of the enterolignans says the Journal of Nutrition. When the bioavailability from flaxseed and the physiological effects of its ingestion was examined in clinical populations, flaxseed ingestion (30 g of seed or 6 g of ALA in the oil) over a 1-month period resulted in a significant ( $P = 0.005$ ) increase in plasma alpha-linoleic acid (ALA) levels<sup>(19)</sup>. Another study examined the cardiovascular beneficial effects of dietary flaxseed introduced in the form of ground flaxseed (30 g) or flaxseed oil, all subjects who received flaxseed oil showed a significant increase in plasma ALA and eicosapentaenoic acid (EPA) concentrations.

### Nutritional values of flaxseeds per 1 tablespoon

Nutrient	Amount per 1 tablespoon (10g)
Calories	55
Saturated Fat	0.3g
Polyunsaturated Fat	3g
Monounsaturated Fat	0.8g
Omega-3 Fatty Acids	1.8g
Omega-6 Fatty Acids	0.5g
Total Carbohydrates	3g
Dietary Fiber	2.8g
Sugars	0.2g
Protein	1.9g
<b>Vitamins and Minerals</b>	
Vitamin B1 (Thiamine)	8% DV
Vitamin B6	2% DV
Folate	2% DV
Calcium	2% DV
Iron	2% DV
Magnesium	7% DV
Phosphorus	4% DV
Potassium	2% DV

### Health Benefits of Flax Seeds

Flaxseeds are also known for their high content of antioxidants, lignans, and phytochemicals, which contribute to their health benefits.

#### Flax seeds help in reducing Blood Pressure

Several bioactive compounds found in flaxseed, such as fiber, polyphenols, and omega-3 fatty acids, have the potential to influence blood pressure<sup>20</sup>.

In a study investigating the impact of flaxseed supplementation on body mass index (BMI), blood pressure, and total cholesterol levels among hypertensive patients, significant improvements were observed. After a twelve-week period, there was a reduction of 13.38 units in systolic blood pressure (SBP) and 5.6 units in diastolic blood pressure (DBP). BMI decreased by 0.86 units, and total cholesterol levels decreased by 20.4 units. These findings suggest that flaxseed supplementation may effectively lower blood pressure, reduce total cholesterol, and improve BMI in hypertensive patients<sup>21</sup>.

Another study aimed at evaluating the effects of daily flaxseed intake on systolic (SBP) and diastolic blood pressure

(DBP) in patients with peripheral artery disease found that consuming 30 grams of milled flaxseed daily for six months led to a significant reduction of 15 mm Hg in SBP and 7 mm Hg in DBP<sup>22</sup>.

#### Flaxseed Intake Reduces LDL Cholesterol Levels

Phytosterols present in flaxseeds are recognized for their ability to lower blood cholesterol levels. A randomized controlled clinical trial involving seventy patients was conducted to investigate the effectiveness of flaxseeds in treating hyperlipidemia. The results indicated that total cholesterol levels decreased in the group receiving flaxseed intervention, whereas they increased in the control group. These findings suggest that consuming flaxseed powder can effectively lower serum lipid levels, as demonstrated by this research<sup>23</sup>.

#### Flax seed Supplementation Decreases Blood Glucose and Insulin Levels

Flaxseed has been shown to effectively lower and stabilize blood glucose responses. According to a study published in the European Journal of Nutrition in 2020, consuming 10 grams of flaxseed three times daily was recommended for its effectiveness in reducing and maintaining blood glucose levels over a 24-hour period<sup>24</sup>.

#### iv) Flaxseed Supplementation Helps to Treat Constipation

Constipation is a multifaceted problem with various underlying causes and potential remedies. Regular consumption of dietary fiber found in flax seeds has been observed to alleviate constipation and notably increase stool frequency.

A study conducted in China aimed to assess the impact of flaxseed flour supplementation on functional constipation and quality of life among adult men and women. Following 4 weeks of flaxseed supplementation, participants experiencing constipation showed improvements in bowel habits. Flaxseed flour proved effective in enhancing defecation frequency, improving bowel movements, and enhancing the quality of life in individuals suffering from chronic functional constipation<sup>25</sup>.

#### Flax seeds reduce hunger cravings

Another potential benefit of flax seeds is the satiating and appetite suppressive effects they can have. Flaxseed is rich in two natural appetite suppressants: omega-3 fats and fiber. Fiber from flaxseed can keep us satisfied and full without contributing any calories. A randomized trial stated that when its subjects were given a flax drink after an overnight fast suppresses appetite and energy intake.<sup>26</sup>

#### Beneficial Effects of Flax Seeds on Pcos

Flaxseed stands out as the best, easiest, cheapest, and most beneficial supplement to include in our PCOS diet. A randomized controlled clinical trial investigated the

effects of consuming flaxseed powder (30 grams per day) on metabolic biomarkers in patients with PCOS. The results demonstrated significant improvements in several parameters within the flaxseed group compared to baseline measurements. These improvements included reduced body weight, insulin concentration, Homeostatic Model Assessment of Insulin Resistance (HOMA-IR), triglycerides (TG), high-sensitivity C-reactive protein (hs-CRP), and leptin levels. Additionally, there was an increase in Quantitative Insulin-Sensitivity Check Index (QUICKI), high-density lipoprotein (HDL), and adiponectin levels ( $p < 0.05$ ).

Comparatively, the flaxseed supplementation group also exhibited significant reductions in insulin concentration, HOMA-IR, TG, hs-CRP, interleukin 6 (IL-6), and leptin levels, alongside increases in QUICKI, HDL, and adiponectin levels, when compared to the control group ( $p < 0.05$ ).<sup>27</sup>

**Effects of Flax Seed Powder on Ovarian Morphology in PCOS:**

A study examined the impact of flax seed powder on ovarian morphology in women with PCOS, revealing significant reductions in mean ovarian volume and the number of follicles after flax seed therapy. The reductions in mean right and left ovarian volumes were  $-3.35 \text{ cm}^3$  and  $-2.383 \text{ cm}^3$ , respectively, and the mean differences in the number of follicles were  $-4.259$  and  $-4.519$  for the right and left ovaries, respectively ( $p < 0.01$ ). These findings support the beneficial effects of flax seeds on PCOS<sup>28</sup>.

**Effects of Flaxseed Oil Omega-3 Supplementation on Metabolic Status in PCOS:**

In a randomized double-blind, placebo-controlled trial, flaxseed oil omega-3 fatty acid supplementation was assessed for its effects on the metabolic status of patients with PCOS. After a 12-week intervention, supplementation significantly decreased insulin values ( $-2.6 \pm 7.7$  vs.  $+1.3 \pm 3.9 \mu\text{U/mL}$ ,  $P = 0.01$ ), Homeostasis Model of Assessment-Estimated Insulin Resistance (HOMA-IR) ( $-0.7 \pm 1.7$  vs.  $+0.3 \pm 0.9$ ,  $P = 0.01$ ), and mF-G scores ( $-1.2 \pm 1.7$  vs.  $-0.1 \pm 0.4$ ,  $P = 0.001$ ). It also increased Quantitative Insulin Sensitivity Check Index (QUICKI) ( $+0.01 \pm 0.02$  vs.  $-0.01 \pm 0.02$ ,  $P = 0.01$ ). Furthermore, flaxseed oil omega-3 supplementation led to significant decreases in serum triglycerides ( $-5.1 \pm 20.9$  vs.  $+9.7 \pm 26.1 \text{ mg/dL}$ ,  $P = 0.01$ ), VLDL-cholesterol ( $-1.0 \pm 4.2$  vs.  $+1.9 \pm 5.2 \text{ mg/dL}$ ,  $P = 0.01$ ), and high-sensitivity C-reactive protein (hs-CRP) ( $-1.6 \pm 3.1$  vs.  $+0.2 \pm 1.5 \text{ mg/L}$ ,  $P = 0.004$ ) compared to the placebo<sup>29</sup>.

In a systematic review on herbal remedies for PCOS effectiveness, it was noted that flax seeds contain lignans, secondary metabolites of *Linum* that regulate estrogen production, enhancing fertility rates and menstrual cycle regularity. These lignans also lower androgen levels, significantly reducing elevated testosterone levels in the

blood, which is beneficial in PCOS treatment. Flaxseed is effective in alleviating symptoms like hyperandrogenism and hirsutism associated with PCOS.

Preclinical studies have validated that incorporating flaxseed into the diet decreases androgen levels in female rats, improves corpus luteum formation, and reduces ovarian follicle cysts. Consequently, regular dietary supplementation with flaxseed could notably decrease ovarian volume, reduce follicle size, and regulate menstrual cycle frequency.<sup>30</sup>

## Summary

Flax seeds are rich in essential nutrients and offer numerous health benefits. They are widely accessible and versatile, making them easy to integrate into daily diets. Flax seeds can aid in managing obesity, promoting heart health, lowering blood pressure, and reducing cholesterol and blood sugar levels. For optimal health benefits, it's advisable to consume flax seeds under the guidance of a healthcare provider.

## References

- Gu, Y., Zhou, G., Zhou, F., Wu, Q., Ma, C., Zhang, Y., Ding, J., & Hua, K. (2022). Life Modifications and PCOS: Old Story But New Tales. *Frontiers in endocrinology*, 13, 808898. <https://doi.org/10.3389/fendo.2022.808898>
- Mills, G., Badeghiesh, A., Suarathana, E., Baghlaf, H., & Dahan, M. H. (2020). Associations between polycystic ovary syndrome and adverse obstetric and neonatal outcomes: a population study of 9.1 million births. *Human reproduction (Oxford, England)*, 35(8), 1914–1921. <https://doi.org/10.1093/humrep/deaa144>
- Hardiman, P., Pillay, O. C., & Atiomo, W. (2003). Polycystic ovary syndrome and endometrial carcinoma. *Lancet (London, England)*, 361(9371), 1810–1812. [https://doi.org/10.1016/s0140-6736\(03\)13409-5](https://doi.org/10.1016/s0140-6736(03)13409-5)
- Escobar-Morreale H. F. (2018). Polycystic ovary syndrome: definition, aetiology, diagnosis and treatment. *Nature reviews. Endocrinology*, 14(5), 270–284. <https://doi.org/10.1038/nrendo.2018.24>
- Hart R. (2008). PCOS and infertility. *Panminerva medica*, 50(4), 305–314.
- Dokras, A., Saini, S., Gibson-Helm, M., Schulkin, J., Cooney, L., & Teede, H. (2017). Gaps in knowledge among physicians regarding diagnostic criteria and management of polycystic ovary syndrome. *Fertility and sterility*, 107(6), 1380–1386.e1. <https://doi.org/10.1016/j.fertnstert.2017.04.011>
- Islam, H., Masud, J., Islam, Y. N., & Haque, F. K. M. (2022). An update on polycystic ovary syndrome: A review of the current state of knowledge in diagnosis, genetic etiology, and emerging treatment options. *Women's health (London, England)*, 18, 17455057221117966.



- <https://doi.org/10.1177/17455057221117966>
8. Rashid, R., Mir, S. A., Kareem, O., Ali, T., Ara, R., Malik, A., Amin, F., & Bader, G. N. (2022). Polycystic ovarian syndrome-current pharmacotherapy and clinical implications. *Taiwanese journal of obstetrics & gynecology*, 61(1), 40–50. <https://doi.org/10.1016/j.tjog.2021.11.009>
  9. Speelman D. L. (2019). Nonpharmacologic Management of Symptoms in Females With Polycystic Ovary Syndrome: A Narrative Review. *The Journal of the American Osteopathic Association*, 119(1), 25–39. <https://doi.org/10.7556/jaoa.2019.006>
  10. Nowak, D. A., Snyder, D. C., Brown, A. J., & Demark-Wahnefried, W. (2007). The Effect of Flaxseed Supplementation on Hormonal Levels Associated with Polycystic Ovarian Syndrome: A Case Study. *Current topics in nutraceutical research*, 5(4), 177–181.
  11. Gambineri, A., Pelusi, C., Vicennati, V., Pagotto, U., & Pasquali, R. (2002). Obesity and the polycystic ovary syndrome. *International journal of obesity and related metabolic disorders : journal of the International Association for the Study of Obesity*, 26(7), 883–896. <https://doi.org/10.1038/sj.ijo.0801994>
  12. Marshall K. (2001). Polycystic ovary syndrome: clinical considerations. *Alternative medicine review : a journal of clinical therapeutic*, 6(3), 272–292.
  13. King J. (2006). Polycystic ovary syndrome. *Journal of midwifery & women's health*, 51(6), 415–422. <https://doi.org/10.1016/j.jmwh.2006.01.008>
  14. Thompson, LU. Flaxseed, lignans, and cancer. In: Cunnane, SC.; Thompson, LU., editors. *Flaxseed in human nutrition*. Chicago, IL: AOCs Press; 1995. p. 219-236.
  15. Al-Nawass KJ, 2015. Effect of different levels of golden flaxseed (*Linum usitatissimum* L.) powder on some blood biochemical quality of male and female broiler. *Res. Opin. Anim. Vet. Sci.*, 5(11): 425-428
  16. Goyal, A., Sharma, V., Upadhyay, N., Gill, S., & Sihag, M. (2014). Flax and flaxseed oil: an ancient medicine & modern functional food. *Journal of food science and technology*, 51(9), 1633–1653. <https://doi.org/10.1007/s13197-013-1247-9>
  17. Singh, K. K., Mridula, D., Rehal, J., & Barnwal, P. (2011). Flaxseed: a potential source of food, feed and fiber. *Critical reviews in food science and nutrition*, 51(3), 210–222. <https://doi.org/10.1080/10408390903537241>
  18. Soni R P, Katoch M, Kumar A, Verma P, Flaxseed: composition and its health benefits. *Res Environ Life Sci.* 2016;9:310-16.
  19. Austria, J. A., Richard, M. N., Chahine, M. N., Edel, A. L., Malcolmson, L. J., Dupasquier, C. M., & Pierce, G. N. (2008). Bioavailability of alpha-linolenic acid in subjects after ingestion of three different forms of flaxseed. *Journal of the American College of Nutrition*, 27(2), 214–221
  20. Haidari, F., Banaei-Jahromi, N., Zakerkish, M., & Ahmadi, K. (2020). The effects of flaxseed supplementation on metabolic status in women with polycystic ovary syndrome: a randomized open-labeled controlled clinical trial. *Nutrition journal*, 19(1), 8. <https://doi.org/10.1186/s12937-020-0524-5>
  21. Toulabi, T., Yarahmadi, M., Goudarzi, F., Ebrahimzadeh, F., Momenizadeh, A., & Yarahmadi, S. (2022). Effects of flaxseed on blood pressure, body mass index, and total cholesterol in hypertensive patients: A randomized clinical trial. *Explore (New York, N.Y.)*, 18(4), 438–445. <https://doi.org/10.1016/j.explore.2021.05.003>
  22. Rodriguez-Leyva, D., Weighell, W., Edel, A. L., LaVallee, R., Dibrov, E., Pinneker, R., Maddaford, T. G., Ramjiawan, B., Aliani, M., Guzman, R., & Pierce, G. N. (2013). Potent antihypertensive action of dietary flaxseed in hypertensive patients. *Hypertension (Dallas, Tex. : 1979)*, 62(6), 1081–1089. <https://doi.org/10.1161/HYPERTENSIONAHA.113.02094>
  23. Torkan, M., Entezari, M. H., & Siavash, M. (2015). Effect of flaxseed on blood lipid level in hyperlipidemic patients. *Reviews on recent clinical trials*, 10(1), 61–67. <https://doi.org/10.2174/1574887110666150121154334>
  24. Almehmadi, A., Lightowler, H., Chohan, M., & Clegg, M. E. (2021). The effect of a split portion of flaxseed on 24-h blood glucose response. *European journal of nutrition*, 60(3), 1363–1373. <https://doi.org/10.1007/s00394-020-02333-x>
  25. Sun, J., Bai, H., Ma, J., Zhang, R., Xie, H., Zhang, Y., Guo, M., & Yao, J. (2020). Effects of flaxseed supplementation on functional constipation and quality of life in a Chinese population: A randomized trial. *Asia Pacific journal of clinical nutrition*, 29(1), 61–67. [https://doi.org/10.6133/apjcn.202003\\_29\(1\).0009](https://doi.org/10.6133/apjcn.202003_29(1).0009)
  26. Ibrügger, S., Kristensen, M., Mikkelsen, M. S., & Astrup, A. (2012). Flaxseed dietary fiber supplements for suppression of appetite and food intake. *Appetite*, 58(2), 490–495. <https://doi.org/10.1016/j.appet.2011.12.024>
  27. Haidari, F., Banaei-Jahromi, N., Zakerkish, M., & Ahmadi, K. (2020). The effects of flaxseed supplementation on metabolic status in women with polycystic ovary syndrome: a randomized open-labeled controlled clinical trial. *Nutrition journal*, 19(1), 8. <https://doi.org/10.1186/s12937-020-0524-5>
  28. Fatima Farzana K1, Abubacker Sulaiman F2, Ruckmani A\*1, Vijayalakshmi K3, Karunya Lakshmi G2, Shri Ranjini S2, Duraivel M1. Effects of Flax Seeds Supplementation in PolyCystic Ovarian Syndrome *Int. J. Pharm. Sci. Rev. Res.* 2015; 31:113-119

29. Mirmasoumi, G., Fazilati, M., Foroozanfard, F., Vahedpoor, Z., Mahmoodi, S., Taghizadeh, M., Esfeh, N. K., Mohseni, M., Karbassizadeh, H., & Asemi, Z. (2018). The Effects of Flaxseed Oil Omega-3 Fatty Acids Supplementation on Metabolic Status of Patients with Polycystic Ovary Syndrome: A Randomized, Double-Blind, Placebo-Controlled Trial. *Experimental and clinical endocrinology & diabetes : official journal, German Society of Endocrinology [and] German Diabetes Association*, 126(4), 222–228. <https://doi.org/10.1055/s-0043-119751>
  30. Lakshmi, J. N., Babu, A. N., Kiran, S. S. M., Nori, L. P., Hassan, N., Ashames, A., Bhandare, R. R., & Shaik, A. B. (2023). Herbs as a Source for the Treatment of Polycystic Ovarian Syndrome: A Systematic Review. *Biotech (Basel (Switzerland))*, 12(1), 4. <https://doi.org/10.3390/biotech12010004>
-